BUILD UP skills – analysis of the current state of the Swedish construction industry and its training in energy-efficient building

Åke Blomsterberg
WSP Environmental
Box 574
SE-201 25 Malmö
Sweden
ake.blomsterberg@wspgroup.se

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Abstract

The energy and climate objectives for 2020 demand major initiatives from the building sector, including the raising of skill levels. The EU programme Intelligent Energy Europe has initiated BUILD UP Skills projects in 30 countries across Europe. Each country runs its own project, but exchanges information and experience with other projects. The aim of the Swedish project is the production of a roadmap and platforms for vocational development and skills improvement for all those who work on building sites. Further education primarily concerns the production of energy-efficient buildings, as well as learning how to install systems for renewable energy and carry out low-energy building renovations. In Sweden, this also includes a review of basic training.

The workforce of the construction industry is relatively well-educated. The building sector is, to a certain extent, fragmented into different branches and organizations. Internationalisation can be seen, although the exact extent is unknown.

The proportion of low-energy buildings in new production is still low, but expected to rise in the coming years. Up to now, the number of annually low energy renovated apartments is still low.

Approximately 100,000 skilled workers within the construction industry need to receