Supported by INTELLIGENT ENERGY EUROPE

BUILD UP SKILLS

ENERGY TRAINING FOR BUILDERS

Status Quo 2012

Final version, June 15 2012

for Danish energy policy, energy consumption, and vocational education for the construction sector

Colophon

Project coordinator:
Charlotte Vartou Forsingdal
Danish Energy Agency
Amaliegade 44
1256 Copenhagen K

Project manager
Vagn Holk Lauridsen
Danish Technological Institute
Gregersenvej 1
2630 Taastrup

Text and data collection:

Charlotte Vartou Forsingdal, Danish Energy Agency
Jesper Kragh, Danish Building Research Institute
Søren Aggerholm, Danish Building Research Institute
Karsten Frøhlich Hougaard, Danish Technological Institute
Karabi Bergmann, Danish Technological Institute
Vagn Holk Lauridsen, Danish Technological Institute
Kai Borggreen, Danish Technological Institute
Pia Bodal, KommunikationsKompagniet
Ulrik Ryssel Albertsen, KommunikationsKompagniet

Thanks to all of the stakeholder contributors (see annex 1).

Financing
The report is financed by the EU programme Intelligent Energy Europe – IEE.

Published:
May 2012. Reprinting permitted with credit to the source.

Contents

Foreword

Build Up Skills Denmark is the Danish contribution to an EU project currently being carried out across 22 European nations. Additional nations will be joining the project in the course of 2012. The project is part of the Intelligent Energy – Europe (IEEE) program, which supports energy optimisation and the use of renewable energy in European Member States. Build Up Skills focuses on the competence levels of the workforce in the construction sector. The project is divided into two pillars:

- Pillar 1 is currently underway: National mapping and roadmap
- Pillar 2 will start in April 2013: Development of education programmes and modules

This national report is the first phase of Pillar 1 in Denmark. The goal is to map the following:

- Existing course and educational programme offers concerning energy efficient new construction and renovation
- The potential for energy improvements in the Danish building stock
- Current Danish policy and strategies for energy efficient construction and renewable energy
- Current Danish policy and strategies for green competences and green jobs
- Education requirements by the year 2020 in the light of the contribution needed from the construction industry to meet the Danish 2020 goals for energy efficiency and use of renewable energy
- Barriers to upskilling the workforce

The results of mapping will form the point of departure for the second phase of Pillar 1, which will then identify the gaps between current education offers and the needs for education and training so that energy optimisation in buildings can contribute as specified to the 2020 goals. The results from Pillar 1 will subsequently form the basis for Pillar 2.

Overall, upskilling of persons working in the construction industry is to contribute to reaching Denmark's and the EU's goals for increased use of renewable energy in buildings.

The Danish Build Up Skills project is being carried out by a consortium of the Danish Energy Agency (coordinator), Danish Technological Institute (project manager), the Danish Building Research Institute, and KommunikationsKompagniet A/S. The consortium was assembled in April 2011 with support from DS Håndværk og Industri (DS Trade and Industry), Tekniq (The Danish Mechanical and Electrical Contractors' Association), Dansk Byggeri (The Danish Construction Association), and the Danish Business Authority (at that time called the Danish Business and Building Authority), after which a national EU application was prepared.

The project is supported by a steering committee which acts as a sparring partner and advisor for the consortium, and by an organisation of relevant stakeholders in the construction and education sectors. More information: www.buildupskills.dk (the website is currently in Danish only).

Summary

Objectives
Energy consumption in buildings accounts for about 40% of the energy consumed in the EU as a whole. Energy optimisation and the use of renewable energy in buildings are thus crucial if the EU 2020 goals are to be reached. The EU 2020 goals include 20% less CO2 emission, 20% renewable energy, and a 20% reduction in energy consumption.

If the construction sector is to play a decisive role in reaching the 2020 goals, then its workforce must have the proper competences in energy efficiency and renewable energy. This is why the EU has launched the Build Up Skills project across Member States.

The purpose of Build Up Skills Denmark is to develop a national roadmap for vocational education, academy profession higher education, professional bachelor programmes, and continuing and further education for the workforce in construction, in order to strengthen competences in energy efficiency and renewable energy in buildings. In this way the Build Up Skills initiative can contribute to Denmark's part in reaching EU's overall 2020 goals.

This report provides an overview of the size of Denmark's heated building stock and its energy consumption for heating. The report also presents current upper secondary vocational education programmes and adult continuing education and training offers that target energy optimisation of the building stock. This status quo provides the basis for examining the extent of necessary future energy saving measures and the competence needs of the workforce in order to reach the 2020 goals. The status quo report can thus ensure a solid basis for drawing up the national roadmap that will follow in the next phases of Pillar 1. **More information can be found in the foreword and in chapter 1.**

Method
The goal of the Danish Government's 2012 Energy Agreement is a 7% reduction in gross energy consumption by 2020 compared with energy use in 2010. For the purposes of this report, this goal is seen as a corresponding reduction in the energy consumption for heating the building stock. If the goal of the Energy Agreement is reached, then Denmark will also fulfil its obligations regarding EU's 2020 goals.

With this as a point of departure, two scenarios have been set for the extent of annual energy saving initiatives within the building stock from 2015 to 2020. The positive scenario (A) assumes factors that will reduce the extent of necessary initiatives; a negative scenario (B) assumes factors that increase the extent of necessary initiatives. A range of typical, overall energy saving initiatives are used, mainly based on the energy solutions prepared by the Danish Knowledge Centre for Energy Savings in Buildings. **Further information on the methodological basis for the calculation of energy consumption can be found in chapters 2 and 4.**

The presentation of relevant education programmes focuses on the education and training of craftsmen for the construction sector workforce. The presentation of each programme includes its competence outcomes that are relevant for reducing energy use and for renewable energy, and the subjects that support these outcomes. The outcomes and the goals have been defined by the secretaries of the national trade committees. The report includes a few medium-cycle tertiary programmes that are relevant for workforce competences in the construction sector. In addition, the report presents a snapshot of the supply of relevant continuing and further education and training, with focus on adult vocational training (AMU) offers. **Further information on the methodological basis for the presentation of education programmes can be found in chapters 2 and 6.**

Characteristics of the construction sector
The construction sector in Denmark is made up of approximately 33,000 enterprises. The great majority are one-man enterprises or have fewer than 10 employees. The sector is very important for Danish economy; in 2010 its net value added was DKK 64 billion, and it employed over 150,000 people. One of its greatest challenges is its level of productivity, which has been falling since 2000. The premise of the potential for improved productivity and efficiency is central to the assessment of the extent of educational shortcomings and needs in the workforce by 2010. **Further information about the characteristics of the construction sector and sector employment can be found in chapter 3 and section 5.8.**

The building stock and energy consumption
The heated building stock in Denmark is composed of approximately 2.6 million constructions; around 60% of the total floor area is used for housing. The rest is used for trade, services, and other commercial activities. A large portion of the building stock was built before 1930 and between 1961 and 1972. Only a tiny fraction (around 1%) of the total area is classified as protected or worthy of preservation. The presentation of the building stock's energy consumption focuses on building envelopes and insulation characteristics, and on exterior windows, doors, and roof windows. In addition, data are presented for gas- and oil-fired heating installations and heat exchangers for district heating.

About 46% of the building stock has less than 200 mm of roof and loft insulation, which indicates an important potential for re-insulation. In addition, 50% of the building stock has poor exterior wall insulation. Re-insulation here, however, is often complicated by technical and architectural circumstances.

The presentation of the building stock's exterior windows and doors and roof windows shows that only about 40% use thermal glass. The remaining 60% have a U-factor of more than 2, which indicates that the replacement of older panes can greatly reduce energy consumption.

The Danish building stock contains around 70,000 gas-fired and 160,000 oil-fired furnaces with poor energy efficiency, and around 150,000 heat exchange units for district heating with a relatively large heat loss. The recent Danish Energy Agreement supports the replacement of oil and natural gas furnaces in existing construction with heating based on renewable energy. **More information on the building stock and its energy consumption can be found in chapter 5.**

Current education programmes for the construction sector
Upper secondary vocational education (EUD) in Denmark is offered and quality controlled by the Ministry of Children and Education (formerly the Ministry of Education) together with the national trade committees, who are responsible for monitoring and dimensioning. The most important EUD programmes for energy optimisation of buildings are: property maintenance technician, electrician, energy technician, glazier, bricklayer, chimney sweep, carpenter/joiner, concreter, technical insulator, woodwork construction, and plumbing, heat and air conditioning energy. The individual programmes are very varied as to whether energy optimisation is a competence goal or not. The concreter programme does not include energy optimisation as a competence goal, but all of the electrician programmes do.

The report details the above education programmes. Apart from the education programmes in question there are a number of other VET education programmes dealing with energy optimisation and which will become part of the future work with the Build Up Skills Denmark project

The tertiary education programmes included that are relevant to the Build Up Skills project are installations technology, architectural technology and construction management, and energy technology.

The majority of adult continuing training programmes for the construction sector workforce are offered by the adult vocational training system (AMU). There are some private suppliers, and producers of construction materials also play a role in continuing education and training by offering product-specific courses. All three groups have for some years seen an increasing demand for courses in energy optimisation and green energy. **More information on current education programmes can be found in chapter 6.**

Scenarios for Danish energy saving initiatives and educational shortcomings and needs
In order to evaluate the potential of specific energy saving initiatives, an estimate has been made of the total floor area of poorly insulated lofts, exterior walls, floors, and windows, based on scaling from those constructions that are registered in the Danisn buildings energy labelling database. Similar estimates have been made as to the number of old and outdated heat exchange units for district heating and as to the number of gas fired and oil-fired furnaces.

An estimate has been made of the number of skilled construction craftsmen needed to carry out energy saving initiatives, based on the extent of these initiatives and a hypothesis as to the time needed for individual tasks. Energy-saving initiatives in the optimistic scenario (A) need to result in annual energy savings of 1250 TJ, and in the conservative scenario (B) in annual energy savings of 2650 TJ.

Scenario A requires an additional 3700 construction craftsmen compared to the number currently employed by the construction sector. This is based on the premise that energy consumption for heating already starts to be reduced from 2011-2014, and a stricter construction code for new construction results in a reduction of overall energy consumption for heating. This scenario also incorporates do-it-yourself (DIY) projects and a number of other initiatives. A final premise is a 40% improvement in construction process efficiency.

If there is no assumption of lowered energy consumption for heating or other energy optimising initiatives, DIY is not incorporated, and construction processes are not assumed to be more effective, then an additional 13,100 craftsmen will be needed to reach the 2020 goals.

The projection of the number of extra craftsmen needed is based on the current education offer. It should be emphasised that the educational shortcomings and needs are estimates that must be verified in the next phase of the Build Up Skills project. **More information can be found in chapter 7.**

Barriers

Barriers for reaching the 2020 goals have been identified at a workshop held by the consortium with the participation of representatives from the stakeholder group. The lack of interdisciplinarity in the construction sector is seen as the greatest challenge, presenting itself in several ways:

- There is a general lack of interdisciplinary insight and understanding between craftsmen's trades.
- The construction workforce most often does not have the necessary competences to be able to conceive of a building holistically, and is too narrowly focused on own areas of expertise.
- There is a lack of understanding between consultants and craftsmen, and there are often communication breakdowns that can hinder energy savings.

There are also specific fields within the vocational education programmes that need to be strengthened, for example competences relevant to new renewable energy sources such as solar panels and heat pumps, and greater insight in sealing and the proper positioning of vapour barriers.

The identified barriers indicate that there is currently a range of additional gaps that are not directly related to education content but which are structural or more overarching, such as:

- There will be a lack of well educated manpower to carry out energy improvement initiatives if demand increases in the future.
- There are a number of barriers in the current vocational and continuing education systems for skilled workers. Some are structural, some are economic, and some are based on familiarity and image.
- Many members of the construction workforce are semi-skilled[1] and need their skills upgraded.
- There is a lack of an incentive structure that can stimulate interest in continuing education and training.

It should be emphasised that these barriers were reported by the stakeholders at the workshop. In the next phase of Pillar 1 an attempt will be made to verify them through interviews among a broader segment of stakeholders. **More information about barriers can be found in chapter 8.**

[1] Although there are members of the workforce for the construction sector without upper secondary qualifications, in fact most of these are well-skilled by way of the adult vocational education system (AMU).

1. Introduction

Europe 2020
Europe 2020 is the EU's growth strategy for the next decade. The strategy focuses on advancing an intelligent, sustainable and inclusive economy. These three mutually reinforcing priorities are to help the EU and its Member States to create a high level of employment, productivity, and social cohesion. The EU has set five ambitious goals – for employment, innovation, education, social integration, and climate/energy – which must be met by 2020. Each Member State has set its own national goals in each of these areas. Concrete EU and international initiatives are to support the strategy.

The EU goals for climate/energy are among others:

- A 20% reduction in primary energy consumption by 2020. This is an indicative goal, and there are no compulsory national goals.
- To phase in 20% of renewable energy (RE) in the overall EU energy mix in 2020. This is an overall EU goal, and the base year for comparison is 2005, when the share of RE in total energy consumption was around 8.5%. There is binding burden sharing between the EU Member States. Denmark has committed to a 30% RE share of its energy consumption in 2020. In 2005, Denmark's RE share was 17%.
- A 20% reduction in CO_2 emissions by 2020. The base year for comparison is 1990. The goal is to be met through EU's quota market, ETS (energy trading system), and through Member States' obligations to reduce non-ETS emission by 20%.

From Europe 2020 to Build Up Skills Denmark
Energy consumption in buildings is a major part of the EU's overall energy consumption. Energy optimisation of buildings and the use of renewable energy can play a decisive role in meeting the EU 2020 goals. If the construction industry is to play a crucial role, then its workforce must possess the competences needed for energy optimisation and the use of renewable energy. It is on this background that the EU Commission has launched the Build Up Skills project across Europe.

The objective of Build Up Skills Denmark is to develop a national roadmap for vocational education, academy profession higher education, professional bachelor programmes, and continuing and further education for the construction industry workforce, in order to strengthen competences in energy efficiency and the use of renewable energy in buildings. The Build Up Skills Initiative can contribute to Denmark being able to live up to the overall EU 2020 goals.

Figure 1 shows that Denmark's final energy consumption has grown slightly (around 5%) since 1990, and the distribution of usage has remained more or less unchanged. Energy consumption in buildings (households, trade, and service) has throughout this period been at around 40% of the adjusted consumption.

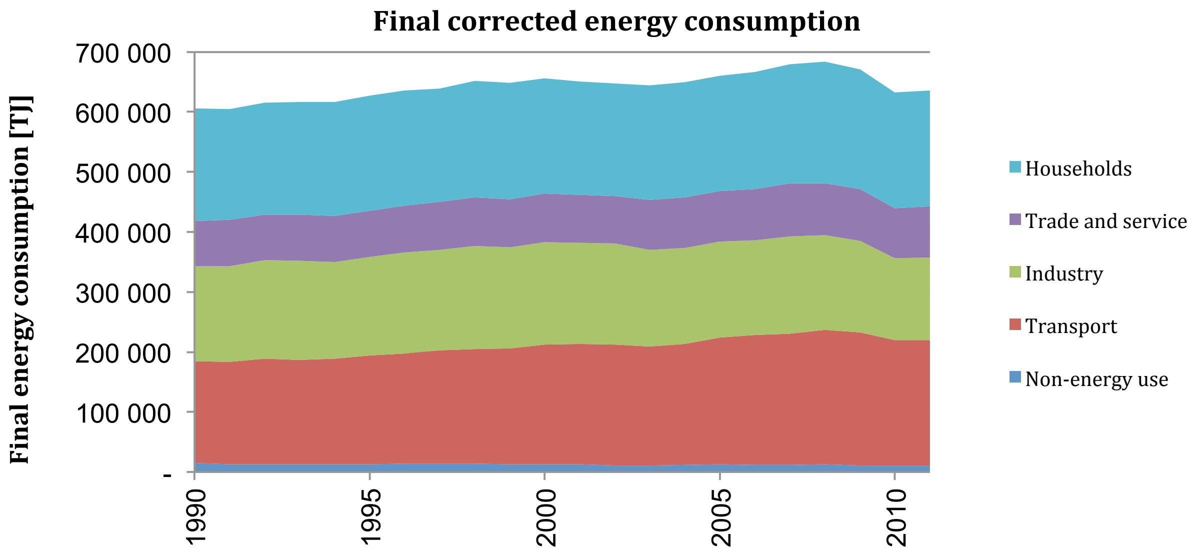

Figure 1: Historical development of the final adjusted energy consumption distributed by usage. Energy consumption for businesses and households does not include energy consumption for transportation.

Since 1990 the total energy consumption for heating has remained more or less constant (around 200-210 PJ/year). This implies that energy renovation in existing buildings is more or less the equivalent of energy consumption in new buildings. Intensified efforts are therefore needed in the existing building stock. This has been taken into account in the current construction code which stipulates re-insulation when replacing and maintaining building elements. Compliance with these stipulations is crucial for the reduction of energy consumption for heating.

This report presents a status quo for parameters in Denmark that can influence whether the 2020 goals can be met or not. The parameters include the size of the building stock and its energy consumption for heating, political energy policy agreements, and upper secondary and adult vocational and continuing education offers related to energy optimisation of the building stock.

If Denmark along with the other EU Member States is to meet the EU 2020 goals, then there is a need for rapid and qualified efforts in the construction sector, which in turn challenges the competences of the construction sector's workforce.

This report has been compiled on the basis of the latest analyses and data from the construction sector regarding energy policy, construction statistics, energy statistics, and relevant vocational education and continuing education programmes. The education analysis focuses on upper secondary vocational education and on adult continuing vocational education and training. There is only sporadic focus on academy profession higher education, professional bachelor programmes, and medium-cycle tertiary programmes, since skilled and semi-skilled workers comprise the great majority of the construction sector's workforce.

The content and structure of this report follow the template used by all of the Member States participating in the Build Up Skills network. This is the English translation of the Danish report.

2. Method

2.1 Methodological premises and limitations

The following section describes the method used to uncover possible educational shortcomings and needs for construction industry craftsmen if the 2020 goals are to be met. Figure 2 presents an overview of this method, which will be further described in this section.

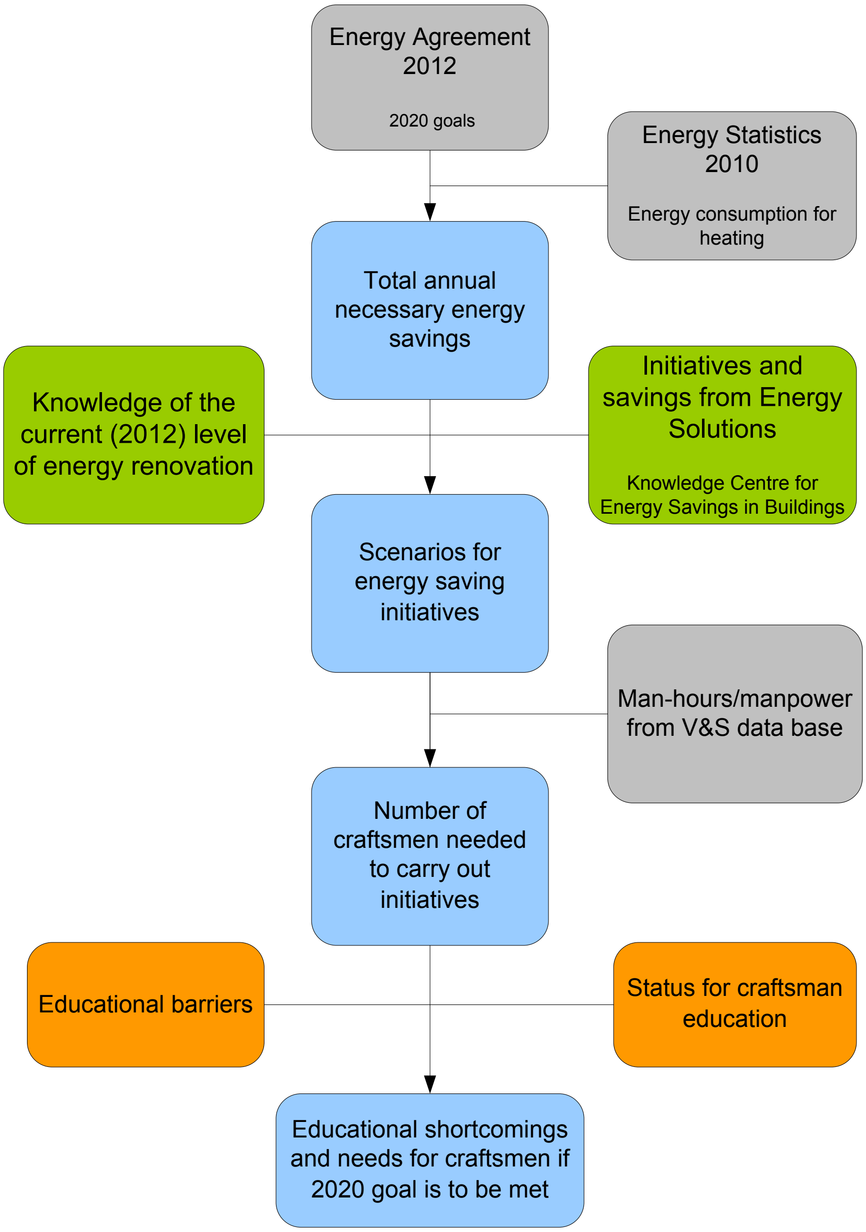

Figure 2: Method employed to assess educational shortcomings and needs for craftsmen if the Energy Agreement 2012 goals are to be met. The V&S database is a price database, see note 17.

The Energy Agreement of 2012 [11] contains a goal of a 7% reduction in climate adjusted gross energy consumption[2] in 2020 compared to 2010. If this goal is reached, then Denmark will have fulfilled all of its obligations to the EU 2020 goal. The Energy Agreement contains no specific goal regarding the reduction of energy consumption for heating. The overall 7% goal has in this report been directly transposed to an equivalent reduction in energy consumption for heating. The status quo report thus takes its point of departure in the following goal:

Energy consumption for heating in 2020 must be 7% less than in 2010
Energy consumption for heating is equivalent to the amount of energy delivered to buildings for the purpose of heating (including hot water). Production and distribution energy loss is not included. In other words, the report does not consider possible energy savings through energy optimisation of production processes for heating. The energy reduction goal is therefore a bit conservative.

The reduction in energy consumption is the difference between projected energy consumption in 2020 and the calculated consumption in 2010 reduced by 7%.

Some energy saving initiatives (such as replacement of pumps and ventilators) result in lower electricity usage. Energy savings from the reduction of electrical usage for household items etc. are not included in the analysis, since its focus is on craftsmen in the construction sector.

Scenarios
The methodology includes two scenarios for assessing energy saving initiatives that will be needed until 2020. The two scenarios are as follows:

Scenario A: the optimistic, which includes positive factors

Scenario B: the conservative, which includes negative factors

Reaching the energy savings goal in both scenarios requires broad and comprehensive efforts targeting re-insulation of building envelopes, replacement of inefficient heating units, and the installation of new renewable energy systems.

2.2 Methodology for the analysis of education programmes

The chapter on education focuses on craftsmen who work in the construction sector. Most of the skilled workers in Denmark have graduated from lower secondary school and have then continued with an upper secondary vocational qualification, possibly supplemented with adult continuing training in a specific field. The education chapter thus starts with a presentation of the vocational education programmes related to trades in the construction industry that most often deal with the construction and operations of low-energy buildings.

[2] Gross energy consumption is adjusted for fuel consumption related to foreign trade in electricity

The choice of programmes presented in the chapter on existing education programmes was made on the basis of the number of students enrolled, i.e. the largest education programmes are included in this report. There has also been an assessment as to which programmes were most important to energy efficient renovation and construction, and the operations of low-energy buildings. This is why a few medium-cycle tertiary programmes are included. The choice of programmes to be examined was made in collaboration with the steering committee and the stakeholder organisation.

A number of skilled craftsmen also enrol in relevant further education programmes that build up competences that they already possess. The most relevant further education programmes are therefore also described in the report. Another large group of craftsmen participate in – or are required to participate in – continuing education programmes in the form of a course or a complete programme in a specific subject area at their current qualification level. In addition, a large share of the construction sector workforce is low-skilled, sometimes with a short-cycle adult vocational qualification or a course from a private supplier. The report therefore also describes continuing education offers.

The description of the individual education levels (vocational, further, and continuing) is drawn up from publicly available information, either via www.uddanelsesguiden.dk or through reference to legislation. Competence outcomes and goals for the tertiary programmes are taken from the education programmes' Ministerial orders. The secretaries for the national trade committees have defined the relevant competence outcomes for green energy and for energy reduction, which are operationalised through subjects in the education programmes. The choice of outcomes is thus not based on a definition.

Courses in continuing education that are relevant to green energy and climate were identified by the Continuing Education Committee for Building, Construction, and Industry, the Service Sector Education Secretariat, and the Continuing Education Committee for Technical Installations and Energy. In addition, the secretaries for the national trade committees have supplemented with additional adult vocational education courses in energy optimisation and energy efficiency.

Suppliers of private courses in energy optimisation have identified relevant courses and have provided figures on the number of participants.

2.3 Methodology for identifying barriers og gaps

Barriers and gaps are identified in section 9, on the basis of discussions in the steering committee and a stakeholder workshop. The barriers and gaps identified in the status quo report are an interim result of work which will continue in the next phase of the analysis.

3. Characteristics of the construction sector

The construction sector has historically been very important for Danish economy. Around 6% of the employed in Denmark are directly employed by the construction sector. To this can be added employment in related sectors such as manufacturing (the construction materials industry) and business services (consultancy). The sector is equally important in financial terms. In 2010 the net value added of the construction sector was DKK 64.3 billion. In comparison, the overall value added of all sectors was DKK 1,220 billion. The Danish construction sector is dominated by micro-enterprises and small- and medium-sized enterprises. The table below presents an overview of enterprises distributed by number of employees for the period 2006-2009.

Table 1 – Number of enterprises in the construction sector 2006-2009

Nr. of employees	2006	2007	2008	2009
0	16 286	17 268	17 360	16 026
1-9	13 748	14 554	14 935	14 304
10-19	2 103	2 228	2 209	1 756
20-49	1 126	1 147	1 162	802
50-99	208	235	246	162
100+	108	115	112	85
total	**33 579**	**35 547**	**36 024**	**33 135**

Source: Statistics Denmark: StatBank – general business statistics. Note: Due to a new accounting method, there is a data gap on the number of full time employees from 2008 to 2009.

The greatest share of enterprises in the construction sector is composed of one-man enterprises and those with few employees. There are few enterprises with over 100 employees.

The table below presents the number of enterprises in the sector distributed by type of enterprise.

Table 2 – Number of enterprises in the construction sector, distributed by type, 2006-2009.

Enterprise type	2006	2007	2008	2009
Building contractor	4 479	4 965	4 753	4 028
General contractor	1 053	1 091	1 210	1 241
Building installations	6 579	6 781	6 853	6 534
Building finishing	14 317	15 155	15 285	14 225
Bricklayers and other specialised construction enterprises, as well as construction site preparation	7 151	7 555	7 923	7 107
I alt	**33 579**	**35 547**	**36 024**	**33 135**

Source: Statistics Denmark: StatBank – general business statistics. Note: Due to a new accounting method, there is a lack of data on the number of full time employees from 2008 to 2009.

In 2009 there were a total of 33,135 registered construction enterprises. The greatest number were building finishing and completion enterprises.

3.1 Value chain and organisation

The construction industry has a complex value chain. As the figure below shows, the value chain includes basic production and the distribution of construction materials along with a range of knowledge-intensive services from private enterprises and public knowledge institutions.

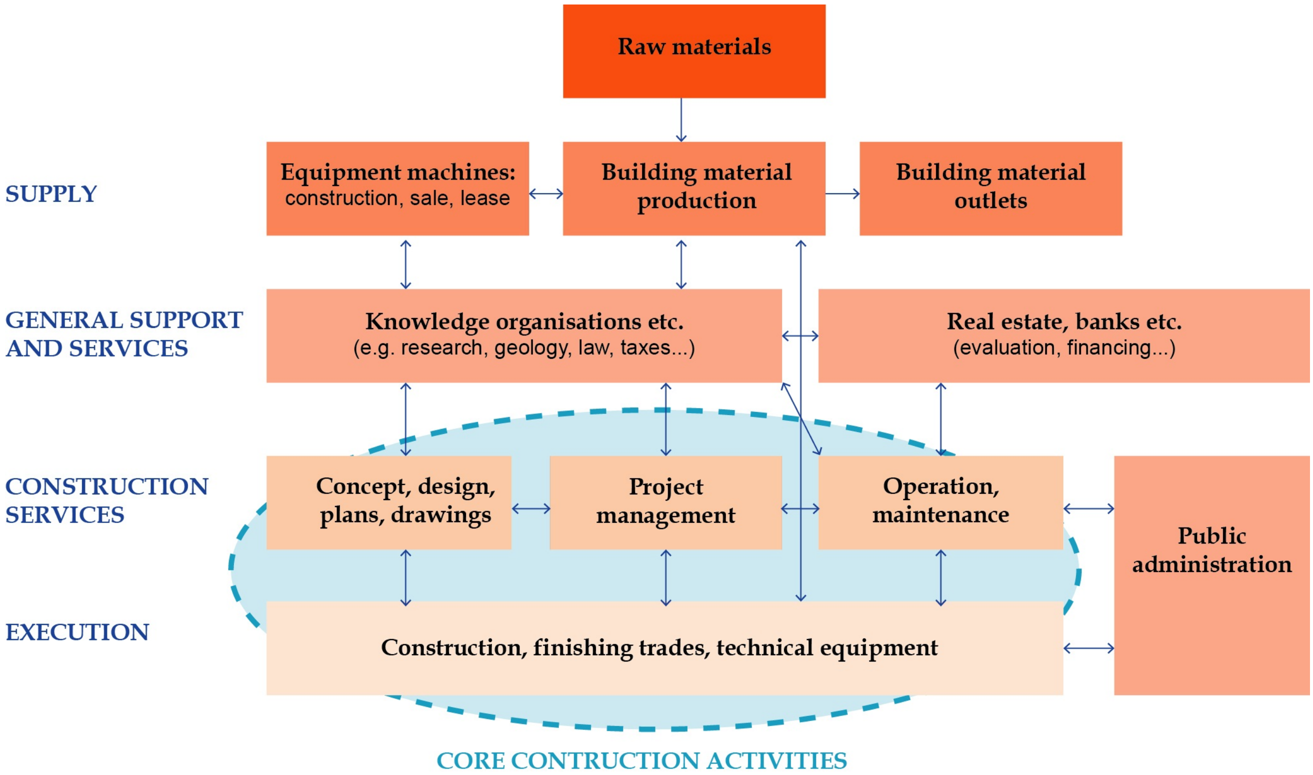

Figure 3: The construction industry value chain

Source: Danish Technological Institute for the EU Commission(2008): Future qualification and skills needs in the construction sector.

The Build Up Skills initiative focuses on what could be called the building industry's core, marked above in blue. Suppliers of construction materials are also important in relation to future competence needs and continuing education.

Actors within the core area are organised in a range of professional trade organisations, interest groups, and social partner organisations. The most important of these are presented below:

Employer organisations

- **Danish Construction Association:** Trade and employer organisation for 6,200 enterprises in the building and construction sector and in contracting
- **Tekniq:** Trade and employer organisation for app. 3,000 enterprises in electrical contracting, plumbing and heating, and ventilation
- **DS Trade and Industry:** Employer and branch organisation for 2,250 small- and medium-sized enterprises in manufacturing, smithery, crafts, plumbing, heating and sanitation, with a total of around 20,000 employees
- **Confederation of Danish Industry (DI)** is a private organisation representing 10,000 companies within manufacturing, trade and service industry.
- **Danske Ark:** Danish Association of Architectural Firms, an association of private firms of consulting architects, with around 25 member firms.

Employee organisations

- **BAT-kartellet:** A professional syndicate for 7 members of the Danish Confederation of Trade Unions whose members work primarily in the building and construction sector. The BAT syndicate does not negotiate labour agreements; this is left to the individual unions.
- **Danish Society of Engineers:** Interest organisation and union for 88,000 technical and scientific professionals, primarily engineers.
- **Union of Salaried Architects:** Union for around 5,600 architects, planners, designers, and persons in archihtect related work on an academic level.
- **Danish Association of Building Experts, Managers and Surveryors**: Union with about 8000 members.

Trade organisations and professional bodies

- **Danish federation of Small and Medium-Sized Enterprises:** Trade organisation for 20,000 small and medium-sized enterprises, including building and construction enterprises.
- **FRI:** Association of consulting engineers, with a total of around 340 member enterprises.
- **DI Byggematerialer:** Trade organisation with 340 members, representing producers, suppliers, dealers, and contractors in the construction industry.
- **Danish Association of Construction Clients:** An interest group representing professional construction clients.

Figure 4: : Main actors in the Danish construction industry

3.2 Future trends and challenges

Economic climate

Construction activity is very sensitive to changes in market conditions, and has therefore been hard hit by the current economic slump in Europe. According to the Danish Construction Association, production value fell 26% (adjusted for inflation) from 2007 to 2010. Despite a small increase in 2011 and prognoses of growth in 2012, overall branch activity is predicted to decrease again in 2013. Growth is especially expected to come from institutional construction and renovation of public housing – due to the Danish government's planned economic kick-start.[3]

The economic slump has increased competitiveness between enterprises and has led to growing international pressure from foreign enterprises and workforces. Concurrently there are a great number of bankruptcies. In 2010 there were 1005 bankruptcies in the construction sector and in 2011 there were 774; in comparison, the average number of bankruptcies annually between 1983 and 1987 was 328.[4]

Labour productivity

A comprehensive report on the competitiveness of the European construction sector points to a low level of productivity as one of the main problems. This low level of productivity is mentioned as due to, among other things:

"*Market and employee driven innovation is poorly deployed due to primary focus on cheapest price instead of the economically most advantageous proposal, but also because of poor deployment of enabling technologies, insufficient use of flexible work organisation practices. The sector is missing opportunities to add significant value to the economy, addressing the grand challenges as well as being more profitable*." [5]

This is true especially for the Danish construction sector. The table below shows changes in labour productivity between 2000 and 2010:

Table 1: Labour productivity for the construction sector since 2000

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Construction	100	89,7	89,7	94,1	91,5	88,9	88,7	85,7	82,1	80,2	77
Manufacturing	100	100,1	101	104,8	110,9	114	119,8	125,5	129,2	127,4	140,8
Overall economy	100	99,5	100,3	102,1	104	104,3	104,8	106	104	102,9	106,8

Source: Statistics Denmark. Note: Year 2000 is defined as index 100. Calculations are based on figures for the entire market economy but exclusive public administration and service. The figures for overall economy are however calculated from figures for the entire economy including public administration and service.

[3] Dansk Byggeri (2012): Konjunkturanalyse februar, 2012.
[4] Dansk Byggeri (2012): Konjunkturanalyse, februar 2012
[5] DG Enterprise & Industry (2011): FWC Sector Competitiveness Studies N° B1/ENTR/06/054 – Sustainable Competitiveness of the Construction Sector – Final report

Growth in labour productivity in Denmark has for the past few years been under the OECD average. The construction sector has shown an almost continuous negative trend since 2000, which makes labour productivity one of the sector's major challenges. At the same time, there has been a growth in labour productivity in manufacturing, which could indicate the need for increased industrialisation in construction processes.

Occupational boundaries

The above mentioned report on the competitiveness of the construction sector describes the restrictive occupational boundaries as an Achilles heel. A Danish analysis has also been carried out about occupational convergence and collaboration on the construction site. The analysis shows that craftsmen work within well-defined occupational boundaries, and that occupational convergence seldom occurs. The analysis also shows that occupational convergence could facilitate construction processes and thus increase productivity. Occupational convergence is thus one of the sector's main challenges, especially from the perspective of education and continuing education. [6]

Underground economy

According to the Rockwool Foundation, the value of the black market in the construction sector is DKK 19 billion. The construction sector is thus the greatest contributor to the underground economy in Denmark. The black market is a major challenge to enterprises' competitiveness, to construction quality, and to employment.

[6] Teknologisk Institut og Byggeriets Uddannelser (2009): Fagglidning og samarbejde på byggepladsen.

4. National policy and strategies for 2020

4.1 Energy policy agreements and strategies

Below is an overview of the international energy policy agreements that Denmark is obliged to fulfil. Afterwards, this chapter presents the Danish Energy Agreement of March 2012, with focus on the goal for energy savings in the construction area by 2020.

The following is a summary of the applicable 2020 goals (as of April 2012):

Energy efficiency (reduced energy consumption)

EU overall (all Member States)	20% compared to 1990
Denmark's obligation to the EU	4% compared to 2006 (gross energy consumption)
Danish goal (Agreement of 2012)	12% compared to 2006 (gross energy consumption)
Danish goal (Agreement of 2012)	7% compared to 2010 (final energy consumption)

Share of the final energy consumption produced by renewable sources

EU overall (all Member States)	20%
Denmark's obligation to the EU	30%
Danish goal (Agreement of 2012)	35%

Kyoto protocol (in force since 2005)

The Kyoto protocol is an international agreement on the reduction of the emission of carbon dioxide and other greenhouse gasses. It was ratified in 1997 and has been in force since 2005. The EU Member States have agreed on burden sharing of emission reductions. Denmark committed to reducing emission by 21% in the period 2008-2012 compared to 1990 levels. Denmark's adjusted CO_2 emissions had by 2010 already fallen 23% compared to 1990.

EU Climate and Energy Package (December 2008)

The goal of this package is an overall reduction in greenhouse gas emission of 20% compared to 1990. Denmark has committed to reducing its non-ETS (EU's Emission Trading Scheme) emissions by 20% compared to the level in 2005, and to increase its share of renewable final energy consumption from 17% in 2005 to 30% in 2020. The former government's Energy Agreement of 2008 specified an absolute reduction of 4% in gross energy consumption in 2020 compared to 2006, which is the equivalent of a decrease of 0.83 Mtoe. Gross energy consumption in 2006 was 20.35 Mtoe, and to comply with the Agreement must be 19.52 Mtoe in 2020. The focus of the Danish Energy Agreement on absolute energy consumption also has a positive effect on CO_2 emission and the security of energy supplies.

More on Denmark's commitments to the EU can be found here:
http://ec.europa.eu/europe2020/pdf/nrp/nrp_denmark_en.pdf

4.2 Energy Agreement 2012 – 2020 (March 2012)

The Energy Agreement in brief [11]

- The Energy Agreement assures broad political support for an ambitious transition to green energy, with focus on energy savings throughout society and the increased use of renewable energy in the forms of windmills, biogases, and biomass.
- The Agreement assures a 12% reduction in gross energy consumption in 2020 compared to 2006, more than 35% renewable energy in 2020, and almost 50% wind power in electricity consumption in 2020.
- The Agreement is a milestone in the efforts to switch Denmark's energy supply (electricity, heating, industry, and transportation) to renewable sources by 2050.
- The initiatives in the Agreement will create green growth and jobs, and at the same time take enterprise competitiveness into consideration.
- The Agreement contains a range of energy policy initiatives for the 2012-2020 period, and will be continually monitored. Supplementary initiatives will be considered by the end of 2018 for the period after 2020.

An energy efficient society with less energy waste
Energy efficiency is a precondition for the ability to increase the share of renewable energy. Because of increasing energy prices, energy efficiency is also an economic issue for households and enterprises. The initiatives in the Agreement will reduce Denmark's final energy consumption (not including transportation) by 7% in 2020 compared to 2010. The agreement contains the following goals:

- Energy suppliers must increasingly try to achieve energy savings through advice and subsidies to households and businesses.
- Energy suppliers' initiatives to support energy savings must increase by 75% in 2013-2014, and by 100% in 2015-2020, compared to efforts in 2010-2012.
- An overall strategy for energy renovation is to be drawn for the existing building stock.

A green and sustainable energy supply based on renewable energy sources
The Agreement assures a notable extra upgrading of windpower corresponding to 1.5 million household's annual consumption. Windpower will by 2020 provide around half of the Danish electricity consumption compared to around one-quarter in 2012. The Agreement specifies:

- the construction by 2020 of two offshore wind farms, 600 MW at *Kriegers Flak* and 400 MW at *Hors Rev*.
- an additional 500 MW of offshore wind farms by 2020.
- strengthened planning of windpower targeting new land-based windmills with a total capacity of 1,800 MW by 2020, so that overall land-based windmill production increases even though older turbines are dismantled.
- the phasing out of the price premium at high electricity prices to avoid overcompensation

- the allocation of DKK 100 million over 4 years to support the development and implementation of new renewable technologies (solar power, wave power) for the production of electricity, and additional DKK 25 million in 2014-2015 to support the construction and piloting of wave power facilities.

Transition to green heating
Heating is to gradually shift to renewable sources. The Agreements specifies:

- the switch from coal to biomass in the main power plants should be made more attractive by changes in legislation on heat distribution,
- smaller isolated decentralised district heating power plants in economic difficulties and with high prices will be allowed to use biomass,
- the allocation of DKK 35 million to promote new renewable energy technologies such as geothermal energy and large-scale heat pumps.

Increased use of renewable energy in buildings
The Agreement supports the phasing out of oil-fired boilers in existing buildings:

- The installation of oil or natural gas heating systems in new buildings will be discontinued in 2013.
- The installation of oil-fired heating systems in existing buildings will be discontinued in 2016 in areas that have district heating or natural gas available.
- DKK 42 million will be allocated in 2012-2015 to support the transition from oil-fired and natural gas heating to renewable sources of heating.
- The current "Go' Energi" information campaign will be phased out in favour of other energy optimisation initiatives.

More renewable energy in industry
The business world must contribute to greener energy. The Agreement specifies:

- subsidy to promote effective use of renewable energy sources in enterprises' production processes. This will increase from DKK 250 million in 2013 to DKK 500 million annually from 2014 to 2020.
- the introduction of an annual subsidy of DKK 30 million from 2013 to 2020 to retain and promote the use of industrial cogeneration energy in manufacturing and in the industrial nursery and garden industry.

Smart electrical grids
A high level of electricity consumption combined with the use of windpower demands and intelligent energy system. The Agreement specifies:

- designing an overall strategy for the implementation of smart electrical grids.
- possible agreements with electricity distribution companies on phasing in of automated digital power meters.

Better framework conditions for the development of biogas

There is an ambitious programme for increasing the use of biogas. In order to provide direction and impetus the Agreement specifies:

- increased support for the use of biogas in cogeneration heating plants,
- new possible uses for biogas – in the natural gas net, in production processes, or for transportation – be made economically attractive through new subsidies,
- that subsidy for biogas production facilities be increased from 20% to 30%,
- that a task force be established to support specific projects and recommend supplementary initiatives if it seems that in 2012-13 the development of biogas lacks impetus.

4.3 The construction code and energy standards

The construction code of 1961 for the first time specified standards for heat insulation for new buildings, grouped by type of building envelope. These standards have become increasingly tightened, and since 1995 have been supplemented by standards for buildings' overall energy supply, called the energy framework. Figure 5 shows how the standards have been tightened since 1961.

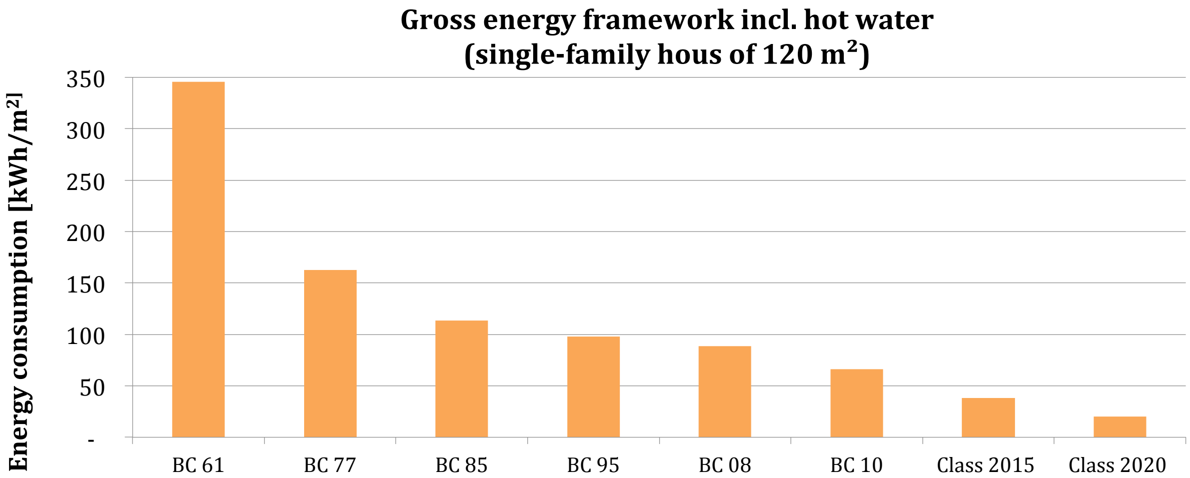

Figure 5: Comparison of energy framework standards for a single-family detached permanent residence.

The current building code BR10
The current building code, BR10 (updated 24-08-2011) sets standards for new and existing buildings.

Standards for new buildings
The framework standards for energy consumption for heating, hot water, air conditioning, ventilation, and lighting are:

Accommodation, student residence halls, hotels, etc.		
Standard buildings	52.5 + 1650/Ae	kWh/m² per year
Low-energy buildings class 2015	30 + 1000/Ae	kWh/m² per year
Low-energy buildings class 2020	20	kWh/m² per year
Offices, institutional buildings, and other buildings		
Standard buildings	71.3 + 1650/Ae	kWh/m² per year

Low-energy buildings class 2015	41 + 1000/Ae	kWh/m² per year
Low-energy buildings class 2020	25	kWh/m² per year

, where Ae is the heated floor area

There is a supplemental energy standard for buildings with a high level of illumination, extra ventilation, high level of hot water consumption, high ceilings, and for buildings that are in use for an extended period daily.

In addition to energy framework standards, there are other standards for new buildings:

- Lowest level of insulation of construction elements,
- Maximum overall heat loss (not including windows), and
- Standards for air-tightness.

Standards for existing buildings

- There are standards for insulation levels for building elements in existing buildings that **increase** their floor area either by construction or the inclusion of other already existing building. If these standards cannot be met, the lack of performance can be compensated for through other energy saving solutions.
- There are standards for heat insulation (expressed in U-factor and linear thermal transmittance) for existing buildings that **replace** building envelope elements. These standards must be met without consideration for profitability. An exemption can be made if the standards cannot be justified with regards to architecture or technological demands of construction or moisture control.
- Standards for re-insulation must be met when **renovating** elements in existing building, but only if these standards are profitable. If not, there can be other less extensive renovation solutions that are profitable, and therefore must be carried out.

Painting, exterior wall plastering, and the repair of holes in roofing are not affected by re-insulation standards for existing buildings.

New standards expected in the future

The building code is expected to be tightened in the future. Beginning in 2013 the installation of oil-fired and natural gas heating units in new buildings will no longer be allowed, but exceptions will be possible if there are no other alternatives available [11].

2015

New buildings

- The current low-energy building code 2015 will become the minimum standard.
- The air exchange through building envelope must not be greater than 1.0l/s per m² heated floor area when measured at a pressure of 50 Pa.
- The thermal indoor climate on sunny days must be documented by calculation for housing, institutions, offices, etc. For housing, the temperature must not exceed 26 °C more than 100 hours per year, and must not exceed 27 °C more than 25 hours per year.
- Minimum standards for window energy performance levels will be changed from -33 to -17 kWh/ m².
- Ventilation must be installed with heat recovery and a temperature transfer efficiency of at least 75% (in dwellings at least 85%).

- It is expected that the standby and operational consumption of energy by lifts will be included as part of the energy framework after 2015.

Existing Buildings

- The energy performance level during the heating season for windows replaced after 1 January 2015 must not be less than -17 kWh/m² per year.
- The energy performance level during the heating season for roof windows replaced after 1 January 2015 must not be less than 0 kWh/m² per year.
- The U-factor including frame for roof windows replaced after 1 January 2015 cannot be higher than 1.40 W/m²K.
- Regulations regarding surface temperature of window frames in exterior walls will be re-evaluated.

2016

Beginning in 2016, the installation of oil-fired heating units in existing buildings will no longer be allowed where there is access to district heating or natural gas heating [10].

2019

The current low-energy building code 2020 is expected by the end of 2018 to become a mandatory minimum standard for the construction of new public buildings [10].

4.4 Implementing the EPBD recast and the RES-directive

Status for the implementation of the directive of the European Parliament and the Commission on the energy performance of buildings.

The recast of Directive 2010/31 on the energy performance of buildings was adopted on 19 May 2010.

Buildings account for 40% of EU's total energy consumption. Therefore, reduction of energy consumption and the use of energy from renewable sources in the construction sector constitute important measures needed to reduce the Union's energy dependency and greenhouse gas emissions. Together with increased use of energy from renewable sources, measures in the directive on the energy performance of buildings in Member States will allow the Union to comply with the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) and honour the long term commitment to maintain global temperature rise below 2 °C.

Another goal of the directive is to contribute to EU's 2020 goal of reducing overall energy consumption and overall greenhouse gas emissions by 20 % of 1990 levels, and to have 20% of overall energy consumption be produced through renewable sources. In Denmark these goals are implemented mainly through:

- The Building Code
- The Act to Promote Energy Savings in Buildings

The current construction code, BR10, contains minimum standards for energy consumption in new buildings and for energy consumption in existing buildings that are renovated. The entire construction sector workforce must therefore be familiar with the regulations in the construction code.

On 23 February 2012 amendments were considered in Parliament to the Act to Promote Energy Savings in Buildings, the Act on Buildings and Dwellings Registration, and to the Building Act. The amendments' primary focus was to assure implementation of parts of the new Building Code. The proposal (in Danish) is available at:

http://www.ft.dk/samling/20111/lovforslag/L84/som_fremsat.htm#dok

The Act to Promote Energy Savings in Buildings contains regulations on energy labelling of buildings, energy inspection of ventilation and climate control installations, and energy inspection of oil-fired furnaces and heating plants.

More information on this can be found at:

http://www.ens.dk/da-DK/ForbrugOgBesparelser/IndsatsIBygninger/Sider/Forside.aspx

and on the website for the Secretariat for Energy Efficient Buildings, www.seeb.dk (Danish only).

Status for the implementation of the directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources

Directive 2009/28/EF on the promotion of the use of energy from renewable sources was enacted on 23 April 2009. The directive specifies mandatory national targets for the Member States. Denmark is committed to the goal of having renewable energy account for 30% of its final energy consumption in 2020. Denmark has prepared a national action plan which can be found at the Danish Energy Agency's website www.ens.dk and on the EU transparency platform, and which contains an account of how Denmark plans to comply with its commitments.

Article 14 in the directive is especially relevant for the Build Up Skills initiative. Article 14 paragraphs 2 to 5 are described below. Coordination between paragraphs 3 and 4 is especially important for the Build Up Skills initiative.

Article 14 paragraph 2 states that Member States shall ensure that information on the net benefits, cost and energy efficiency of equipment and systems for the use of heating, cooling and electricity from renewable energy sources are made available. This information was previously available at www.geoenergi.dk (Center for Energy Savings) before the recent Energy Agreement of 2012, which led to the Center being closed down. Since the Agreement came into effect, energy producers' obligations to save energy have increased, and they now fulfil the task of supplying the information required by paragraph 2.

Article 14 paragraph 3 specifies that Member States shall ensure that certification schemes or equivalent qualification schemes become or are available by 31 December 2012 for installers of small-scale biomass boilers and stoves, solar photovoltaic and solar thermal systems, shallow geothermal systems, and heat pumps. Such schemes shall be based on the criteria laid down in Annex IV of the Directive. Finally, the section specifies that Member States shall recognise certifications awarded by other Member States in accordance with those criteria.

Paragraph 3 should be seen in association with paragraph 4 which specifies that Member States shall make available to the public information on certification schemes or equivalent qualification schemes as referred to in paragraph 3. In addition, Member States may make available the list of installers who are qualified or certified in accordance with the provisions referred to in paragraph 3.

Denmark is in the process of implementing article 14 paragraph 3, and on 8 February 2012 proposed legislation giving the minister for Climate, Energy and Buildings the authority to issue regulations that implement article 14 paragraph 3. This legislation is expected was passed in spring 2012. The proposed legislation can be found (in Danish) at:

http://www.ft.dk/samling/20111/lovforslag/L84/som_fremsat.htm#dok.

Article 14 paragraph 5 specifies that Member States must ensure that guidance is made available to all relevant actors, notably for planners and architects so that they are able properly to consider the optimal combination of renewable energy sources, of high-efficiency technologies and of district heating and cooling when planning, designing, building and renovating industrial or residential areas.

For this purpose the “Danish Knowledge Center for Energy Savings in Buildings” was established. The Center was formed after a tender, refers to the Centre for Energy Savings under the Danish Energy Agency, and is run in the form of a consortium consisting of Danish Technological Institute, Danish Building Research Institute/Aalborg University, Viegand & Maagøe, and KommunikationsKompagniet.

The Knowledge Center has its physical address at Danish Technological Institute in Taastrup, Denmark. The Center collects and disseminates knowledge for the construction sectors’ actors about concrete and practical possibilities for reducing energy consumption in buildings. The Center develops energy solutions that make the implementation of energy saving initiatives easier and faster. The Center’s home page, www.byggeriogenergi.dk, contains information about and catalogues of energy solutions and package solutions for almost every building element and component. Energy solutions describe how buildings can be made more energy efficient and how much can be saved, and present the proper way to carry out these solutions.

5. Building stock, energy consumption, and workforce

5.1 The Danish building stock

The Danish building stock is composed of 2.6 million buildings. Around 60% are used for housing, and the remaining 40% for trade, service, and other commercial activities. The following presents overviews of the building stock in terms of age, ownership, conservation and preservation status, and heating type.

5.2 The building stock's heated area

Table 3 below shows the total number of buildings and calculated heated floor area[7] for the Danish building stock, distributed by BBR-usage code (BBR is the Central Register of Buildings and Dwellings). It must be assumed that the areas in data fields 210-290 are unheated or partially heated by a commercial production process carried out in the building. The heated area is assumed to be the sum of data fields 217 (dwelling area) and 218 (commercial area).

Table 3 Number of buildings and heated area for the entire Danish building stock, calculated from the Building and Dwelling Register (BBR) fields 217 (dwelling area) and 218 (commercial area). Data retrieved January 2012[2].

BBR data fields (usage code)		Number [-]	Heated area* [m²]	Area share [%]
110	Farmhouse	121,250	22,671,509	5.0
120	Single-family (detached)	1,092,810	158,204,680	34.8
130	Semi-detached/terraced	237,321	35,815,094	7.9
140	Multi-story housing blocks	90,163	83,700,924	18.4
150	Dormitory/student housing	1,818	1,421,596	0.3
160	24 hr. care centre	4,503	4,532,201	1.0
190	Other permanent residence	5,953	742,474	0.2
310	Transportation facility	15,815	6,537,379	1.4
320	Office/commerce	78,720	68,913,696	15.2
330	Hotel and service	14,735	6,700,658	1.5
390	Other transport, commerce	4,994	1,432,460	0.3
410	Cultural centre	11,603	5,098,278	1.1
420	Teaching	19,404	22,684,382	5.0
430	Hospital	2,444	4,608,629	1.0
440	Day care facility	8,905	3,576,547	0.8
490	Other institutional facility	3,462	1,577,815	0.3
510	Summer cottage	223,090	16,244,161	3.6
520	Holiday home	4,415	896,456	0.2
530	Sports facility	9,174	6,487,790	1.4
540	Allotment garden house	16,266	552,166	0.1
590	Other leisure and recreation buildings	16,046	1,881,555	0.4

** Heated area is calculated as the sum of data field 217(dwelling area) and data field 218 (commercial area).*

[7] Heated area = heated floor area for the purposes of this study.

It can be seen that farmhouses, single-family detached houses, semi-detached or terraced houses, multi-story housing, and office/commerce account for over 80% of the heated area.

New construction

Table 2 below shows the number of new buildings annually and heated area, based on a 10-year average.

Table 4. Number of new buildings annually, distributed by heated area annually and annual increase, based on a 10-year average (2000-2010). Data retrieved from the BBR January 2012 [2].

BBR data field (usage code)		Average number of new buildings annually [-]	Average heated area built annually* [m²]	Annual increase [%]
110	Farmhouse	340	76,963	0.3
120	Single-family (detached)	6267	1,026,560	0.6
130	Semi-detached/terraced	3274	531,869	1.5
140	Multi-story housing blocks	434	563,157	0.7
150	Dormitory/student housing	21	20,899	1.5
160	24 hr. care centre	72	70,160	1.5
190	Other permanent residence	87	6,918	0.9
310	Transportation facility	139	123,795	1.9
320	Office/commerce	927	1,188,946	1.7
330	Hotel and service	134	60,704	0.9
390	Other transport, commerce	102	32,307	2.3
410	Cultural centre	65	35,668	0.7
420	Teaching	200	170,568	0.8
430	Hospital	21	34,522	0.7
440	Day care facility	117	37,202	1.0
490	Other institutional facility	52	12,775	0.8
510	Summer cottage	2658	235,737	1.5
520	Holiday home	65	8,922	1.0
530	Sports facility	140	94,244	1.5
540	Allotment garden house	81	3,313	0.6
590	Other leisure and recreation buildings	335	33,032	1.8
Total		-	4,368,261	1.0

** Heated area is calculated as the sum of data field 217(dwelling area) and data field 218 (commercial area)*

Based on 10 year period, the average annual increase in the total heated building stock area was 1%. There were substantial differences from year to year, as seen in Figure 6 which shows the annual construction of heated area from 2000 to 2010.

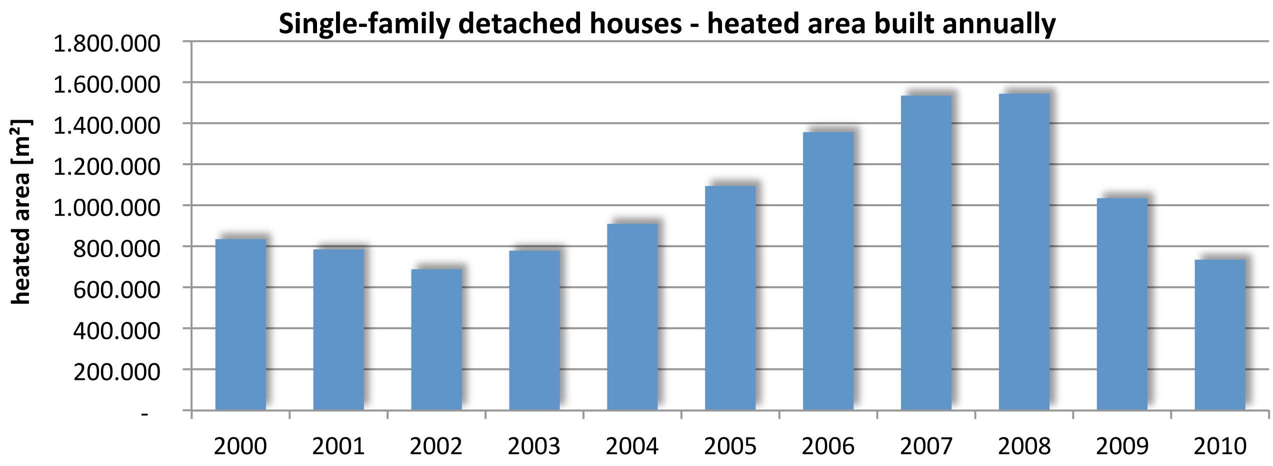

Figure 6: Heated area built annually. Heated area is calculated as the sum of data field 217 (dwelling area) and 218 (commercial area).

The building stock's heated area distributed by age

A great deal of the Danish building stock was constructed before 1930 and between 1961 and 1972, as shown in Figure 7:

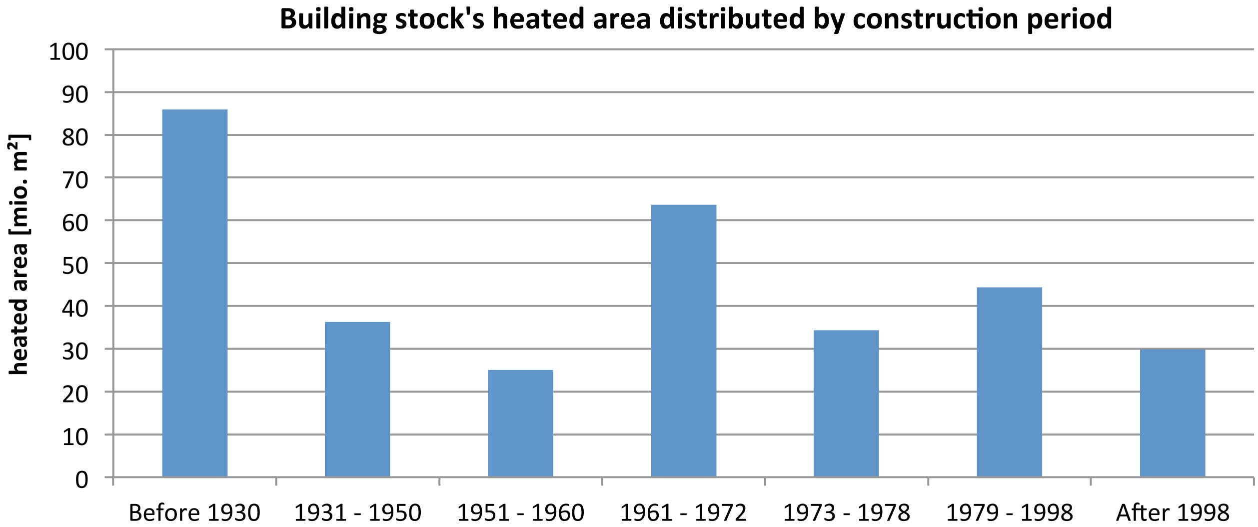

Figure 7: Danish buildings' total heated area (dwelling + commercial), distributed by period of construction [2].

The building stock's heated area distributed by ownership

The ownership of buildings is interesting in relation to incentives for and barriers to energy renovation. Return on investment over time is often the greatest barrier for private individuals. In private rental building there is a paradox in that the owner invests in energy renovation but the renter benefits from energy savings. One of the greatest barriers in public buildings is that the budgets for construction (renovation) and operations (energy savings) are often separated. Figure 8 shows heated area distributed by ownership (BBR field codes). The majority (58%) of heated area is owned by individuals or by partnerships, and 18% is owned by corporations, limited liability partnerships, or other business structures.

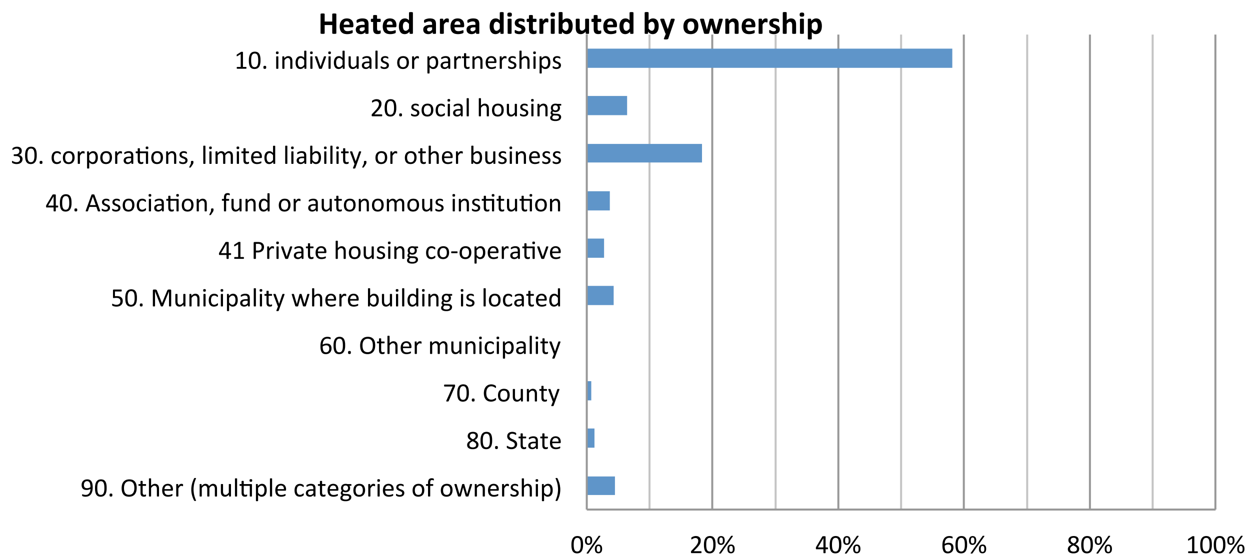

Figure 8: Heated area (dwelling + commercial) distributed by ownership [2].

Heated area for listed structures

There are several categories of listing which limit possibilities for energy renovation. Table 5 presents the listed area and its share of the total heated area for the BBR usage codes used. Overall, listed areas amount to 5.5 million m², corresponding to 1% of the total heated building area. Listed buildings are therefore not an important barrier to energy renovation.

Table 5: Heated area of listed buildings, and share of total heated area. Data on listed buildings retrieved from the BBR [2].

BBR data field (usage code) anvendelseskode		Heated area that is listed [m²]	Share* [%]
110	Farmhouse	254,019	1.1
120	Single-family houses	565,921	0.4
130	Semi-detached/terraced	343,509	1.0
140	Multi-story housing blocks	1,359,608	1.6
150	Dormitory/student housing	13,613	1.0
160	24 hr. care centre	78,338	1.7
190	Other permanent residence	32,663	4.4
310	Transportation facility	53,127	0.8
320	Office/commerce	1,483,315	2.2
330	Hotel and service	228,673	3.4
390	Other transport, commerce	25,420	1.8
410	Cultural centre	519,795	10.2
420	Teaching	301,406	1.3
430	Hospital	79,380	1.7
440	Day care facility	25,830	0.7
490	Other institutional facility	89,711	5.7
510	Summer cottage	20,166	0.1
520	Holiday home	9,576	1.1
530	Sports facility	43,148	0.7
540	Allotment garden house	866	0.2
590	Other leisure and recreation buildings	14,116	0.8
Total		5,542,200	1.2

*The share of the each usage code's total heated area (dwelling + commercial).

The building stock's heated area distributed by type of heating

The type of heating is important in relation to finding the most optimal energy renovation solutions. District/block heating is very common in Denmark, and accounts for over 50% of the total heated area, as shown in Figure 9. In addition, central heating with own facilities accounts for around 1/3 of the heated area, and electric room heaters and panel heaters account for around 7%.

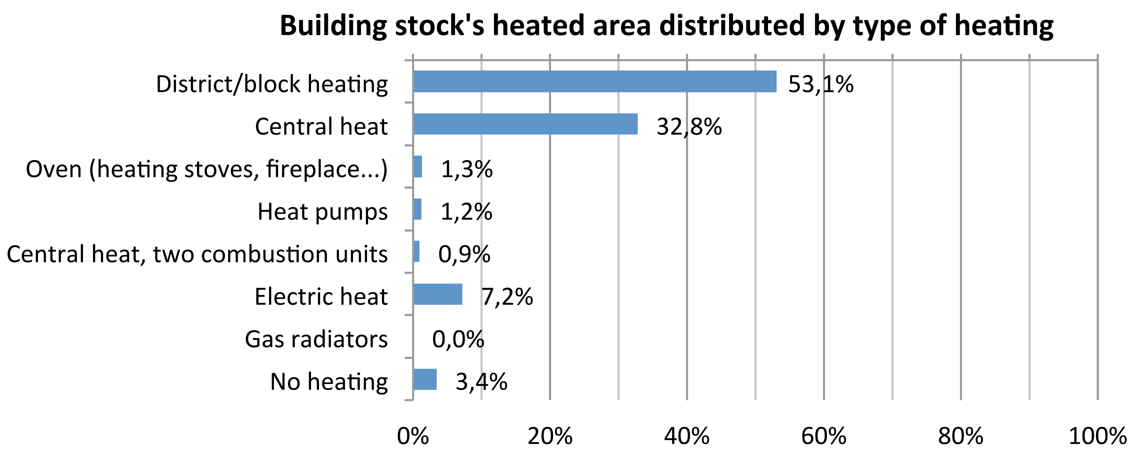

Figure 9: Building stock's heated area (dwelling + commercial) distributed by type of heating.

5.3 Energy labelled low-energy buildings

Table 6 shows the number and heated area of low-energy buildings constructed from 2006[8] to 2012, based on figures from the energy labelling data base [4].

Table 6: Number of low-energy buildings constructed and their heated area. Data retrieved from the energy Labelling data base January 2012 [4]. The table only includes buildings constructed from 2006 to 2012.

BBR data field (usage code)		Number A1	Number A2	Total Number	Total heated area [m²]
110	Farmhouse	30	162	192	44,596
120	Single-family houses	540	2461	3001	567,664
130	Semi-detached/terraced	222	755	977	212,572
140	Multi-story housing blocks	43	122	165	304,403
150	Dormitory/student housing	3	8	11	17,543
160	24 hr. care centre	12	26	38	58,602
190	Other permanent residence	1	2	3	26,263
310	Transportation facility	0	1	1	918
320	Office/commerce	27	129	156	615,626
330	Hotel and service	3	6	9	7,903
390	Other transport, commerce	1	2	3	5,089
410	Cultural centre	3	12	15	5,423
420	Teaching	14	29	43	125,428
430	Hospital	4	1	5	10,919
440	Day care facility	30	34	64	51,776
490	Other institutional facility	1	18	19	18,456
510	Summer cottage	9	50	59	9,291
520	Holiday home	0	1	1	617
530	Sports facility	4	8	12	11,569
590	Other leisure and recreation buildings	2	6	8	1,489
Total		949	3,833	4,782	2,096,147

Figure 10 shows energy labelled areas built before and after 1979 distributed over two groups of energy standards corresponding to the energy grades (A-G). Buildings constructed before 1979 are mostly in the lower (worst) half of the grading, and 77% of those constructed after 1979 are in the upper half.

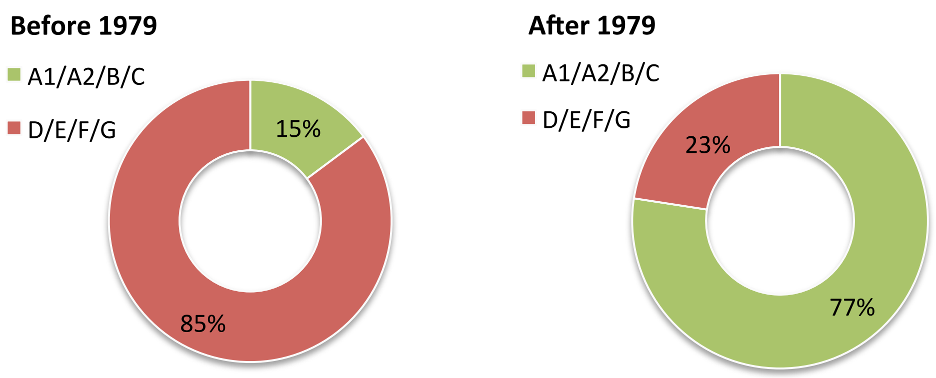

Figure 10: Distribution of heated area by energy grade for buildings used for housing, office, and commerce. Data retrieved from the energy labelling data base in January 2012 [4].

[8] The data base contains data for buildings constructed before 2006, data from this period have been considered faulty and thus are omitted.

5.4 Building envelope and insulation

Danish buildings are traditionally made of brick, sometimes supplemented with woodwork. The older building stock is typically constructed with a solid exterior wall or a cavity wall, the latter often insulated at a later date with granules of varying quality. Buildings from after 1961 have normally been insulated during construction in compliance with building codes in effect at the time of construction.

A relatively large share of Danish buildings has over time been energy labelled when sold. Information from the labelling process is useful in presenting an overall picture of the insulation quality of Danish buildings. The following presents data from a subset of the energy labelling data base. Each building element is presented with an sfb code (a standard code system for building elements, here used in relation to elements in the building envelope) and can thus be placed in an overall category (loft, exterior wall, floor, window). Based on these categories, figures 9 through 13 show the scaled total area distributed by insulation level.[9] Since a number of construction techniques have been employed, the insulation level is presented as an insulation thickness equivalent to the overall thermal resistance of the entire structure. Data for heating installations distributed over three efficiency levels are also employed.

Roof and loft insulation

Roofs are often tiled, but in the 1960s and 1970s were often constructed of fibre cement board. Roofs and lofts are insulated to varying degrees, but in general the most poorly insulated lofts have been re-insulated at some point after construction. Older re-insulation seldom complies with current standards of 300-400 mm. Figure 11 shows roof/loft area distributed by insulation level (thickness).

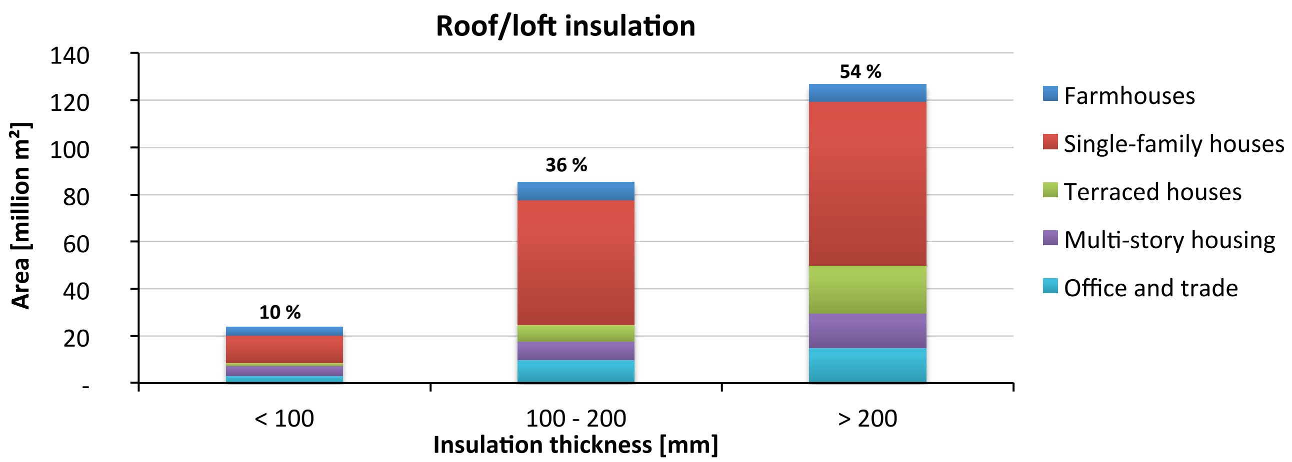

Figure 11: Scaled roof/loft area, calculated from heated area data in the energy labelling data base and the BBR. It is assumed that U-factors of 0.2 and 0.4 W/m²K correspond to insulation thickness of respectively around 200 mm and 100 mm.

The total roof/loft area insulated with less than 200 mm can be seen in Figure 11 to be more than 110 million m². There is no way to directly assess how much area can be re-insulated without major difficulties, but because of technical construction issues, most probably only a modest amount. At the same time, the figure shows that over 50% of roof/loft area is insulated with more than 200mm.

[9] Scaled total area calculated from the heated area data in the energy labelling data base and the overall dwelling and commercial area in the BBR.

Exterior wall insulation

Figure 12 shows exterior wall area distributed by equivalent insulation levels, since some exterior walls are for example made of expanded clay concrete, which itself has insulation properties.

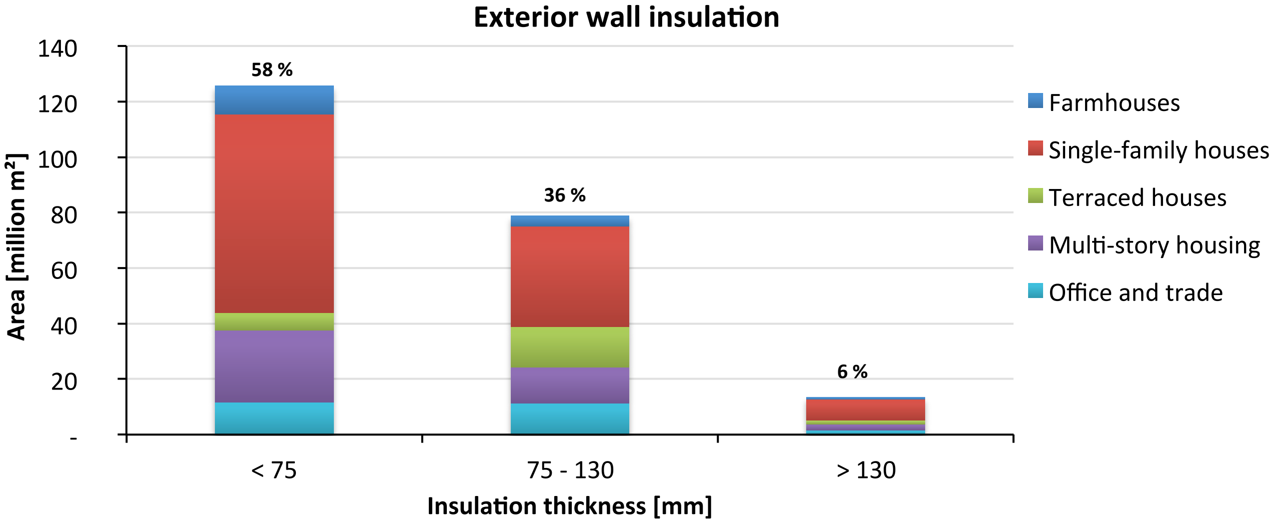

Figure 12: Scaled roof/loft area, calculated from heated area data in the energy labelling data base and the BBR. It is assumed that U-factors of 0.2 and 0.4 W/m²K correspond to insulation thickness of respectively around 130 mm and 75 mm.

Figure 12 shows that around 125 million m² of exterior walls have a poor insulation level of under 75 mm. It should be noted, however, that because of architectural issues and technical issues the re-insulation of exterior walls is often complicated.

Basement slabs and floors

Basement slabs and story partitions are generally poorly insulated in older buildings. Most single-family detached houses are composed of 1 or 2 floors and perhaps a partially heated basement (heated by heat loss from the heating installation). Apartment blocks and commercial spaces are normally 3 to 6 storeys high. Figure 13 shows a data subset of the insulation level in basements slabs and floors, expressed in equivalent insulation thickness.

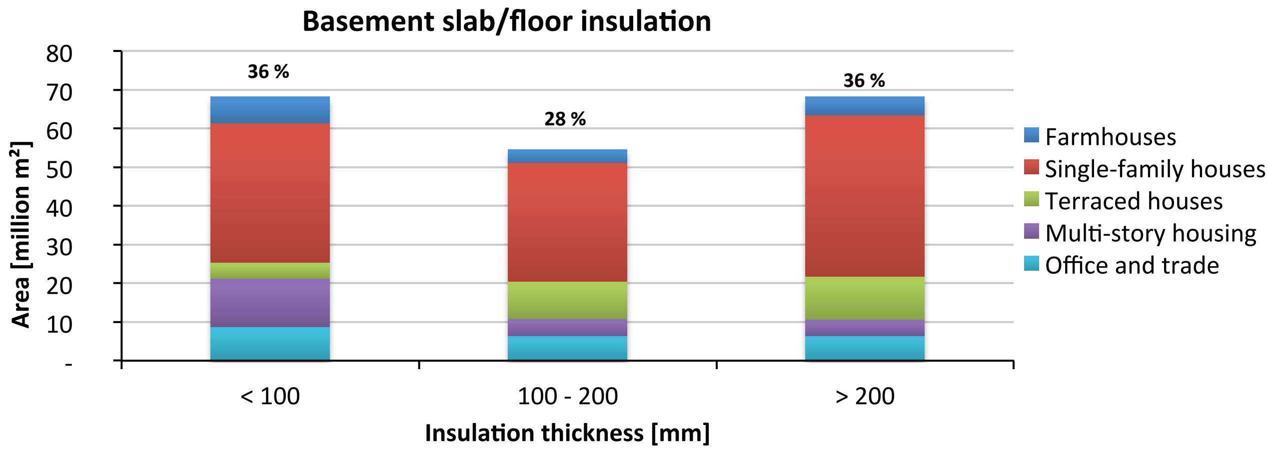

Figure 13: Scaled basement slab/floor area, calculated from heated area data in the energy labelling data base and the BBR. It is assumed that U-factors of 0.2 and 0.4 W/m²K correspond to insulation thickness of respectively around 200 mm and 100 mm.

Windows and doors

Figure 14 shows the total scaled area of windows and doors, based on a subsector of data from the energy labelling data base [4]. The windows are distributed by U-factor, which is assumed to indicate whether the window is made with a single pane, is double glazed, or is a 2 or 3 layer energy glazing unit window.

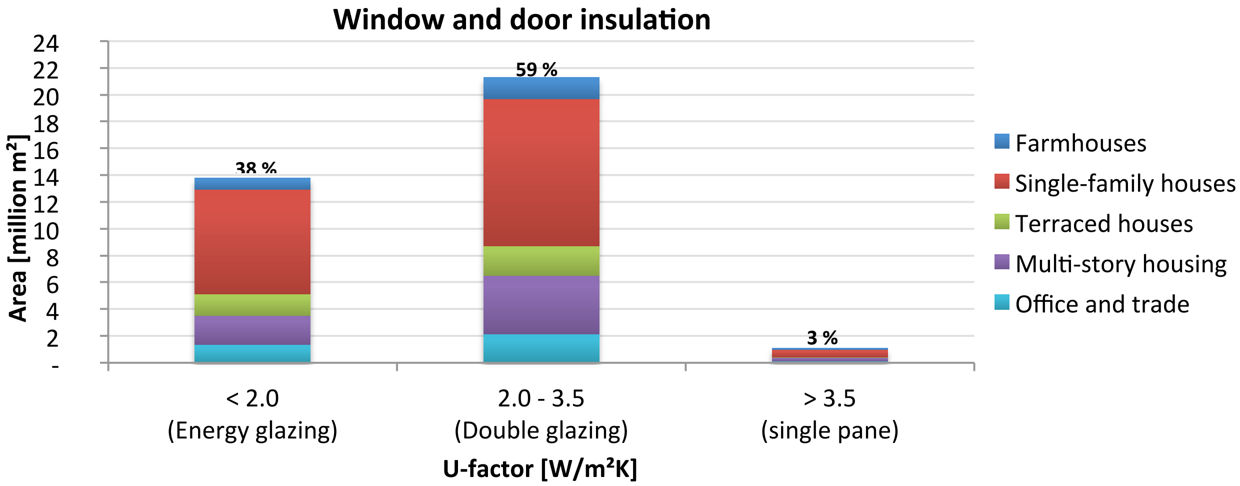

Figure 14: Scaled window and door area calculated from heated area data in the energy labelling data base and the BBR. Single pane windows are assumed to have a U-fact between 2.0 and 3.5 W/m²K, double-glazed windows (or windows with two single panes) are assumed to have a U+factor greater than 3.5 W/m²K, and newer low-energy windows are assumed to have a U-factor of less than 2.0 W/m²K.

Figure 14 shows that over 200 million m² of window and door area have U-factors that indicate single layer or older double-glazed glass. This represents a great potential for energy savings, since there are few architectural or technical problems associated with insulation solutions.

Roof windows

Figure 15 shows the scaled area for roof windows distributed by U-factor. This presents picture similar to that in Figure 14 above for windows and doors.

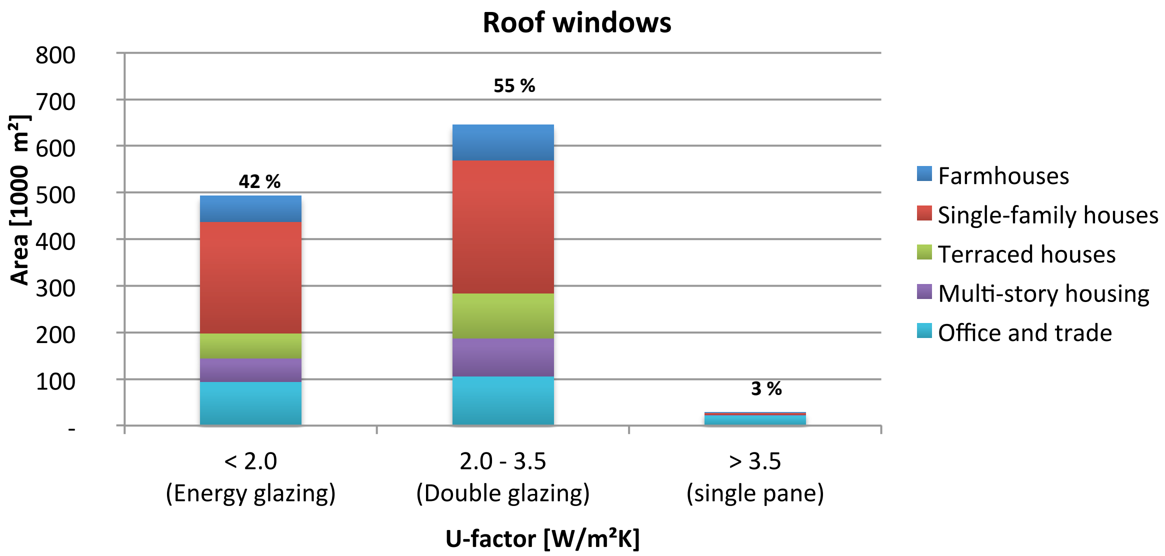

Figure 15: Scaled roof window area calculated from heated area data in the energy labelling data base and the BBR.

5.5 Gas-fired and oil-fired boilers and heat exchange units for district heating

Data subsets were retrieved for gas-fired and oil-fired boilers and for heat exchange units for district heating. The boilers are distributed over three levels of part-load efficiency.

Gas-fired boilers

Figure 16 shows the total scaled number of gas-fired boilers distributed by registered part-load efficiency.

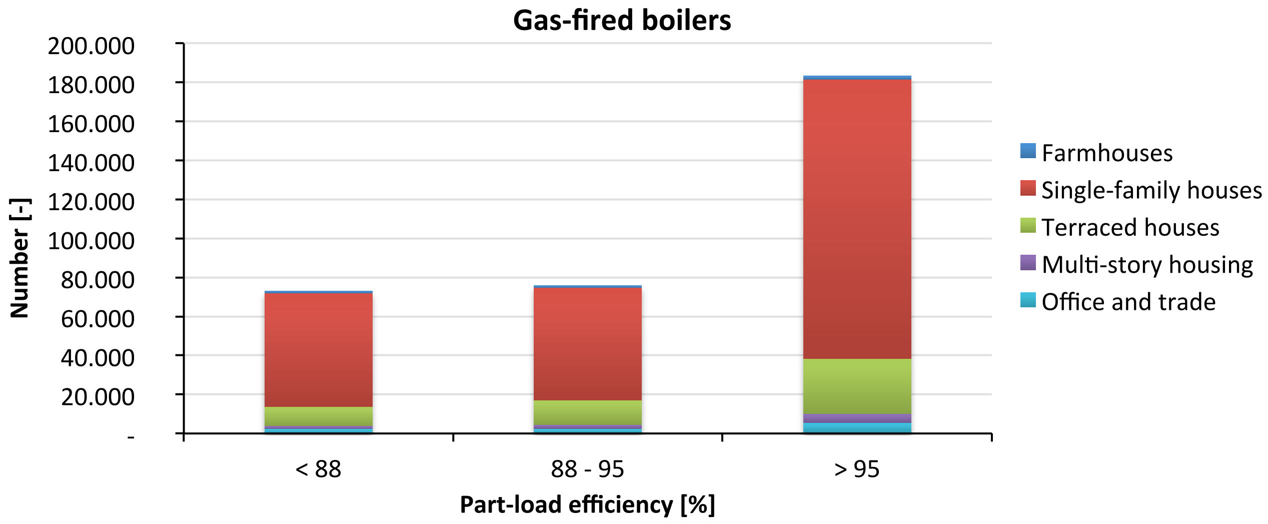

Figure 16: Scaled number of gas-fired boilers, data from the energy labelling data base and the BBR.

There are a total of 70,000 older gas-fired boilers with a part-load efficiency of less than 88%.

Oil-fired boilers

Figure 17 shows the corresponding scaled number of oil-fired boilers distributed by registered part-load efficiency.

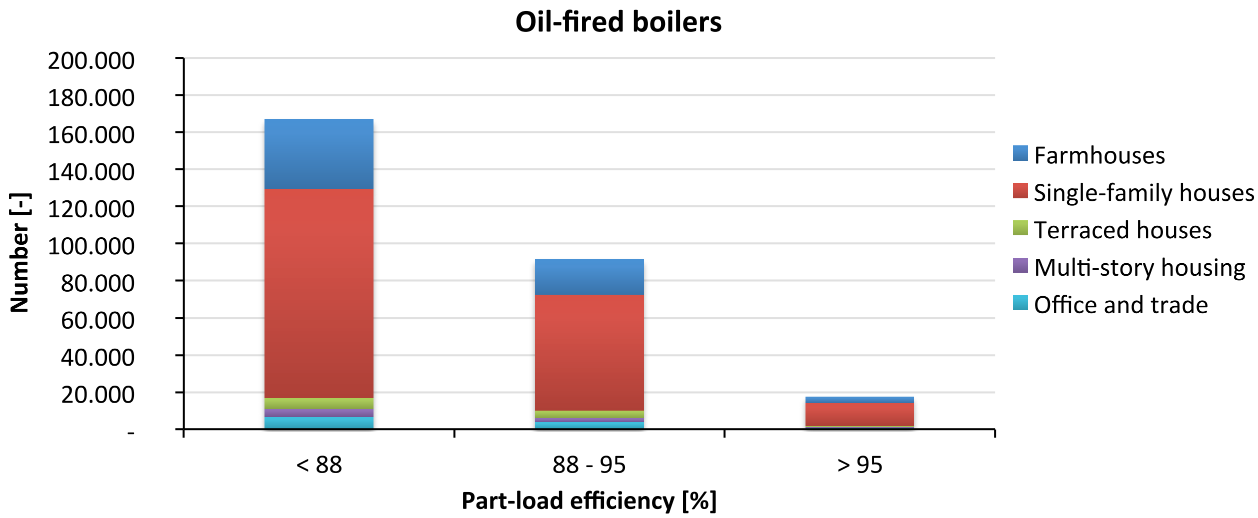

Figure 17: Scaled number of oil-fired boilers, data from the energy labelling data base.

A comparison of figures 14 and 15 shows that the general energy efficiency of oil-fired boilers is much lower than that of gas-fired boilers. In order to support the change from oil and natural gas boilers to renewable energy heating sources, the Energy Agreement has allocated DKK 42 million to support initiatives for and analyses of energy efficient alternatives such as heat pumps, solar heating, and solar cells.

It should be noted that there is some uncertainty in the BBR as to the number of oil-fired boilers registered. A correction has been used in scaling for the total number installed in farmhouses, single-family detached houses, and semi-detached or terraced houses.

Heat exchange units for district heating
Figure 18 shows the scaled number of heat exchange units for district heating, distributed by local heat loss.

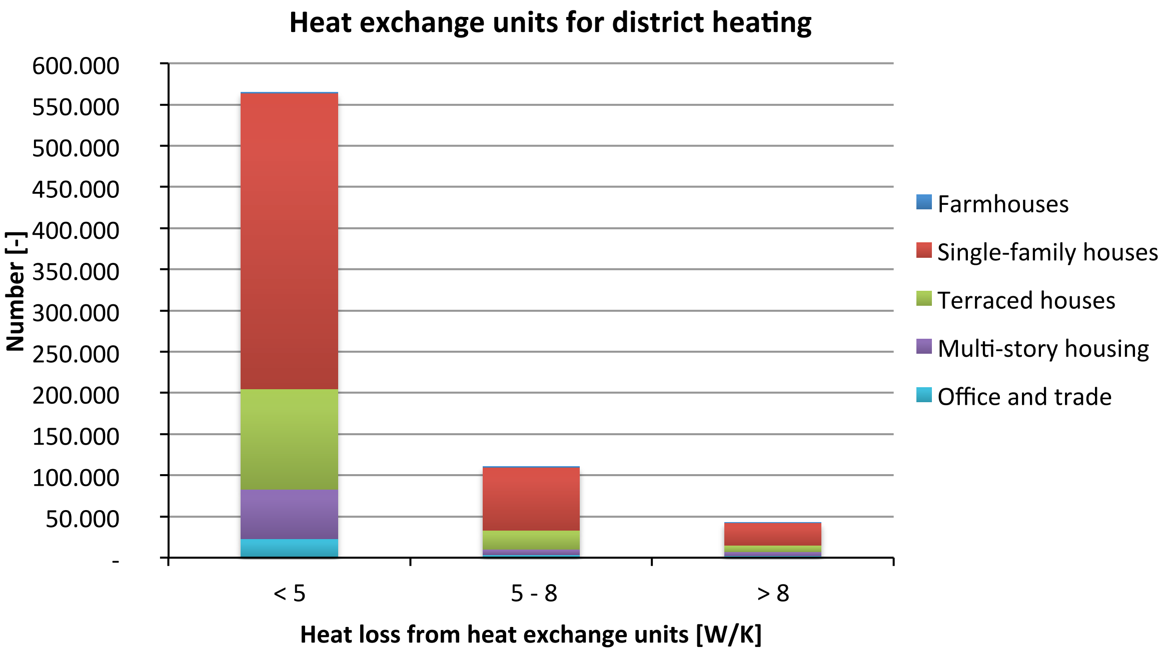

Figure 18: Scaled number of heat exchange units for district heating, data from the energy labelling data base and the BBR.

It can be seen that around 150,000 heat exchange units in district heating installations have a heat loss greater than 5 W/K, which indicates an older unit.

5.6 Development of heating and renewable energy systems, 2007-2011

A mapping study carried out by Tekniq (The Danish Mechanical and Electrical Contractors' Association) in 2012 shows that oil-fired boilers and electric panels are being phased out, and increasing numbers of solar cells are being installed [12].

"The investigation provides an overview of green energy developments. Figures show that around 52,000 oil-fired boilers have been phased out since 2007, and there are 6,500 fewer houses with electric heating compared to 2007. This is a decrease respectively of 14% and 5%. During the same period, 6.4% more houses have established district heating connections, and 9% more use natural gas for heating. The number of wood pellet boilers has increased by 43%, solar heating installations by 18%, heat pumps by 221%, and solar cells by 2,100%"

Facts on energy sources from 2007 to 2011 [12]

District heating installations:
2007: 1,502,873 dwellings
2011: 1,598,861 dwellings
Increase: 6.4 % — Annual change: +24.000 new installations
(Source: Statistics Denmark)

Oil-fired boilers:
2007: 384,852 dwellings
2011: 332,893 dwellings
Decrease: 13.5 % — Annual change: -13.000 change to other heating source
(Source: Statistics Denmark)

Natural gas boilers:
2007: 366,667 dwellings
2009: 399,322 dwellings
Increase: 8.9 % — Annual change: +8000 new installations
(Source: Statistics Denmark)

Electric heating:
2007: 133,629 dwellings
2011: 127,163 dwellings
Decrease: 4.8 % — Annual change: -1600 change to other heating sources
(Source: Statistics Denmark)

Wood pellet boiler:
2007: 56,000 units
2011: 80,000 units
Increase: 42.9 % — Annual change: +6000 units
(Source: Dansk Energibrancheforening (Energy Trade association) and the Danish Energy Agency)

Solar heating installations:
2007: 370,000 m²
2011: 436,000 m²
Increase: 17.8 % — Annual change: +16.500 m²
(Source: Dansk Solvarmeforening (Danish Solar Energy Association)

Solar cells:
2007: 500 kW
2011: 11,000 kW
Increase: 2,100 % — Annual change: +2600 kW
(Source: Energinet)

Heat pumps:
2007: 14,000 units
2011: 45,000 units
Increase: 221.4 % — Annual change: +7750 units
(Source: Danish Energy Agency and Tekniq)

Scenario for heating and renewable energy sources

"Heat Plan Denmark" [13] presents a scenario for a "rapid development" of the heating sector by 2050. The highlights are presented below.

From 2010 to 2020 the following focus areas are specified:

- Room heating savings of an average of 25%, corresponding to 20% of net heating needs.
- Reduce district heating return temperature on the average to 40 degrees C.
- District or block heating to provide 100% of heating for all new city housing construction.
- Increase district heating and "neighbour heating" for smaller towns to provide respectively 65 % and 5%.
- Increase the share of heat pumps to 25%.
- Maintain 5% individual natural gas installations.
- Electric and oil heating to be phased out as individual housing heating sources by 2020.
- Use biogas motors for district heating.
- Increase the use of biomass in district heating, which will stimulate biomass production.
- Increase the area of solar energy panels for the production of district heating to 4 million m².
- Increase the use of electric boilers and heat pumps for district heating as a supplement to decentralised natural gas district heating plants, which will be reserved for regulation in the electrical grid.
- Make use of the cogeneration potential from the remaining coal and gas fired power plants.
- Make use of waste heat from industry.
- Make use of cogeneration energy from new biomass fired power plants, to minimise thermal loss in distribution and to increase efficiency from 40% to 90% on a yearly basis.
- Make use of flue gas from the biomass fired cogeneration plants through flue gas condensation, so that efficiency can be further increased from 90% to 105%.
- Begin scaling geothermal plants.

Figure 19 shows the distribution of heat sources in this scenario.

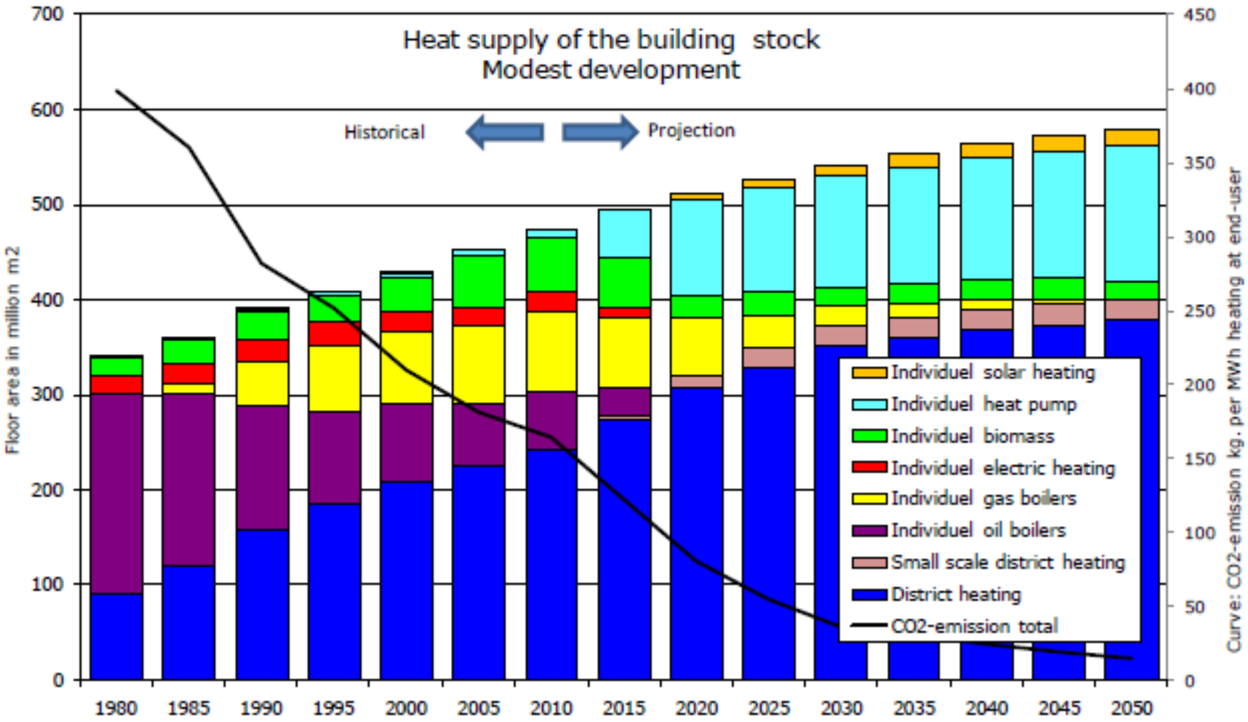

Figure 19: "Rapid development" scenario from Heat Plan Denmark 2010, showing the development of heat sources by 2050.

The above scenario is thus more ambitious then the Energy Agreement, since it assumes a 20% net reduction of energy consumption.

5.7 Statistics for energy consumption in Denmark

According to Energy Statistics 2010 [3] from the Danish Energy Agency, the climate-adjusted gross energy consumption in 2010 was 815 TJ. Compared to 1990, adjusted gross energy consumption fell slightly, by 0.5%. Energy consumption by households and trade and service enterprises accounted for 44%, as shown in Figure 20.

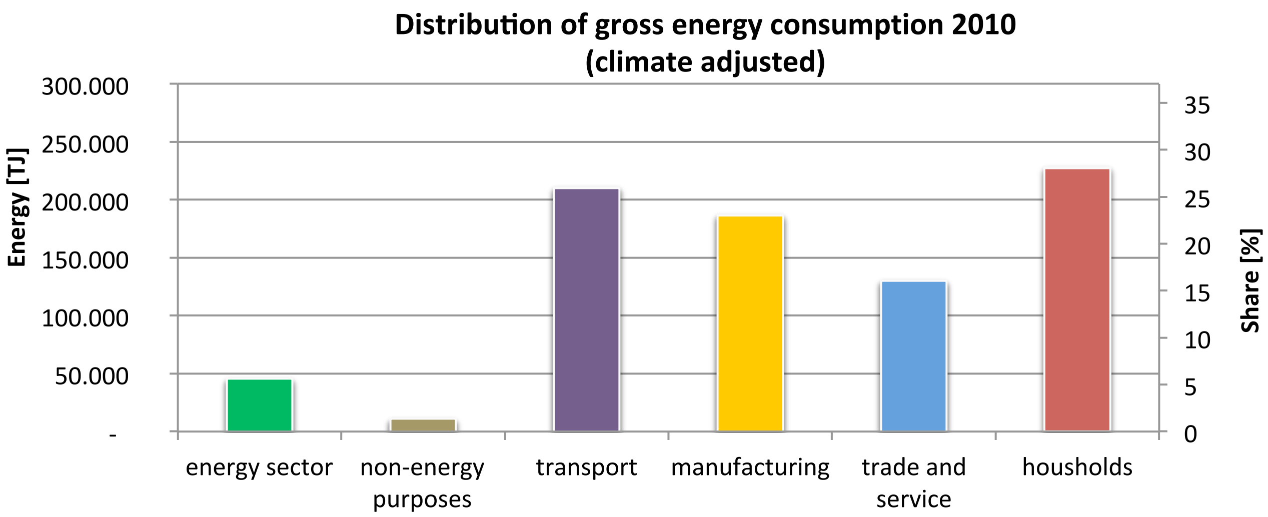

Figure 20: Denmark's total climate adjusted gross energy consumption for 2010, distributed by usage.

Statistics on energy consumption for heating

Energy consumption by households is calculated separately from consumption by trade and service enterprises in the Energy Statistics. The energy used for heating corresponds to the amount of energy delivered to buildings including energy loss in the buildings' heating installations. Since 1990 the energy consumption for heating has increased by about 3% (see Figure 21), while at the same time the heated floor area increased 19%.

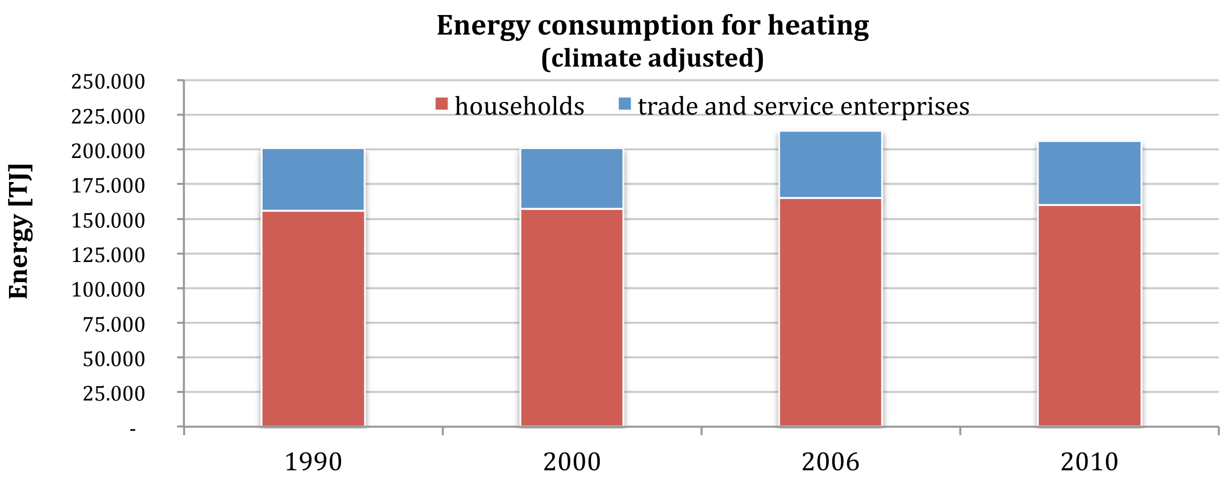

Figure 21: Denmark's climate adjusted energy consumption for heating, selected years [3].

As shown in figure 19, households account for over 75% of the total energy consumption for heating. A household thus consumes an average of 150 kWh/m² per year, while trade and service enterprises consume 185 kWh/m² per year.

The Energy Statistics also calculate consumption of electricity, shown in Figure 22. The consumption of electricity from 1990 to 2010 increased 3% in households and 27% in trade and service enterprises.

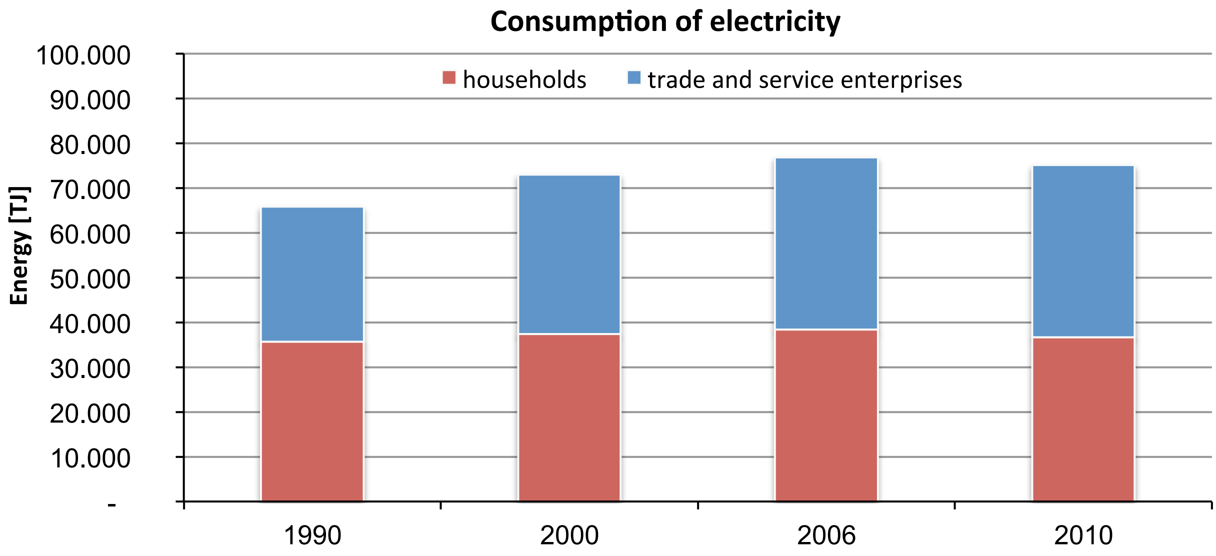

Figure 22: Denmark's consumption of electricity, households and trade and service enterprises, selected years [3].

Renewable energy in the building stock

The share of renewable energy used for heating buildings has increased to 20% in 2010 (Figure 23).

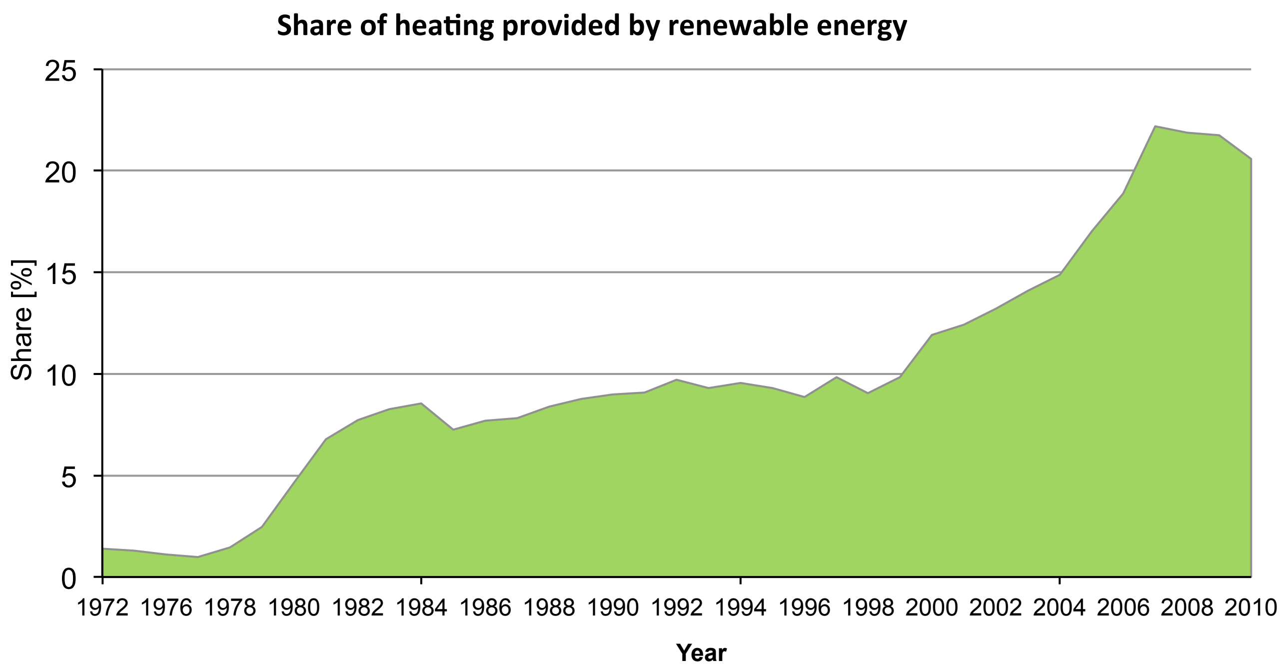

Figure 23: Share of renewable energy [3].

Calculation model for energy consumption in Danish buildings

The Danish Building Research Institute has constructed a calculation model for net energy consumption for heating buildings used for housing and for trade and service [5], [6]. The calculation model can be used to assess potential savings in different types of buildings from different historical periods. Table 7 presents the total net energy consumption (including hot water) for heating, distributed by period of construction and type of building.

Table 7: Calculated distribution of the total net energy consumption for heating and hot water in buildings used for housing or trans and service enterprises [5] og [6].

Construction period	Farm-Houses	Single-family detached houses	Terraced houses	Apartments	Trade & Service	Total
pre 1850	1	1	0,2	0,3	0,3	2
1850-1930	5	12	1	8	2	28
1931-1950	1	7	1	5	1	14
1951-1960	0,3	5	1	2	1	10
1961-1972	0,2	12	1	4	3	20
1973-1978	0,1	6	1	1	1	9
1979-1998	0,2	3	2	2	3	11
1999-2006	0,1	1	1	1	1	3
After 2007	0,0	0,4	0,2	0,2	0,5	1
Total	**7**	**47**	**8**	**24**	**14**	**100**

The greatest share of consumption is by buildings from before 1973, primarily single-family detached houses, and pre-1950 apartment buildings.

5.8 Employment in the construction sector

The following presents a statistical overview of the workforce in the construction sector, distributed by education level, workplace functions, and profession, The construction sector is defined by Statistics Denmark as group 3 in the 10-grouping of the Danish Industrial Classification of All Economic Activities 2007 (DB07), based on EU's NACE codes. [10]

The construction sector is a major employer in the Danish labour market. The table below shows the number of persons employed from the first quarter of 2009 through the third quarter of 2011.

Table 8 – Number employed in the construction sector

Year	2009				2010				2011			
Quarter	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Number (1000)	172	167	175	173	156	142	157	167	152	150	156	169

Source: Statistics Denmark, Workforce Examination. The figures represent the age group 15 to 64.

Employment in the sector is cyclical, and has in the period shown varied from 142,000 in the 2nd quarter of 2010 to 175,000 in the 3rd quarter of 2009.

Employment distributed by education

The core workforce in the construction sector is composed of persons with an upper secondary vocational qualification as the highest level of completed education. The second major group is composed of semi-skilled workers with a lower secondary qualification. Persons in the latter group will typically have participated in some form of continuing adult vocational education and training (AMU).

Table 9: Employment in the building and construction sector, distributed by highest completed education qualification

Qualification/year	2008	2009	2010
Lower secondary	56 069	49 706	40 921
General upper secondary	3 237	2 805	2 311
Vocational upper secondary	2 367	2 095	1 763
Vocational education and training (VET)	108 264	101 398	91 780
Short-cycle tertiary	10 277	9 806	9 199
Medium-cycle tertiary	7 786	7 232	6 463
Bachelor	421	386	330
Long-cycle tertiary	1 435	1 320	1 188
No information	3 571	3 079	2 548
Total	193 427	177 827	156 503

Source: Statistics Denmark - Statstistikbanken.dk/RASU22.
Note: In 2009 the registration-based workforce statistics began to employ income as a data basis. This means that there is a data gap in the statistics from 2008 to 2009 as the new data sources were phased in.

[10] Group 3 (construction) includes: development of building projects; construction of residential and non-residential buildings; construction of roads and railways; construction of utility projects; construction of other civil engineering projects; demolition; site preparation; test drilling and boring; electrical installation; plumbing, heat and air-conditioning installation; other construction installation; plastering; joinery installation; floor and wall covering; painting; glazing; other building completion and finishing; roofing activities; bricklaying; other specialised construction activities.

Persons with general upper secondary or vocational upper secondary qualifications will statistically be registered as semi-skilled even though they have completed a post-compulsory youth education programme. Short-cycle tertiary programmes (academy profession programmes) include a range of technician qualifications, plumbing, heat and air-conditioning installation, and electrical installation qualifications. Medium-cycle tertiary programmes (professional bachelor) include the bachelor of architectural technology and construction management and engineers with a professional bachelor degree. The remaining bachelor qualifications and long-cycle tertiary qualifications include civil engineering and architects.

The figures in table 9 include all trade groups including white collar employees without a qualification specific to the construction sector. To obtain a nuanced overview it is relevant to present the distribution by education of employees in the main employment categories of the construction sector, presented in table 10 below.

Table 10: Construction sector employees, distributed by education and field of employment, in % share of total workforce

	Lower secondary	Upper secondary	Vocational (VET)	Short-cycle tertiary	Medium-cycle tertiary	Long-cycle tertiary	No information
	%	%	%	%	%	%	%
Development of building projects	12,4	6,7	35,0	7,3	22,5	9,3	6,8
Construction of residential and non-residential buildings	26,8	3,0	51,4	3,3	11,0	2,1	2,5
Construction of roads and railways	41,5	2,6	37,0	3,7	9,8	2,7	2,8
Construction of utility projects	44,9	2,2	43,4	3,4	3,2	0,6	2,5
Construction of other civil engineering projects	37,2	2,6	49,0	2,1	6,2	0,6	2,4
Demolition	46,2	2,4	36,7	1,5	5,0	0,9	7,4
Site preparation	46,7	1,7	43,3	1,1	2,7	0,5	4,1
Test drilling and boring	28,1	6,3	34,4	6,3	21,9	.	3,1
Electrical installation	19,8	3,5	58,6	14,3	2,7	0,5	0,6
Plumbing, heat and air-conditioning installation	19,4	1,5	65,9	9,8	2,3	0,3	0,8
Other construction installation	28,4	3,3	57,9	3,9	4,5	0,6	1,5
Plastering	20,0	.	65,0	2,5	2,5	2,5	7,5
Joinery installation	21,3	2,4	69,6	2,1	3,2	0,3	1,1
Floor and wall covering	41,1	4,0	48,0	1,4	2,7	0,3	2,5
Painting	22,4	1,9	70,6	1,1	1,4	0,3	2,3
Glazing	23,4	1,9	69,9	1,2	1,8	0,4	1,5
Other building completion and finishing	29,1	5,4	56,8	2,2	2,8	1,2	2,6
Roofing activities	41,5	2,5	47,4	2,5	3,6	0,5	2,1
Bricklaying	23,2	1,8	69,1	1,8	2,6	0,3	1,2
Other specialised construction activities	38,7	3,4	49,4	2,3	3,1	0,7	2,4
Total	25,9	2,6	59,6	5,1	4,4	0,8	1,6

Source: The Economic Council of the Labour Movement, based on construction employment in the registry of workforce statistics 2010.

The table provides an overview of those parts of the sector that primarily employ a semi-skilled workforce, for example for demolition and site preparation. It is also worth nothing that over 40% of those employed in roofing activities and in floor and wall covering are semi-skilled.

Employment distributed by main construction activity

Employment in the construction sector can be divided into four main activities: new construction, repair and maintenance, plant and facilities construction, and office work. In addition, there is a category of "other". Table 11 shows employment distributed by main activity for the first quarter of each year of the period 2002-2011. The figures are adjusted for seasonal variations.

Table 11: Employment in the construction sector distributed by main activity

Activity	2002 Q1	2003 Q1	2004 Q1	2005 Q1	2006 Q1	2007 Q1	2008 Q1	2009 Q1	2010 Q1	2011 Q1
New construction and additions	40 938	40 648	39 189	38 544	41 776	49 077	48 672	38 169	25 914	30 182
Repair and maintenance	53 795	50 473	51 989	56 230	54 430	62 432	57 540	56 856	49 369	52 571
Plant and facilities	19 498	18 152	15 992	17 772	16 622	21 074	23 016	22 421	16 396	18 569
Other	8 254	7 834	7 700	5 790	5 954	5 889	7 374	5 907	4 841	4 219
Office	24 147	23 707	22 332	21 750	22 014	25 702	24 500	24 252	23 826	22 145
Not at work because of weather, vacation, illness, training, etc.	8 170	9 053	9 681	11 438	10 657	13 414	11 802	12 573	12 098	9 657
Total	154 802	149 867	146 883	151 524	151 453	177 588	172 904	160 178	132 444	137 343

Source: Statistics Denmark – Employed in construction by branch (DB07), type, and adjusted for seasonal variation.

Not surprisingly, the table shows that employment in new construction and additions is highly cyclical, ranging from 50,000 in 2007 to 30,000 in 2011. Throughout the entire period shown, the greatest share of employment in the construction sector is in repair and maintenance. Employment in this field has recently become relatively more important for overall employment, due in part to public subsidy for renovation projects.

Employment of the working population with a construction-related competence, distributed by industrial classification

Limiting the building and construction sector to group 3 in the 10-grouping classification (DB07) excludes two major groups with relevance for the overall construction sector workforce: 1) consultancy activities, and 2) members of the workforce who have construction-related qualifications but are not employed directly in construction. In order to obtain a complete overview it is relevant to examine employment in classification groups with construction-related qualifications among all of the 10-group DB07 industrial classifications:

1. Agriculture, forestry and fishing
2. Manufacturing, mining and quarrying, and utility services
3. Construction
4. Trade and transport etc.
5. Information and communication
6. Financial and insurance

7. Real estate
8. Other business services
9. Public administration, education and health
10. Arts, entertainment and other services
11. Activity not stated

Table 12 shows employment distribution by main groups in the 10-group DB07 industrial classification. "Qualification" means the highest level of completed education as of October 2009.

Table 2 Employment of the working population with a construction-related qualification, distributed by main industrial classification. Note: some qualifications have the same name in this table, but include slightly different specialisations or educational pathways (C.E. = civil engineer). Numbers 1 through 11 refer to the industrial classifications above.

Qualification	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**
C.E., buildings	2	14	14	9	2	.	4	84	21	3	.	153
Aluminium fitter	.	17	9	3	.	.	.	1	4	.	.	34
C.E., facilities	1	99	2	15	15	.	1	120	113	4	2	372
C.E., Architectural Technology and Construction Management, facilities	.	1	1	1	1	.	.	6	.	.	.	10
Civil construction worker	30	51	651	57	3	2	2	71	48	4	5	924
Architect, master's	26	194	98	251	142	91	223	3.325	1.711	181	92	6.334
Architect, PhD.	.	.	.	2	2	1	1	16	35	3	1	61
Construction, technical engineer.	12	92	157	47	12	25	20	263	156	6	7	797
C.E., construction	.	5	.	3	.	.	1	23	12	1	.	45
Construction engineer, bachelor	.	.	7	32	3	1	.	61	20	5	.	129
Wall, ceiling and unit installer	.	24	55	33	1	.	2	9	26	3	.	153
Building technician	34	537	932	432	30	81	131	484	630	88	35	3.414
Engineer, academy profession, buildings	5	161	286	108	72	36	63	734	265	12	8	1.750
C.E. buildings	5	246	132	106	126	31	18	899	400	14	6	1.983
Engineer, professional bachelor, buildings	4	267	697	99	36	19	28	1.178	318	22	4	2.672
Technical engineer, buildings	21	494	758	236	66	87	117	1.278	687	35	27	3.806
C.E., Architectural Technology and Construction Management	.	2	1	2	2	.	.	6	1	.	.	14
Architectural Technology and Construction Management	38	508	1.527	449	35	295	389	1.953	1.031	106	45	6.376
House painter	67	642	7.072	1.117	47	33	315	508	1.391	343	125	11.660
Joiner/carpenter	127	1.229	3.282	850	37	56	275	378	933	281	71	7.519
Concreter	3	34	515	39	1	.	3	34	52	8	2	691
C.E., unspecified	25	1.811	166	588	1.426	244	34	2.466	1.290	102	30	8.182
Design-innovation, engineer, bachelor	1	9	.	19	7	2	2	20	18	13	1	92
Diploma degree, bachelor, unspecified	7	171	19	65	36	8	7	104	44	4	4	469
Property technician, commercial-institutional.	.	2	5	7	.	.	30	25	190	9	.	268
Property assistant	.	.	.	.	.	.	10	3	5	.	.	18
Property service technician, housing	1	3	5	8	2	1	304	18	26	5	2	375
Electrician, building automation	.	2	6	.	.	.	.	.	.	.	.	8
Electrician, installation technology	263	5.365	11.111	4.393	1.553	176	427	2.187	2.187	723	117	28.502
Electrician, installation technology	58	1.413	2.302	799	189	60	150	581	387	106	51	6.096

Electrician, general installations	.	4	16	2	.	.	.	.	1	.	.	23
Academy profession engineer, energy	.	54	5	8	8	4	.	32	7	1	1	120
C.E. energy	1	170	5	39	96	4	1	114	25	7	4	466
Glazier	8	128	742	189	6	5	45	62	130	28	13	1.356
Floor layer	1	30	245	109	2	.	3	12	20	4	5	431
C.E., housing construction	1	8	11	6	7	2	2	72	12	2	.	123
Technical engineer, housing construction	1	50	92	26	5	18	17	181	83	3	1	477
C.E. indoor environment	.	4	1	1	1	.	.	11	9	2	1	30
Installations technology	.	92	365	43	15	.	2	86	23	3	3	632
Installations technology, high voltage	2	334	427	155	63	3	6	134	53	13	5	1.195
Installations technology, plumbing	11	133	503	161	6	7	28	98	71	13	14	1.045
Climate and environment technician	.	1	7	.	.	.	1	.	1	.	.	10
C.E. construction	1	33	7	5	8	2	1	58	15	1	1	132
C. E. construction	2	31	.	8	3	1	.	32	9	1	1	88
Woodcutting machinist	49	1.522	528	493	13	10	45	129	280	82	18	3.169
Bricklayer	282	986	9.334	1.116	43	62	353	547	1.127	281	161	14.292
Chimney sweep	9	80	62	100	2	3	15	532	86	15	4	908
Plasterer	.	.	12	2	.	.	1	2	6	.	.	23
Roofer	.	6	117	5	.	.	.	4	5	4	.	141
Technical insulator	2	27	139	17	2	.	3	11	14	2	2	219
Thatcher	1	1	21	2	.	.	1	.	2	.	.	28
Carpenter/joiner	792	3.570	20.527	3.193	153	183	1.027	1.476	3.405	823	297	35.446
Plumber (energy systems specialist)	15	136	1.500	225	8	2	35	76	137	21	3	2.158
Plumber (industrial systems specialist)	1	6	13	4	.	.	1	1	.	.	.	26
Plumber (ventilation systems specialist)	.	7	33	2	.	.	.	1	2	1	.	46
Plumber	6	76	380	79	4	5	12	47	46	5	2	662
Plumber (roof and facade specialist)	59	1.101	4.363	967	52	21	369	466	726	157	49	8.330
Total	1.974	21.983	69.265	16.727	4.343	1.581	4.525	21.019	18.296	3.550	1.220	164.483

Source: Statistics Denmark, Workforce Registry (RAS)(November 2008) and population's highest completed qualification as of October 2009, age group 15-69. Only persons with a CPR number (personal identification number) are included. Comparison with data in StatBank is not possible, since data are delimited differently.

The table shows that there were 164,000 persons with a construction-related qualification who were employed as of November 2009. Of these, around 70,000 were employed in the construction sector. Around 21,000 were employed in group 8, other business services, primarily architects, engineers, and constructing architects (BA in architectural technology and construction management).

Finally, 22,000 were employed in manufacturing and 18,000 were employed in group 9, public administration, education and health.

The table thus shows that only around half of those with a construction-related qualification find employment in the construction sector.

5.9 Lack of statistical information

There is no official record of the extent of energy renovation carried out, and it is therefore difficult to estimate the current level and its effect.

It must be assumed that an important share of energy renovation is “do-it-yourself” work or black market economy, neither of which is statistically documented.

There is also a lack of knowledge about the amount of time needed for energy renovation projects now and in the future. Some studies show that after only a few iterations of the same work processes, the time required is reduced by 20 to 50%.

6. Current construction sector education

The following presents a number of current construction sector education programmes that are seen as relevant for the competences of those who carry out construction projects. It includes relevant upper secondary vocational education, medium-cycle tertiary education, and continuing and further education. The following relevant upper secondary programmes are included:

- Property maintenance technician
- Electrician
- Energy technician
- Glazier
- Bricklayer
- Chimney sweep
- Joiner
- Concreter
- Technical insulator
- Woodwork construction
- Plumbing, heat and air-conditioning energy

The following medium-cycle tertiary programmes are included:

- Energy technology
- Installations technology (electric and plumbing, heat and a/c)
- Architectural technology and construction management

There are also relevant continuing and further education offers for the construction sector, mostly within the adult vocational training system (AMU). A few of the larger private suppliers are also included in the presentation.

Apart from the education programmes mentioned above there are a number of other VET-education programmes dealing with energy optimisation and which will become part of the future work with the Build Up Skills Denmark project

6.1 Upper secondary vocation education (EUD)

Governance and provision

Danish upper secondary vocational education (EUD) is supplied and quality assured by the Ministry of Children and Education (previously Ministry of Education), in collaboration with the national trade committees, which are responsible for dimensioning and monitoring. The school-based part of the programmes is partially financed by the State on a taximeter basis.[11] Practical training, where students enter into a contract with an employer, is financed by the employers. The individual employer receives a subsidy from the Employers' Reimbursement Fund, which is financed by mandatory contributions from all employers, both public and private.

Vocational education programmes in construction are provided by technical colleges, vocational training centres (EUC), or trade schools. There are 12 "entryways" to vocational education. The construction entryway includes woodwork construction, bricklayer, carpenter/joiner, glazier, plumbing/heating/air conditioning, technical insulator, and concreter. The entryway "electricity, automation, and ICT" includes the electrician programme, the entryway "building and user service" includes property maintenance technician, and the entryway "production and development" includes energy technician, which is a specialisation in the metalworker programme.

Course of study and level

An upper secondary vocational education programme consists of a basic course and a main course. A student who has completed 9 years of lower secondary school will typically spend 10 to 20 weeks in the basic programme, depending on the choice of specialisation and possible add-on courses. The main course lasts 3 to 3.5 years, and is a combination of school-based and work-based (apprenticeship) training. The maximum duration can thus be 4 years.

An assessment of prior learning is carried out for all students before they start. The school can thus find out if there are parts of the education programme that students already master and can receive credit transfer for. Evaluation is made on the basis of the students' own documentation and actual capabilities. The school also evaluates possible needs for supplementary education during the course of the programme. Students who receive credit for prior learning must be offered courses at an advanced level or other training assignments that are appropriate for the school-based portion of the programme. Students who are offered advanced placement but turn it down must work at their apprenticeship enterprises while these courses are in session.

The student and the apprenticeship enterprise can, on the basis of assessed prior learning and relevant workplace (construction site) experience, apply to the trade committees to shorten the work placement. Applications may be sent in before the apprenticeship contract is signed, and at latest a half year after signing. The application must include proof of previous relevant workplace experience.

A successful apprenticeship exam ends the vocational education programme. The qualification is in Denmark recognised as level 4 in the Danish Qualification Framework for lifelong learning, level 4 of the European Qualification Framework, and level 4 in the International Standard Classification of Education (ISCED).

Quality assurance

[11] http://www.eng.uvm.dk/Education/General/The-Taximeter-System

The social partners are an integrated part of management and quality assurance of upper secondary vocational education. This is done through the Advisory Council for Vocational Education (REU). The REU operates as an advisory organ for the Ministry of Children and Education in questions regarding upper secondary vocational education. The REU is composed of equal numbers of representatives from employer and employee organisations. Each vocational programme has its own trade committee, which has the following main tasks and responsibilities.

- Length and structure of the programme, including the distribution of school-based and work-based portions.
- Programme objectives
- Other content-related framework conditions such as differentiated courses
- Evaluation plan for general area subjects and specialisation subjects
- Apprenticeships
- Programme entryway(s)
- Educational guidelines for the individual programmes
- Guidelines for the apprenticeship exam
- Approval of apprenticeship enterprises

The Minister for Children and Education specifies regulations upon recommendation of the trade committees.

The trade committees are responsible for the continuous adaptation and development of the VET programmes. The committees monitor the skills development in the labour market and, on that basis, recommend changes to existing programmes. They may also recommend the establishment of new VET programmes or the restructuring or discontinuation of out-dated VET programmes. Each trade committee must annually send the Minister a report on such activities, also describing the trade committee's plan of action for its activities.

Monitoring

The education programmes are monitored to make sure that they achieve their objectives. This occurs through an annual impact measurement based on the programmes' employment participation rates. The Ministry for Children and Education consults with the trade committees on those programmes that do not achieve their objectives. The trade committees prepare an annual monitoring report focusing on labour market developments that are relevant for the quantitative and qualitative demand for a skilled workforce. This is to assure a continual dynamic adjustment of the programmes so that they can best match labour market demand. Monitoring efforts also include a highly developed statistical base.

Institutions are monitored to assure that each programme is offered in accordance with regulations and frameworks applicable to each institutions' overall operations, which the Ministry is responsible for. Monitoring is based on the quality of programme implementation, including test results and statistics on drop-out and programme completion. The social partners also take part in this monitoring. The local training committees[12] act as advisor to the institutions in all matters concerning the VET programmes within their jurisdiction, and promote cooperation between education institutions and the local labour market.

Content
The content of vocational education programmes is determined by competence outcomes specified by the trade committees within the legislative and economic framework, along with other standards from other authorities. When for example energy standards are tightened in the building code, then this must be included in vocational education programmes. The trade committees specify the education guidelines within the legislative framework set out by the Minister. This is then sent to hearing in the vocational education institutions before final approval by the Ministry.

Energy optimisation

The following presents the individual education programmes' focus on energy optimisation and efficiency improvement. The presentation is based on the competence outcomes that are specified in the Ministerial order regarding the educational guidelines for vocational education programmes. In order to obtain a more concrete picture of what actually is taught, the guidelines where the individual subjects are specified and described are also presented. The guidelines' description of individual subjects makes it possible to see how the individual competence outcomes are operationalised.

This is the background for the following presentation of the competence outcomes related to energy optimisation and the subjects relevant to achieving these objectives.

Property maintenance technician
The overall competence outcomes are that the student can

- contribute to optimal resource savings and environmentally aware property operations (outcome 1) and
- instruct on environmentally aware behaviour related to energy consumption (outcome 14).

In addition there are operations outcomes

- operate buildings' technical facilities and installations (outcome 6),
- in accordance with applicable regulations perform indoor and outdoor repairs and replacements of technical systems, facilities, installations, and machines (outcome 7) and
- manage operations and maintenance of heating and ventilation systems (outcome 8).

There is also a particular outcome that the student can

- prepare maintenance plans, programmes, and reports […] (outcome 21).

---

[12] The local training committees (*de lokale uddannelsesudvalg*) assist the vocational education institutions in the local planning of the programmes. The committees consist of members representing the organisations represented on the national trade committees. They are appointed by the trade committee upon recommendation from the local branches/affiliates of the organisations. The local training committees also include representatives from the institution, the teachers and the trainees.

The outcomes are operationalised through the subjects *building maintenance* 1 and 2, *ventilation and indoor climate* 1 and 2, and *heating systems* 1 and 2.

In general, this programme focuses on resource-saving and environmentally aware operations and maintenance of properties and ventilation, heating and technical systems. A property maintenance technician does not professionally participate in new construction, but rather has an advisory function.

Electrician
All elements of the electrician programme deal with energy. The overall outcome that the student can "optimise work processes and installation solutions through creativity and innovation, and gather relevant information with the goal of becoming an entrepreneur" focuses sharply on energy optimisation.

The focus on energy optimisation is sharpened even more in the competence outcomes for the programme specialisations. The outcomes for building automation are that the student can

- carry out electrical installations, install automation systems and distribution boards and control panels in housing, commercial buildings, and industry, connect electrical equipment in accordance with applicable regulations and in relation to the student's specialisation, and assure that installation principles are complied with (outcome 4),
- dimension sockets, main and group cabling, section- and distribution boards, lighting, three phase installation, and motor installations (outcome 9),
- advise and instruct users on system and installation operations (outcome 11),
- prepare small automated systems, including the connection of 1 and 3-phased electrical equipment, motors with various control device principles, and standard wiring and mains connections on the basis of knowledge of the most common mechanical control, steering, and sensor devices, electromechanical relays, and timer relays (outcome 13),
- install, program, and configure central and decentral intelligent building installations and other types of building networks (outcome 38),
- construct and manage, adjust, and energy optimise ventilation, heating, and cooling systems by using central control and monitoring (CCM) (outcome 40),
- integrate intelligent building systems, CCM, protection, alarm and monitoring systems, as well as building management systems (outcome 43), and
- during operations, service, and maintenance, carry out energy optimisation on automated building systems in accordance with energy standards (outcome 44).

The outcomes for the general installations specialisation are that the student must be able to

- carry out electrical installations, including small distribution boards and control panels in housing, commercial buildings, and industry, as well as connect electrical equipment to the mains in accordance with applicable regulations and assure that installations principles are complied with (outcome 45),
- install and maintain small automation systems and motorised installations (outcome 46),
- install and service, troubleshoot, and maintain lighting systems in buildings (outcome 48),
- with guidance, troubleshoot and maintain electrical installations (outcome 51), and
- with guidance, dimension lighting, motor installations, and three-phase installations in housing and commercial buildings (outcome 53).

Students specialising in installations technology must live up to outcomes 4, 9, 11, and 13 above, and in addition must be able to

- install, manage, adjust, service, troubleshoot, and maintain lighting systems in housing, commercial buildings, and industry (outcome 14),
- advise about and carry out energy optimisation in accordance with applicable energy standards (outcome 16),
- construct, install, program, maintain, and troubleshoot automated systems including motorised installations (outcome 17),
- design and calculate lighting installations that meet the demands and requirements of comfort, environment, and energy (outcome 18), and
- install and program centralised intelligent building systems in housing, commercial buildings, and industry (outcome 19).

Students specialising in communications technology and students specialising in control and regulation technology must also live up to outcomes 4, 9 11 and 13. In addition, these students must be able to

- construct, install, program, put into service, maintain, and troubleshoot automated machine systems in accordance with applicable regulations (outcome 21),
- use various types of control and regulation methods by following documentation and descriptions, and troubleshoot, repair, and maintain automated systems (outcome 22)
- energy optimise automated machine systems (outcome 28).

These competence outcomes are operationalised through a range of subjects, some part of the basic (shared) programme, and some part of the individual specialisations. In the basic programme the subjects *technical innovation* and *use of robots in production systems* contain competence goals. In the installations technology specialisation the relevant subjects are:

- Intelligent building systems
- Energy technology and environmental requirements
- Installation and assembly technology
- Dimensioning, measuring technology, and troubleshooting
- Lighting technology
- Lighting systems
- Automation systems for machines (institutional buildings)
- Automation systems in buildings
- Energy and environmental policy
- Energy optimisation
- System technology, electricity, and energy systems
- Control and regulation of electro technical systems

The communications technology specialisation also includes the subject *electrical technology*.

The control and regulations technology specialisation also includes the subjects *automatic machine systems* and *control technology*.

The building automation specialisation also includes: *ventilation, heating, and cooling; central control and monitoring; data collection and integration,* and; *intelligent building systems in small buildings*.

Energy technician

This specialisation is part of the metalworker programme. The programme focuses on energy optimisation in many ways. The overall competence outcomes relevant to energy optimisation are that the student can

- plan and install, repair, and maintain housing heating systems, district heating stations, and industrial heating plants (outcome 28),
- install, repair, and maintain heating, water, drainage, gas, and ventilation installations, including the use of control and regulation techniques in accordance with applicable regulations and standards (outcome 29),
- advise on the most appropriate repairs relevant to customer requests and expectations for operational reliability, economy, and applicable safety and environmental regulations (outcome 30), and
- produce individual components for plate and pipe constructions (outcome 31).

The subjects that operationalise these outcomes are:

- From idea to water, heating and sanitation – technical installation
- Alternative energy
- Control and regulation
- Construction drawings and quality
- Installation technology – piping, domestic water, and heating
- Installation technology – drains, gas and heating
- Installation technology – district heating and gas
- Energy instruction

Elective specialisation subjects are:

- Energy- and environmental policy
- Energy optimisation
- Systems technology for energy installations
- Regulation of energy systems
- Technical innovation
- Thermal jointing
- Welding (pipe certification)
- Thin sheet, zinc
- Control and regulation of thermal distribution systems

Glazier
The glazier programme's competence outcomes are that the student should be able to

- advise about the choice of materials and construction for an assignment, taking style, qualities, function, economy, timetable, and maintenance into consideration (outcome 7) and
- prepare and mount glass including electronics and fittings mounted on glass, carry out framing, work with car windows, aluminium and glass facades, and aluminium roof structures, fit window and door elements, renovate windows, and repair leaded windows (outcome 10).

The competence outcomes are operationalised in the compulsory subjects *understanding materials* and *functional glass*. Relevant elective subjects are *roof construction and joinings in aluminium* and *exterior wall and window renovation*.

Bricklayer
Students in the bricklayer programme should by the end of the basic course be able to

- read construction plans and diagrams and be able to employ praxis-related basic techniques for drawing diagrams and projection views, including symbols and illustration methods (outcome 1),
- prepare sketches and manuals and electronic drawings, including illustrations and projection drawings related to practical assignments (outcome 2),
- plan and carry out standard tile and floor assignments and brickwork constructions, and account for the rules, regulations, and specifications that are applicable for the work and its quality, and for the importance of planning for quality in process and result (outcome 3), and
- select, combine, and fashion materials relevant for tile and floor work and brickwork constructions, use the profession's most common tools, and produce simple tools and auxiliary instruments (outcome 5).

Competence outcomes for the specialisation programme are that the students should be able to:

- lay tiles in new construction, urban renewal, and repair and restoration projects, and carry out moisture control measures in wetrooms (outcome 1),
- build floor constructions of concrete with ceramic or natural stone covering, assess damage to existing tiles, and repair older and more recent damage (outcome 2),
- recognise styles, architecture, and design, and employ concepts of aesthetics (outcome 10),
- gather information from written and electronic sources on the importance of social, economic, and political forces for current societal development and the interaction between societal and commercial development, including environmental aspects (outcome 16),
- explain the concepts of innovation, entrepreneurship, and independence (outcome 17),
- participate in preventive safety arrangements, and organise these on the construction site or in the enterprise (outcome 18), and
- structure, plan, and assess assignments from the point of view of international norms and enterprise relevant consequences (outcome 19).

The competence outcomes are operationalised through the compulsory subjects *construction and society 1 and 2* and *bricklayer technology*, and through the electives *plastering and surface treatment* and *restoration*.

Chimney sweep
In the chimney sweep programme almost everything deals with energy optimisation in one form or another. The overall competence outcomes are to be able to:

- clean, troubleshoot, and carry out mandatory inspection of oil-fired boiler installations and solid fuel boilers using fossil fuels, report control measurement results, advise customers about energy efficiency measures and how to carry out projects in accordance with safety regulations (outcome 1),
- install, repair, and clean chimneys, carry out control measurement and fire-preventive inspection of chimneys and other all other types of systems for combustion and heating including channels and piping, and ventilation systems and their channels (outcome 2),
- service oil-fired systems and control and adjust biofuel-fired boilers (outcome 3),

- clean boilers in solid fuel, liquid fuel, and gas systems and wood burning stoves, including channels and piping (outcome 4), and
- clean and maintain ventilation channels, and provide service and advice on combustion and fire hazard and environmental questions (outcome 5).

The competence outcomes for the basic programme are that the students should be able to

- explain the composition of flue gas produced by the combustion of various fuels, and explain how flue gas affects the environment (outcome 1),
- participate in advising a customer on the choice of boilers and ovens for solid fossil fuels and biofuels, using knowledge about combustion's chemical reactions (outcome 2),
- assess the placement of small chimneys and fireplaces and advise the customer on the basis of relevant laws and regulations, prepare reports and other documentation about fire preventive inspection, chimney cleaning, and technical aspects of combustion (outcome 3),
- explain how an oil-fired boiler works and what its components are, and present technical information and documentation (outcome 4),
- explain cleaning methods, smoke draft, and tools and their practical use, in accordance with rules for a safe and healthy work environment (outcome 5), and
- assess physical factors that determine how a chimney functions and that are relevant for calculation and dimensioning of chimneys and fireplaces (outcome 6).

The competence outcomes for the main (specialisation) programme are that the student can

- troubleshoot, perform mandatory inspection, and clean oil-fired boiler systems and solid fuel-fired boiler systems that employ fossil fuels (outcome 1),
- report control measurements of boiler systems (outcome 2),
- calculate boiler system profitability in order to be able to advise on energy optimisation (outcome 3),
- clean, troubleshoot, and repair chimneys, fireplaces, and boilers (outcome 6),
- troubleshoot and carry out control measurements on combustion and ventilation systems (outcome 7),
- calculate and advise customers on the environmental and energy consequences of fireplace combustion (outcome 8),
- clean ventilation systems and assess their functionality (outcome 9),
- approve new chimneys, fireplaces, and furnace rooms, and issue operations certificates (outcome 11),
- assess the physical factors that determine the air-tightness of a building in relation to air flow for combustion (outcome 12),
- advise on the correct choice of and installation of chimneys and fireplaces, and on the layout of furnace rooms (outcome 13),
- explain the choice of fuels and their combustion principles (outcome 15), and
- troubleshoot and adjust biofuel-fired boiler systems (outcome 17).

Subjects in the specialisation programme that operationalise these outcomes are

- Combustion techniques
- Basic legislation
- Boiler system technology
- Cleaning of oil-fired boilers
- Cleaning of fossil fuel boilers
- Control measurement of oil and fossil fuel systems
- Control of measurement equipment

- Reporting of measurement results
- Advice/counselling on boiler systems
- Understanding boiler systems
- Quality assurance of own work
- Reporting
- Environment and quality of cleaning
- Choice of and familiarity with tools
- Ventilation technology
- Gas technology
- Professional documentation
- Cleaning technology
- Biofuel combustion technology
- Chimney technology
- Adjustment of fireplaces
- Understanding heating systems
- Laws and regulations
- Preventive environmental measures
- Chimney sweeper
- Cleaning of wood burning stoves
- Chimney sweeping
- Cleaning of stovepipes
- Cleaning of ventilation
- Adjustment of biofuel systems
- Proper choice of energy efficient combustion
- Reaming chimneys
- Cleaning of biofuel systems
- Control measurement of biofuel burners
- Troubleshooting biofuel systems
- Troubleshooting ventilation systems
- Cleaning of gas boilers and flues
- Cleaning of straw-fired systems
- Advice and counselling on chimneys and stovepipes
- Registration of fireplaces and chimneys
- Troubleshooting of chimneys and stovepipes
- Troubleshooting of other boiler systems
- Fire prevention inspection
- Familiarity with boiler expansion and expansion tanks
- Testing for chimney leaks
- Renovation of chimneys

The boiler system technologist specialisation also includes the subjects *understanding heating systems, chimney sweeper,* and *boiler systems technologist*.

Joiner
The overall competence outcomes are that the student have competences in

- planning and carrying out work on the basis of relevant laws and regulations for construction and production, including energy standards, fireproofing, competitive bidding and tendering, and submission of tender (outcome 4) and
- assessment of working environment and safety, respecting colleagues' work and the global environment (outcome 5).

The competence outcomes for the basic programme are that students should be able to

- choose, set up, operate and maintain standard tools used in the construction sector and in woodwork construction and furniture manufacturing including manual hand tools, electric hand tools, and stationary machines, on the basis of power transmission calculations , cutting speeds, surface quality, and sanding and abrasion materials (outcome 7), and
- develop and improve the enterprise by using knowledge of basic global production and market conditions for the construction sector and for the woodworking and furniture industry (outcome 11).

The outcomes for the specialisation programme are that students should be able to

- set up, operate and maintain standard tools including manual hand tools, electric hand tools, and standard machines at the shop or construction site (outcome 1),
- carry out work operations by hand or by machine in the production of windows and doors, in compliance with environmental and safety regulations (outcome 11),
- choose machines, tools, methods for machining, and materials relevant to both industrial and craftsman production of staircases, in compliance with environmental and safety regulations and building code regulations regarding staircases (outcome 12),
- on the basis of knowledge of standard door and window types, measure, install, and grout windows and interior and exterior doors, including choosing and using the proper mounting materials and in compliance with environmental and safety regulations (outcome 17),
- measure, form, and install kitchen and bathroom elements on all types of surfaces, and install backband moulding, window sills, flashing, trim, hardware, handles, sinks, and table tops in all materials on site and in compliance with environmental and safety regulations (outcome 18),
- construct joist flooring, light interior walls and interior wall lining, and lay wooden parquet floors and plank floors with skirting in compliance with environmental and safety regulations (outcome 19),
- install lofts and support structures, insulation and moulding trim in compliance with environmental and safety regulations (outcome 20), and
- carry out work operations by hand or machine in the production of furniture for sitting, including the product categories of small prototype modelling, furniture for sitting, and furniture for upholstering, in compliance with environmental and safety regulations (outcome 21).

The area subjects that operationalise these competences are: *design, production and product development* and the compulsory specialisation subjects *industrial and craftsman production of windows and doors; installation of doors and windows;* and *light partitions and lofts*. elective specialisation subjects are: *energy efficient construction/renovation; exterior windows;* and *wall, ceiling, and unit installation*.

Concreter
The trade committee has not indicated any competence outcomes or subjects that deal with energy optimisation.

Technical insulator
Students in the specialisation course should be able to

- quality assure and control own work (outcome 6),
- perform all types of insulation jobs on piping installations in hot and cold water systems, and fireproofing and insulation of industrial and process systems (outcome 7),
- install mineral wool insulation around ventilation system channels (outcome 8),
- insulate refrigeration rooms and accompanying technical installations (outcome 9), and

- insulate technical refrigeration installations (outcome 11).

No subjects were indicated that operationalise these competence outcomes.

Woodwork construction
Students in woodwork construction should be able to

- plan and carry out standard job functions and tasks in the expected quality and in accordance with applicable laws, regulations, and traditions (outcome 1), and
- plan and carry out job functions and tasks with respect for the immediate, the neighbouring, and the global environments (outcome 6).

In the specialisation course the student should be able to

- gather information from written and electronic reference works on instructions, laws, and regulations regarding materials, safety, and work procedures (outcome 6),
- advise on the choice of materials and construction methods for a job, taking consideration to style, fire hazard, moisture, noise, insulation, price, timetable, and maintenance (outcome 8),
- choose the dimensions, materials, tools, and safety equipment for a job (outcome 11),
- construct, buttress, and mount roofing and trusses (outcome 15), and
- construct and mount exterior walls and linings (outcome 26).

The subjects that operationalise these competence outcomes are:

- Hipped roof construction
- Valley roof construction
- Installation of windows and doors
- Exterior roofing
- Floor construction and wooden floors
- Exterior wall construction and lining
- Compound woodwork constructions
- Thatched roof substructures
- Arched attic windows
- Aluminium doors and windows
- Aluminium roof constructing and joining
- Aluminium exterior wall construction

The carpenter specialisation also includes the subject *vapour barriers*.

Plumbing-energy specialist[13]
The plumbing-energy specialist programme contains many elements that focus on energy optimisation. Overall competence goals are that all students should be able to

- advise and perform job functions regarding choice of materials and components and regarding operations and maintenance (outcome 5),
- incorporate the importance of clean-tech and energy optimisation in a global perspective (outcome 6), and
- incorporate innovation and entrepreneurship and advise on energy optimisation and alternative solutions (outcome 7).

Competence outcomes in the basic programme (plumber) are that the students should be able to

[13] The Danish occupational term “VVS” translates literally as ‘water, heating, and sanitation’. The corresponding Danish DB07 is the equivalent to the NACE code for ‘plumbing, heat, and airconditioning installation. The simplified terms ‘plumbing’ and ‘plumber’ will be used here.

- install gas and sanitary systems and install, repair, and service combustion, non-combustion, and renewable energy systems under 135 kW (outcome 9), and
- renovate, service, and replace appurtenant mechanical and electrical components and fixtures, and make simple energy-technological calculations (outcome 10).

Additional competence outcomes for the plumbing-energy specialisation are that students should be able to

- plan, dimension, install, service, and optimise energy systems, heating systems, renewable energy systems, compound energy systems, low-temperature systems, and expansion systems (outcome 12),
- install and service programmable automatic control and regulation systems related to the plumbing profession (outcome 13), and
- install, adjust, troubleshoot, and replace automatic and mechanical and electro technical components, and make energy-technical calculations, measurements, and analyses and advise end users (outcome 14).

Students in the plumbing/sheet metal specialisation must live up to competence outcomes 9 and 10.

Competence outcomes for the ventilation technology specialisation are that students should be able to

- service, adjust, energy optimise and troubleshoot air conditioning and ventilation systems, and prepare relevant documentation (outcome 17), and
- mount, connect, program, and install automatic control and regulation systems in air conditioning and ventilation systems, and carry out control measurements (outcome 18).

Subjects in the plumbing specialisation that operationalise the outcomes are:

- Installation and assembly, plumbing, plumbing/sheet metal, and plumbing-energy
- Surface water installations
- Installation and assembly, plumbing and plumbing/sheet metal
- Technology innovation
- Heat pumps
- Energy check-up, technical installations
- Energy service, technical installations
- Biofuels
- Solar energy
- Inspection and service of district heating systems
- Adjustment of ventilation and air conditioning systems

Subjects in the ventilation technologist specialisation are:

- Energy- and environmental policy 1, expert
- Energy optimisation 2, advanced
- Energy optimisation 2, expert
- Systems technology for energy systems 3, advanced
- Systems technology for energy systems 3, expert
- Adjustment of energy systems 4, advanced
- Adjustment of energy systems 4, expert
- Air conditioning, control measurement, and indoor environment
- Control and regulation, ventilation technology
- Ventilation technology
- Installation and assembly, ventilation technology

- Control and regulation, ventilation technology
- Measurement and testing for leaks in ventilation channels
- Climate measurement and components
- Air conditioning technology, service, and operations
- Adjustment of ventilation and air conditioning systems
- Dimensioning of ventilation and air conditioning systems

Subjects in the plumbing-energy specialisation are:
- Sanitation facilities automation
- Installation and assembly, plumbing, plumbing/sheet metal, and plumbing-energy
- Surface water installations
- Control and adjustment, plumbing energy specialist
- Oil furnace installer
- Installation and assembly, plumbing energy specialist
- Control and regulation, plumbing energy specialist
- Distance monitoring of plumbing installations
- Heat pumps
- Adjustment of heat producing gas-burning boilers
- Service of heat producing gas-burning boilers
- Troubleshooting and correction of heat producing gas-burning boilers
- Certification for gas installations under 135 kW
- Biofuels
- Solar heating
- Alteration of existing heating systems
- Combustion techniques – gas combustion
- Inspection and service of distance heating installations

Subjects in the plumbing/sheet metal specialisation are:
- Installation and assembly, plumbing, plumbing/sheet metal, and plumbing-energy
- Surface water installations
- Installation and assembly, plumbing energy specialist
- Solar cells on roofs and exterior walls
- Inspection and service of distance heating installations

Subjects in the rustproof industrial systems specialisation:
- Installation and assembly, rustproof industrial systems
- Electrical technology in machine systems
- Basic pneumatics
- Basic PLC controls

6.2 Tertiary vocationally-oriented education

Governance and provision

The academies of professional higher education and the professional bachelor institutions supply academy profession and professional bachelor qualifications. The programmes are offered under the auspices of the Ministry of Science, Innovation, and Higher Education and are solely state-financed. Requirements for admission are a completed upper secondary youth qualification such as an upper secondary vocational qualification or a general upper secondary qualification, along with a range of trade-specific requirements. Relevant programmes dealing with low-energy construction and energy optimisation are the academy programmes *energy technology* and *installations technology*, and the professional bachelor programme *architectural technology and construction management.*

Academy profession programmes last between 1.5 and 2.5 years, and are composed of between 90 and 150 ECTS credits [14]. For example, the *installations technology* programme consists of theoretical school-based education for the first two semesters. The third semester is devoted to specialisation, which is then used in praxis in the fourth semester during a 12 week company internship either in Denmark or abroad. During the fourth semester the student also works on a final project. After the final exam, the student is awarded a academy profession higher education degree (AK). This qualification is placed on level 5 in the Danish Qualification Framework for Lifelong Learning, and is the equivalent of level 5 in the European Qualification Framework, and level 5 ISCED.

Professional bachelor programmes usually last about 3.5 years and are composed 210 ECTS credits. The programmes contain theoretical and practical components, and compulsory as well as elective subjects. During the 6th semester there is a 20-week internship, which is followed by a written bachelor project. The programme leads to the degree of professional bachelor. After 2 semesters students have earned a *mapping and land surveying technician* qualification, and after 4 semesters a *building technician* qualification, and can choose to stop their education with either of these. A professional bachelor qualification is placed on level 6 in the Danish Qualification Framework for Lifelong Learning, and is the equivalent of level 6 in the European Qualification Framework, and level 6 ISCED.

The general competence outcomes are specified in the Danish Qualification Framework for Lifelong Learning. The programme competence outcomes are specified in the Ministerial orders for each programme.

Content and quality assurance

Academies of professional higher education and professional bachelor institutions are autonomous institutions subject to centrally specified ordinances. The board of directors of each institution has the overall responsibility for the institution and its management. Management is responsible for operations. In addition, the Ministry and the board of each institution enter into development contract agreements.

[14] European Credit Transfer and Accumulation System.

The Advisory Council for Academy Profession and Professional Bachelor Programmes advises the Minister on:

1. Programme development
2. General questions on supply of qualifications in relation to documented labour market demand
3. General consequences for the programmes as a result of new or changing labour market demand
4. Objectives and structural framework
5. Admissions requirements
6. Coherence with other programmes and education fields
7. Framework for applied pedagogical development projects
8. Continuing and further education
9. International education
10. Quality assurance and development

The Minister of Science, Innovation and Higher Education appoints as the Council's chairman someone with special insight into the educational fields that are relevant for the Council's advisory activities. The Minister also appoints 18 members on the recommendation of stakeholders and organisations in the field of education. The Minister can supplement the Council with up to 2 personally appointed members. In addition, the Minister can appoint ad hoc representatives from consulting and professional organisations, upon recommendation from these organisations.

In order to assure quality, all academy profession and professional bachelor programmes must be accredited in accordance with specified criteria for relevance and quality. Academy profession programmes are accredited every four years, and professional bachelor programmes every five years.[15] The Minister approves the programmes on the basis of positive accreditation. In addition to the Accreditation Council's assessment, the Ministry also has a general supervisory role.

Programmes in energy optimisation

The following describes competence outcomes related to energy efficiency and optimisation and some of the subjects that operationalise these objectives.

Energy technologist

The academy profession programme *energy technologist* is designed especially to meet environmental and energy challenges. The programme is multidisciplinary, composed of elements from both *electrician* and *plumbing*, and targets energy optimisation of technological installations and process systems in buildings, including the identification and solution of problems related to energy and energy loss. Students learn methods for carrying out technical calculations and energy

15 Criteria are specified in Bekendtgørelse nr. 684 om akkreditering og godkendelse af erhvervsakademiuddannelser og professionsbacheloruddannelser af 27. juni 2008 (Ministerial order 684 of 27 June 2008 on accreditation and approval of academy profession and professional bachelor programmes).

saving measures in housing and in industrial buildings. All of the competence outcomes are presented below.

An energy technologist is familiar with:

- theories, concepts, and methods for construction installation, process, and production systems, and alternative and new forms of energy,
- control and regulation of installations and systems, and
- applicable laws and regulations.

An energy technologist has the necessary skills to:

- assess solutions across the fields of electricity and plumbing in relation to economy, energy consumption, and environmental awareness,
- assess complex project design and planning,
- document solutions in relation to applicable standards and licensing regulations,
- communicate a project's size, quality, and complexity,
- calculate energy use on the basis of project descriptions, and
- assess practice-related problems and present possible solutions that take economy, energy consumption, and environmental awareness into account.

The energy technologist can:

- advise on practical energy optimisation and energy supply for commercial and private construction and industrial process systems,
- acquire in a structured context skills and new knowledge related to technical possibilities, collaboration partners, end users, and political strategies,
- participate in professional and multidisciplinary collaboration with a professional national and international approach,
- integrate knowledge of technical, economic, organisational, safety, and environmental factors in project design and dimensioning, and
- carry out basic dimensioning of installations and initialise technical installation systems.

The subjects that operationalise these outcomes are:
Energy in the building complex (including construction techniques); indoor environment; automation; control and regulation; energy efficient methods for construction installations; process and production systems, and; *alternative and new forms of energy.*

Installations technology

The competence outcome for the academy profession degree in installations technology specialising in high-voltage current is for the student to know about

- specialist level high voltage theory and its application for installation and system operations, and energy consequences (outcome 1).

Elective subjects are *climate and environment* and *alternative energy*.

Students specialising in plumbing installation must know about

- plumbing theory and its application for installation techniques and energy consequences for gas and plumbing systems (outcome 1), and
- plumbing installations and related work in supply and production systems, including renewable energy (outcome 2).

Elective subjects are *alternative energy / energy saving measures* and *climate and environment.*

Students in both specialisations must be able to

- assess and carry out practice-related plumbing solutions, taking safety, energy, and environmental factors into account (outcome 3).

Students in both specialisations can elect subjects dealing with ‘energy efficiency improvement’.

Compulsory courses in the high-voltage specialisation are: *technology, energy efficiency improvement and project design for technological calculation of electric supply systems; building installations; building automation and automation for small machines and systems.*

Relevant elective courses are for example: *supervisory control and data acquisition* (SCADA); *climate and environment alternative energy; communication;* and *high-voltage authorisation exam*.

Compulsory courses in the plumbing specialisation are: *Technology, energy efficiency improvement and project design for technological calculation of energy supply systems* and *building installations for indoor environment, ventilation, heating, sanitary installations, and gas.*

Relevant elective courses are for example: *gas technology 2 and troubleshooting; building automation; alternative energy and energy-saving initiatives; climate and environment; indoor environment simulation; sprinkler systems;* and *authorisation exam for plumbing, heating, sanitary installations, and gas installations.*

Architectural technology and construction management

Competence outcomes are that the student should

- know about societal and technological factors that affect building processes, including problems related to energy, work environment, and local and global sustainability (outcome 5), and
- be able to assess and understand societal and technological factors that can affect the design of buildings, including energy, work environment, and sustainability (outcome 6).

In addition the student should have competences in practical project design.

These outcomes are operationalised through the subject *project design* which contains elements related to the practical application of energy factors and energy frameworks and standards for project design.

6.3 Continuing and further education and training

Adult vocational education and training

Governance, provision, and funding

Most of the continuing training for the construction sector workforce is developed and provided by the Adult Vocational Training system. The goal of this system is to develop workforce competences so that they better match the demands of a changing labour market. The target group is composed of semi-skilled employees and those with short-cycle qualifications up to and including upper secondary vocational qualifications. The system is part of the Ministry of Children and Education, and its structure resembles that of the upper secondary vocational education system, in that the social partners play a central role in managing and monitoring adult vocational training, through the national Advisory Council for Adult and Continuing Training (REVE) and through sector-related continuing training and education committees and local training committees at institutions offering continuing training programmes.

Adult vocational training offers are developed by the continuing training committees for construction and industry (BAI) and for technical installations and energy (ETIE), and the service sector's education secretariat (SUS). Programmes are developed to match prevailing labour market conditions. The Minister approves programmes and specifies supply. Approval or rejection must by law take no longer than 6 weeks from the time of application. Programmes may be implemented immediately after approval.

Many types of institutions offer adult vocational training, such as adult vocational training (AMU) centres, upper secondary vocational education and training centres, and regional adult continuing training (VEU) centres. Instruction is both practical and theoretical. All courses lead to a qualification. Since the system includes qualification levels from 2 to 5 in the Qualification Framework for Lifelong Learning, it is not possible to present the competence outcomes. Admission to and graduation from an adult vocational training course is often accompanied by an individual competence clarification and assessment, so that the participant can receive recognition for prior competences and skills. The combination of assessment of prior competences and an adult vocational training course is one of the pathways whereby a semi-skilled worker can become qualified as a skilled worker.

Institutions that are approved as suppliers of adult vocational training are permitted to offer comprehensive "training packages". These packages are composed of several adult vocational training subjects and affiliated single subjects from upper secondary vocational programmes. The packages can be composed of courses from a single joint competence description (FKB), or across several joint competence descriptions. FKBs describe outcomes and frameworks for participants' basic competence development relevant to requirements in labour market job areas. Training packages can be given a title, and the participant can receive a qualifications certificate for the whole package.

Certificates are given to adults who complete a subject or programme or who receive credit for prior learning and competences.

Social partner agreements in the construction sector earmark funds for continuing training. There is a competence fund that subsidises employees' continuing training. Participants in adult continuing training receive salary compensation (an amount corresponding to unemployment benefits), and pay around DKK 110 to 150 per day for tuition. Participants who already have a tertiary qualification pay full tuition, and unemployed participants are offered full scholarships.

Relevant adult vocational training programmes

There are around 50 adult vocational training courses that deal with energy optimisation. The content of these courses coincides with that of courses offered in the vocational education system, and they will therefore not be presented here.

Participation is in general increasing. In 2008 there were 1321 participants in energy-related courses, and in 2010 there were 2187 participants. This indicates increasing interest in and need for energy optimisation.

Private suppliers

In addition to public supply of approved continuing education and training, there are a number of private suppliers. Private courses are fully user-paid, often financed by the participant's employer. The following is a list of the major suppliers of adult vocation training courses related to energy optimisation and efficiency improvement. The statistics and the list of courses offered can provide an idea of the supply of and interest in these fields.

It should be noted that this is by no means an exhaustive list.

Byggecentrum

Participants 2011	791
Participants 2010	457
Participants 2009	361

Subjects:

2009	**Title:** ESCO (Energy Service Company) conference Energy conference (in collaboration with Middelfart Municipality) The new energy standards in building code BR08 Courses for energy consultants Low-energy construction Energy renovation in buildings
2010	ESCO (Energy Service Company) conference

Energy renovation of buildings
Low-energy construction – basic course
Low-energy construction - building envelope
Low-energy construction – technological installations
Preparatory course for energy consultants

2011

Energy renovation of buildings
Low-energy construction – basic course
Low-energy construction - building envelope
Low-energy construction – technological installations
Preparatory course for energy consultants (large buildings)
Preparatory course for energy consultants (small buildings)
Building Code BR10 – practical overview
Energy

Danish Technological Institute

Participants 2011	2700
Participants 2010	2100

Courses:

- Calculation and dimensioning of solar heating systems
- Understanding energy consumption and regulations for economical energy operations of larger building
- Energy standards in the building code
- Energy guide to installations
- Energy guide to installations, module 2
- Energy guide to building envelopes
- Energy guide to building envelopes, module 2
- Surface water for toilets and washing clothes
- KSO (quality assurance scheme) solar cell course module 1
- KSO (quality assurance scheme) solar cell course module 2
- Heat pump systems and heat recovery systems
- Energy efficient operations
- Energy guide to heat consumption
- Dynamic adjustment of installations
- Heating systems and installations
- Adjustment of heating, ventilation, and domestic water systems
- Floor heating
- District heating boiler operator
- Connection systems for district heating
- Safeguarding public water supply systems against pollution
- CCM systems
- Ventilation for operations staff 1
- Ventilation systems – control measurement and adjustment

- Efficient ventilation and air conditioning
- Efficient industry ventilation
- Ventilation for operations staff 2

Solar

Participants 2012	322[16]
Participants 2011	350
Participants 2010	200

Courses:

- Energy guidance course
- Energy guide to energy saving initiatives for electricity and plumbing, heating and sanitary installations
- Short course - energy guide to energy saving initiatives for electricity and plumbing, heating and sanitary installations
- Energy optimisation in Intelligent Building Systems, Central Control and Monitoring, and HVAC systems
- Energy calculation for ventilation and heat recovery systems
- Energy calculation for heat pump and ventilation systems
- Energy calculation for solar heating systems for housing
- Energy calculation for solar energy systems for housing – solar panels for electricity
- Energy optimisation in Central Control and Monitoring and Building Management Systems – start-up
- Documenting and registering installations
- Energy expert education programme
- Hands-on energy and environmental laboratory
- Blue Energy calculator

There has been a marked increase in the number of participants. In the case of Byggecentrum there has been an increase in the number of courses offered from 6 in 2009 to 8 in 2011.

According to the industry association DI Byggematerialer (building materials), producers and wholesalers also offer courses to those working in the construction sector, and many have been intensifying such activities. Again according to the association, this is due to an increased demand for cross-disciplinary and holistic energy renovation, and also because it can be difficult to introduce new solutions to the workforce. There are no statistics as to how widespread this course activity is.

Further education for adults

The further education system for adults system (VVU) is at the same level as academy profession programmes. Admission requirements are a completed relevant qualification such as a vocational qualification along with at least two years of relevant work experience. There are currently no VVU programmes that target the construction sector.

[16] At time of writing

Diploma degree

The diploma degree is a continuing professional education at the bachelor level. Admission requirements are the same as for VVU - a completed relevant qualification such as a vocational qualification along with at least two years of relevant work experience. The diploma programme primarily targets adults with an academy profession or bachelor qualification, but for example architects and civil engineers can also participate. Examples of diploma degrees relevant to the construction sector are *high-voltage electrical technology and maintenance.*

The *architectural technology and construction management* qualification can provide the basis for applying for admissions to the school of architecture. Along with a supplemental qualifying course the qualification can also enable application for admission to the *bachelor of engineering* programme. In addition, the qualification can lead to admission to a long-cycle civil engineering degree in *building and facilities construction*, and provide transfer credit towards the first part (bachelor) of the civil engineering degree in t*echnical science in architecture and design*. Finally, it can lead to further studies in a range of diploma and master's programmes such as: *technical diploma degree; management diploma; master's in construction management; master's in fire safety*; and *master's in developer counselling and value design*.

The academy profession degree in *energy technology* can give access to further studies towards a *bachelor of engineering* or a degree in *civil engineering*.

7. Educational shortcomings and needs in 2020

The following examines whether in the current status quo there are shortcomings or needs if 2020 goals are to be met. It is important to realise that this is a first estimate which will be verified and elaborated in the next phase of the Build Up Skills project.

7.1 Scenarios for educational shortcomings and energy saving initiatives

It is assumed that the political goal of a 7% reduction of gross energy consumption in 2020 compared to 2010 directly corresponds the same reduction of energy consumption for heating, cf. energy statistics 2010 [3]. This is a conservative approach, in that the energy efficiency improvement expected in the energy sector by 2020 is not taken into consideration.

Given the statistics on energy consumption for heating households and trade and commercial buildings in 2010, a 7% reduction will correspond to a reduction of 2,400 TJ in 2020.

Two scenarios have been used to calculate the extent of necessary energy saving initiatives:

- **Scenario A: the optimistic, which includes positive factors**
- **Scenario B: the conservative, which includes negative factors**

These are discussed in the following.

Time frame for implementing future energy saving initiatives

Both scenarios calculate with the period from 2015 through 2020 for implementation of energy saving initiatives. Energy savings that are achieved from 2011 to 2014 will reduce the extent of initiatives needed to meet the 2020 goal. Factors that can influence this are for example the green subsidy scheme in the 2012 proposed Finance Act. This scheme will be initiated in 2013, and allocate DKK 500 million for both 2013 and 2014. The two scenarios assume overall developments until 2015 as follows:

- **Scenario A: Energy consumption for heating is reduced by 0.5% per year from 2011 – 2014**
- **Scenario B: Unchanged energy consumption for heating from 2011 – 2015**

”Do-it-yourself” work

It can be expected that a share of energy efficiency improvement in the building stock will be carried out by owners or other non-skilled workers as “black market” jobs, rather than by construction sector craftsmen. The extent of such work is estimated in [16] at around 1/3 of the total energy efficiency improvement. However, the real extent will probably be somewhat lower, as some types of tasks require authorisation, special tools, etc.

- **Scenario A: Around 10% of the overall energy savings is attributed to “do-it-yourself” work**
- **Scenario B: The effect of “do-it-yourself” work is not included**

New construction, energy renovation, and demolition

Energy consumption for heat has remained more or less constant since 1990. In other words, annual energy savings through energy efficiency improvement of the existing building stock and through demolition of outworn buildings more or less corresponds to the annual increase in energy consumption due to new construction.

It is estimated that a continuation of the current level of energy efficiency improvement of the existing building stock will result in total energy savings greater than the increase in consumption in new construction, due to tightened energy standards for new construction and maintenance of existing buildings. Similarly, it is estimated that there will be an increase in demolition of older buildings as these become increasingly energy-obsolete.

Building code energy standards for new buildings are expected by 2015 to specify a 50% reduction in energy consumption for heating relative to 2010. It is expected that that around 4 million m² of floor area will still be constructed annually. This will result in an annual heating savings of 80 GWh (corresponding to 20 kWh/m²).

- **Scenario A: Energy consumption for heating is reduced by 80 GWh/year**
- **Scenario B: Unchanged conditions corresponding to the historical development**

Energy saving initiatives

The following overall energy saving initiatives have been included.

Building envelope	Heating and ventilation	Renewable energy
Re-insulation of loft/roof	Replacement of gas/oil boilers	Solar heating systems
Re-insulation of exterior walls	Replacement of heat exchangers for district heating	Solar cell systems
Re-insulation of floors	Replacement of hot water tanks	Geothermal energy systems
		Air-source heat pumps
Cavity wall insulation	Adjustment of heating systems	
	Ventilation with heat recovery	
Replacement of windows and doors	Inspection of ventilation systems	
Replacement of roof windows		**Electricity saving initiatives**
Replacement of glazing	**Heating conversion**	Replacement of pumps
	From oil to district heating	Replacement of ventilators
	From oil to natural gas	Lighting systems (offices etc.)
	From oil to heat pumps	
	From electricity to heat pumps	

Energy savings through the above initiatives are based mainly on solutions from the Danish Knowledge Centre for Energy Savings in Buildings [14]. Each solution presents savings for a number of parameters (for example insulation thickness), which in the scenarios are simplified to rounded-off values assessed as applicable for typical situations and solutions.

Other less extensive initiatives
In addition to the above list there are less extensive initiatives that also will contribute to energy savings, for example extra panes (storm windows) on single-glazed glass, replacement of skylight domes, and the installation of radiator thermostats. The effect of such initiatives is seen as a savings of 10% in scenario a; these initiatives are not considered in scenario B.

- **Scenario A: Other initiatives account for 10% of the total energy savings**
- **Scenario B: Other initiatives are not included**

Improved thermal comfort
The general experience is that calculated energy savings due to energy renovation of the building stock do not always live up to expectations. This is normally because inhabitants/users change their habits regarding thermal indoor environment (by using a higher average temperature) so that energy savings are reduced (5-10% per degree of temperature increase).

- **Scenario A: The effect of energy saving initiatives is not reduced**
- **Scenario B: The effect of energy saving initiatives is reduced by 10% (1 °C higher indoor temperature)**

Distribution of energy saving initiatives
The choice of which initiatives to implement can be made in many ways, weighting the workforce and man-hours needed, energy efficiency/renewable energy sources, or increased energy efficiency of heating installations versus less heat loss through re-insulation.

In both scenarios the initiatives are distributed as widely as possible; it is assumed that the lowest overhead can be achieved by carrying out energy saving initiatives as part of the ongoing maintenance of building envelopes or replacement of installations. One of the premises of the distribution method is an estimate of the current level of energy efficiency based on the calculations presented in sections 5.4 and 5.5

Energy saving initiatives are distributed in the same proportion as the current distribution of energy consumption for heating in households and trade and service buildings. This proportion is used in both scenarios.

Reduced electricity consumption
Some of the initiatives such as the installation of solar cells or the replacement of pumps do not result in reduced heating energy consumption, but rather in reduced electricity consumption. The effects of such initiatives cannot be included in the same way as other heat saving initiatives, and they are therefore calculated separately.

Other buildings
The scenarios operate with a scaled potential for the extent of initiatives based on the energy labelling data base registration of farmhouses, single-family detached houses, semi-detached or terraces houses, multi-story housing blocks, and trade and service buildings. As described previously, these buildings account for 80% of the total heated floor area. The remaining buildings are varied and with a limited data base, and they are therefore included in the category of trade and service buildings.

Manpower
The objective of the scenarios is to estimate the need for skilled craftsmen. Data is therefore retrieved for the time used for the previously described energy saving initiatives, based on the *V&S Prisdatabase*[17].

In addition, it is assumed that the effective net working time for a craftsman is 1000 hours per year, in that time for transportation, tenders, illness, bad weather, etc. is not included.

The results for the two scenarios are presented in the following two tables.

[17] vvv.prisdata.dk, a privately run price data base for construction bidding and tenders.

Scenario A – the optimistic

Farmhouses, single-family detached houses and semi-detached or terraced houses (total number: 1,450,000)					
Energy saving initiatives		Annual savings per unit [kWh/m²] / [kWh/unit]	Extent of initiative [m²] / [unit]	Annual savings [kWh]	Number of craftsmen [-]
Building envelope	Re-insulate lofts/eaves/sloping walls	15	1,000,000	15,000,000	500
	Re-insulate exterior walls	100	100,000	10,000,000	310
	Insulate cavity walls	90	100,000	9,000,000	60
	Re-insulate floors/basement slabs	20	25,000	500,000	113
	Replace windows and doors	110	500,000	55,000,000	1,600
	Replace roof windows	90	25,000	2,250,000	523
Installations	Replace heat exchangers in DH	1,500	5,000	7,500,000	20
	Replace oil boilers	5,000	2,000	10,000,000	40
	Convert oil to heat pumps	13,500	4,000	54,000,000	176
	Convert oil to distance heating	4,300	5,000	21,500,000	30
	Replace hot water tanks	180	5,000	900,000	35
	Inspect heating systems	500	20,000	10,000,000	40
	Ventilation with heat recovery	6,000	500	3,000,000	14
	Solar heating installations (8 m²)	4,000	2,000	8,000,000	64
	Solar cell installations (36 m²)	4,000	10,000	(40,000,000)	420
	Replace circulator pumps	350	10,000	(3,500,000)	20
Multi-story housing blocks (total number: 90,000)					
Building envelope	Re-insulate lofts/eaves/sloping walls	15	100,000	1,500,000	50
	Re-insulate exterior walls	100	50,000	5,000,000	155
	Insulate cavity walls	90	50,000	4,500,000	30
	Re-insulate floors/basement slabs	20	10,000	200,000	45
	Replace windows and doors	110	50,000	5,500,000	160
Installations	Replace heat exchangers DH	3,000	2,000	6,000,000	10
	Replace exhaust systems with heat recovery systems	30,000	500	15,000,000	37
	Inspect heating systems	2,000	1,000	2,000,000	15
	Inspect ventilation systems	5,000	2,000	10,000,000	30
	Solar heating installations (30 m²)	15,000	1,000	15,000,000	60
	Solar cell installations (70 m²)	8,100	1,000	(8,100,000)	70
	Replace ventilators	1,000	1,000	(1,000,000)	6
	Replace circulator pumps	350	2,000	(700,000)	4
Office and trade etc.					
Building envelope	Re-insulate lofts/eaves/sloping walls	15	200,000	3,000,000	100
	Re-insulate exterior walls	100	200,000	20,000,000	620
	Insulate cavity walls	90	50,000	4,500,000	30
	Re-insulate floors/basement slabs	20	10,000	200,000	45
	Replace windows and doors	110	150,000	16,500,000	480
Installations	Replace heat exchangers in DH	3,000	5,000	15,000,000	25
	Inspect heating systems	2,000	3,000	6,000,000	45
	Inspect ventilation systems	5,000	2,000	10,000,000	30
	Solar heating installations (30 m²)	15,000	100	1,500,000	6
	Solar cell installations (70 m²)	8,100	1,000	(8,100,000)	70
	Replace ventilators	1,000	1,000	(1,000,000)	6
	Replace circulator pumps	350	1,000	(350,000)	2
	Lighting systems (kWh/m²]	5	100,000	(500,000)	100
Total heating savings				**344,550,000 app. 1,250 TJ**	**5,567**
Total electricity savings				**(55,150,000)**	**628**

Savings in parentheses are savings in electricity consumption are not included in the total heating savings.

Scenario B – the conservative

Farmhouses, single-family detached houses and semi-detached or terraced houses (total number: 1,450,000)					
Energy saving initiatives		Annual savings per unit [kWh/m²] / [kWh/unit]	Extent of initiative [m²] / [unit]	Annual savings [kWh]	Number of craftsmen [-]
Building envelope	Re-insulate lofts/eaves/sloping walls	15	2,000,000	30,000,000	1,000
	Re-insulate exterior walls	100	200,000	20,000,000	620
	Insulate cavity walls	90	200,000	18,000,000	120
	Re-insulate floors/basement slabs	20	60,000	1,200,000	270
	Replace windows and doors	110	1,000,000	110,000,000	3,200
	Replace roof windows	90	55,000	4,950,000	1,151
Installations	Replace heat exchangers in DH	1,500	11,000	16,500,000	44
	Replace gas boilers	5,000	4,000	20,000,000	80
	Convert oil to heat pumps	13,500	9,000	121,500,000	396
	Convert oil to distance heating	4,300	11,000	47,300,000	66
	Replace hot water tanks	180	11,000	1,980,000	77
	Inspect heating systems	500	43,000	21,500,000	86
	Ventilation with heat recovery	6,000	1,000	6,000,000	27
	Solar heating installations (8 m²)	4,000	4,000	16,000,000	128
	Solar cell installations (36 m²)	4,000	21,000	(84,000,000)	882
	Replace circulator pumps	350	21,000	(7,350,000)	42
Multi-story housing blocks (total number: 90,000)					
Building envelope	Re-insulate lofts/eaves/sloping walls	15	220,000	3,300,000	110
	Re-insulate exterior walls	100	110,000	11,000,000	341
	Insulate cavity walls	90	110,000	9,900,000	66
	Re-insulate floors/basement slabs	20	20,000	400,000	90
	Replace windows and doors	110	150,000	16,500,000	480
Installations	Replace heat exchangers in DH	3,000	5,000	15,000,000	25
	Replace exhaust systems with heat recovery systems	30,000	1,000	30,000,000	74
	Inspect heating systems	2,000	2,000	4,000,000	30
	Inspect ventilation systems	5,000	4,000	20,000,000	60
	Solar heating installations (30 m²)	15,000	2,000	30,000,000	120
	Solar cell installations (70 m²)	8,100	2,000	(16,200,000)	140
	Replace ventilators	1,000	2,000	(2,000,000)	12
	Replace circulator pumps	350	4,000	(1,400,000)	8
Office and trade etc.					
Building envelope	Re-insulate lofts/eaves/sloping walls	15	450,000	6,750,000	225
	Re-insulate exterior walls	100	450,000	45,000,000	1,395
	Insulate cavity walls	90	110,000	9,900,000	66
	Re-insulate floors/basement slabs	20	20,000	400,000	90
	Replace windows and doors	110	320,000	35,200,000	1,024
Installations	Replace heat exchangers in DH	3,000	10,000	30,000,000	50
	Inspect heating systems	2,000	6,000	12,000,000	90
	Inspect ventilation systems	5,000	4,000	20,000,000	60
	Solar heating installations (30 m²)	15,000	200	3,000,000	12
	Solar cell installations (70 m²)	8,100	2,000	(16,200,000)	140
	Replace ventilators	1,000	2,000	(2,000,000)	12
	Replace circulator pumps	350	2,000	(700,000)	4
	Lighting systems (kWh/m²]	5	200,000	(1,000,000)	200
Total heating savings				**737,280,000 app. 2,650 TJ**	**11,813**
Total electricity savings				**(114,650,000)**	**1,300**

Savings in parentheses are savings in electricity consumption are not included in the total heating savings.

The optimistic scenario concludes that initiatives will need to reduce energy consumption for heating by 1,250 TJ per year, which can be done by 5,500 to 6000 skilled construction craftsmen. The conservative scenario concludes that initiatives will need to reduce energy consumption for heating by 2,650 TJ per year, which can be done by around 12,000 skilled construction craftsmen.

Some of the initiatives also lead to savings in electricity consumption. The overall electricity savings in scenarios A and B are around 200 and 413 TJ per year respectively, which corresponds to a decrease in electricity consumption in household and trade and service buildings of 1 to 3% in 2020.

Distribution of craftsmen by trade group

A number of craftsmen are needed in each trade group to implement the energy savings initiations. The time consumption has been estimated on the basis of the V&S Prisdatabase (see note above), which results in the following table showing the number of craftsmen needed in each trade group.

Table 13 Number of skilled construction sector craftsmen needed for the energy saving initiatives from 2015 to 2020, distributed by trade group

Trade group	Initiatives	Scenario A	Scenario B
Bricklaying	Exterior wall insulation, floor structures, basement slabs	1.408	3.058
Carpenter/joiner	Insulate lofts, replace windows	3.973	8.352
Plumbing/heating/air conditioning (VVS)	Heating and ventilation systems	703	1.479
Electrical installations	Lighting installations and replacement of ventilators	112	224
Total		6.195	13.113

The time needed for these initiatives will likely be reduced as craftsmen gain experience and more time-efficient products and solutions are developed. Some undocumented studies show that relatively few repetitions of the same job tasks lead to time savings of 20 to 40%. This does not seem unrealistic when comparing construction productivity with manufacturing productivity (see table 2, chapter 3). Assuming a 40% time reduction leads to the following table showing the number of craftsmen needed.

Table 14 Number of skilled construction sector craftsmen needed for the energy saving initiatives from 2015 to 2020, assuming a 40% time reduction due to experience and improved products, distributed by trade group

Trade group	Initiatives	Scenario A	Scenario B
Bricklaying	Exterior wall insulation, floor structures, basement slabs	845	1.835
Carpenter/joiner	Insulate lofts, replace windows	2.384	5.011
Plumbing/heating/air conditioning (VVS)	Heating and ventilation systems	422	888
Electrical installations	Lighting installations and replacement of ventilators	67	134
Total		3.717	7.868

Summary

The most optimistic scenario shows a need for 3,700 extra construction craftsmen compared to the current number of craftsmen in the construction sector. This assumes that energy consumption for heating already begins to be reduced from 2011 to 2014, and that tightened building code regulations for new construction lead to a reduction in the total energy consumption for heating. The optimistic scenario also includes “do-it-yourself” initiatives and a number of less extensive energy saving initiatives. Finally, the optimistic scenario assumes a 40% efficiency improvement in construction processes.

The conservative scenario excludes reduced energy consumption for heating and “do-it-yourself” initiatives, and excludes efficiency improvement in construction processes. In this scenario, around 13,100 extra craftsmen will be needed to meet 2020 goals.

Projection of the need for construction craftsmen is built on current education provision for the construction sector. The presentation of educational shortcomings and needs is an estimate that must be verified and elaborated in the next phase of the Build Up Skills project. This includes questions as to whether the necessary competences can be provided through A) the current education system, for example through targeted upskilling of semi-skilled persons, B) the creation of new types of upper secondary vocational education programmes, and/or C) through new continuing and further education initiatives for skilled craftsmen.

8. Barriers

Overall, the most important professional fields for energy optimising buildings are already included in the existing education system, as presented in chapter 6. In principle the 2020 goals can be met by increasing the number of craftsmen currently employed in the construction sector, as presented in chapter 7.

There are however a number of barriers that make scaling an insufficient response. These barriers are both structural and economic. There are in addition a number of other factors related to economic incentives and the characteristics of the continuing education system.

A consortium workshop with 17 stakeholder representatives identified education system barriers to supplying the necessary competences in 2020. **The following is the opinion of the stakeholders about current barriers to education and continuing training in the construction sector.** These barriers will be investigated further in the next phase of the project.

Structural barriers

- The coming generational cohorts are small, and a lack of workforce population is expected. According to a projection by the Economic Council of the Labour Movement, there will be a shortfall of 30,000 skilled workers in 2020. According to the same analysis, in 2020 the construction sector will employ 175,000 persons, which is the same as in 2009. To this can be added the 3,700 to 13,000 extra persons that this report indicates as extra workforce for energy saving initiatives. Small cohorts are therefore a real barrier to ensuring a sufficient skilled workforce in the construction sector in 2020.
- There is at the same time a paradox, in that there is a current lack of apprenticeship places in the construction industry. Since work placement is an integrated part of craftsman education programmes, this caps the number that can be trained as skilled workers.
- This system of training committees composed of construction sector stakeholders hinders rapid adaptation. Changes in upper secondary vocational programmes take about 3.5 to 4 years from approval to implementation.
- It is difficult for semi-skilled persons to decide to start a 4-year long education programme.
- A number of skilled craftsmen switch to other sectors, after which it is difficult for them to return to construction.
- Semi-skilled persons often change profession, which makes it difficult to develop and maintain competences and knowledge in this group.
- Much construction sector employment is project-based, which hinders knowledge transfer and weakens classic peer-to-peer training.
- The upper secondary vocational and continuing education systems present few opportunities for modular qualifications that fit the individual student’s abilities and wishes.
- The upper secondary vocational and the continuing education systems lack interdisciplinary opportunities.

- The increased use of foreign workforce in construction presents special challenges regarding competence levels and communication.

Economic barriers

- Student subsidy for adult vocational training programmes (AMU) is being reduced in 2012 from 100 per cent of the unemployment benefit level to 80 per cent. In addition, students with a tertiary qualification now have to pay full tuition. This is perceived as a barrier for enterprises who want to have their workforce upskilled through the AMU system.
- From the point of view of the master craftsman, enterprise productivity is reduced when employees are participating in continuing training, and therefore earnings are reduced in the short term, which is also a barrier.

Barriers in the adult vocational training system (AMU)

While the adult vocational training system (AMU) basically functions well, there are a number of built-in barriers, paradoxes, and challenges, including:

- The AMU system has an image problem. Even though the existence of the system is well-known, employees and employers know little about the concrete offers and how these have been improved through the latest reforms. Few are familiar with what AMU offers and how AMU courses can contribute to the individual and to the enterprise.
- The AMU structure is not robust enough to assure that semi-skilled persons achieve a satisfactory qualifications level.
- Course supply is not very transparent. There is little cohesion in the courses offered by the different professional organisations; and potential students seldom look at catalogues from other trade groups even though this could be relevant (it would perhaps be useful to think more about job profiles and less about professions). The home page www.efteruddannelse.dk lacks the necessary functionality for transparency. There is also a lack of transparency in the supply of private courses, especially those offered by producers and dealers/wholesalers.
- Counsellors, for example the Youth Guidance Centres, do not necessarily have up-to-date insight into craftsman education programmes, and are perhaps also a bit prejudiced as to who is best suited for being a craftsman and are better at “marketing” academic programmes than vocational programmes. In other words, the general upper secondary programmes often “steal” academically talented students. This creates a negative spiral for vocational programmes, which are then left with “weaker” students.
- There is no state support for continuing or further education available for craftsmen with a qualification at academy profession level.
- There is a lack of AMU courses that target academy profession qualification levels and master craftsmen.
- AMU needs increased flexibility, since employees are often sent on courses when there is a slow period in production.
- The adaptability of the AMU system is very varied. It is more adaptable for example in the electrical trades than in the carpentry and joiner trades.
- The AMU system can perhaps be seen as not so up-to-date, since there is increasing

participation in private courses and decreasing participation in AMU courses.
- Many enterprises in the construction sector have little long-term planning on the agenda, and continuing education is thus not a priority.

Incentive barriers

- There are no particular economic incentives to craftsmen for continuing education. There is a clear lack of correlation between continuing education and increased salary.
- There is no particular prestige in continuing and further education. The craftsman does not receive a new job title or anything else that demonstrates new competences. The only exceptions are courses that grant a certificate, and these are the most popular; this confirms the need to translate education activities into something tangible.
- The master craftsman is often unclear as to whether continuing education of his employees can lead to better economy for the enterprise.
- There is little familiarity with using the flexible spending account *(fritvalgskonto)* to finance continuing education. This account was introduced in a range of labour market accords in 2007. It allows setting aside a small per cent of salary in a special account which the employee can then have paid out in the future, use for extra vacation or pension, or use for educational activities.
- Neither managers nor employees seem to recognise the need for continuing education.
- Energy renovation is considered a niche and not an integrated part renovation activities.

9. Conclusion

This status quo report presents an overview of national policy and strategies for improved energy efficiency in buildings in 2020. It describes the building stock by age, size, type, and energy conditions, and informs about Danish energy consumption. It also presents the Danish vocational education system and the current programmes offered of relevance to the construction sector workforce.

Two scenarios are presented which show two different levels of extra workforce needed to implement energy saving initiatives in buildings so that the energy efficiency goals for buildings can be met.

It is clear that ambitious and sustained efforts are needed if Denmark is to reach its goal of reducing energy consumption for heating in buildings by 7%. This should especially be seen in the light of the fact that energy consumption has been constant for many years, and there has been no decline in energy consumption despite recent policy and societal focus.

Energy optimising efforts can also include increasing the education levels of the building sector as assumed in this project. This status quo report shows that 3,700 to 13,000 more skilled construction workers will be needed to complete the necessary work on insulation, heating systems, replacement of windows, etc.

Much of the Danish building stock was constructed either before 1930 or between 1961 and 1972. Information from the energy labelling data base shows that there is a great potential for energy savings, especially in pre-1979 buildings. A very large group of buildings thus can be energy renovated; the 2020 goals can only be met if the owners of these buildings carry out energy improvement initiatives. The purpose of this report, however, is not to address market barriers, but rather to focus solely on education barriers.

Finally, this report identifies a range of barriers and gaps that have been experienced in relation to competence development among craftsmen. This will be the point of departure for mapping to be carried out in the next phase of the project.

All in all, this report presents a status quo – a snapshot of where we are now and where we want to go – and starts the discussion of what initiatives are needed in order to get there.

The status quo report is thus a point of departure for the work to come in preparing the final roadmap for needs, initiatives, and priorities for meeting the 2020 goals.

10. References

[1] Bygningsreglement 2010 (24.08.2011), Erhvervs- og Byggestyrelsen, 2010

[2] Bygnings og boligregistret (BBR), Energistyrelsen version, januar 2012

[3] Energistatistik 2010, Energistyrelsen, 2010

[4] Energimærkningsordningens database, Fællessekretariat for eftersyns- og mærkningsordningerne, januar 2011.

[5] Potentielle energibesparelser i det eksisterende byggeri. (SBI 2009:05), Wittchen K. B., Hørsholm: Statens Byggeforskningsinstitut., 2009

[6] Danske bygningers energibehov i 2050. (SBI 2010:56), Wittchen K. B., Kragh J, Hørsholm: Statens Byggeforskningsinstitut., 2010

[7] Vores Energi, Regeringen, november 2011

[8] Styrket uddannelse og efteruddannelse i lavenergibyggeri og energirenovering, Erhvervs- og Byggestyrelsens, 2011

[9] SOLVARME - status og strategi, Energistyrelsen og Energi-net.dk, Maj 2007

[10] Energiaftale 2008, februar 2008, Energistyrelsen, http://193.88.185.141/Graphics/ENS_Energipolitik/Energiaftalen/energiaftale-21022008_final.pdf

[11] Energiaftale 2012, marts 2012, Energistyrelsen http://www.ens.dk/da-DK/Politik/Dansk-klima-og-energi-politik/politiskeaftaler/Documents/Energiaftale%202012-2020.pdf

[12] Opgørelse af varmekilder og VE-anlæg, Tekniq, Februar 2012 http://www.energy-supply.dk/article/view/76793/52000_oliefyr_er_skrottet_siden_2007

[13] Varmeplan Danmark 2010, Rambøll Danmark, September 2010.

[14] Energiløsninger, Videncenter for Energibesparelser i bygninger, 2011

[15] Afdækning af potentiale for varmepumper til opvarmning af helårshuse i Danmark til erstatning for oliefyr, november 2011

[16] Hvidbog om bygningsrenovering, Bygherreforeningen og Grundejernes investeringsfond, august 2011.

[17] V&S prisdata 2012, Byggecentrum, 2012

Annex I – Stakeholders

Bat Kartellet (http://www.batkartellet.dk)
- Camilla Vakgaard
- Gunde Odgaard
- Sidse Buch

BVU Net (http://bvunet.dk/)
- Niels Haldor Bertelsen

Byggecentrum (http://www.byggecentrum.dk)
- Lars Tangaa
- Hanne Høeg Jensen

Byggeriets Uddannelser (http://www.bygud.dk)
- Rasmus Zier Bro
- Bodil Rasmussen
- Jan Ejlerskov Petersen
- Torsten Lindum Poulsen

Dansk Byggeri (http://www.danskbyggeri.dk)
- Sidse Frich Thygesen

Dansk Håndværk & Industri (http://www.ds-net.dk)
- Birger T Christiansien

Dansk Industri
- Christine Bernt Henriksen

Danske Ark (http://danskeark.dk)
- Michael Koch

Den Jyske Håndværkerskole (http://www.hadstents.dk)
- Hanne Bisgaard Hansen

Energitjenesten (http://www.energitjenesten.dk)
- Marianne Bender

Erhvervsskolerne (http://www.erhvervsskolerne.dk)
- Jens Juul
- Kim Knudsen

EVU, El- og Vvs-branchens Uddannelsessekretariat (http://www.evu.dk)
- Henrik Bertelsen
- Trine J. Rasmussen

FRI (http://www.frinet.dk)
- Henrik Garver

Håndværksrådet (http://www.hvr.dk)
- Heike Hoffmann
- Henrik Lilja

Metalindustriens uddannelser(MI) (http://www.industriensuddannelser.dk)
- Flemming Dan Andersen

Sekretariatatet for Energieffektivebygninger (http://www.seeb.dk)
- Uffe Groes

Selandia - Center for erhvervsrettet uddannelse (Bæredygtigt byggeri) (http://www.selandia-ceu.dk)
- Henrik Helge
- Erik Larsen

Serviceerhvervenes Uddannelsessekretariat (http://www.sus-udd.dk)
- Ellen Larsen

Snedkernes Uddannelser (http://www.traefremtid.dk)
- Hanne Pein

Tekniq (http://www.tekniq.dk)
- Søren Rise
- Tina Volby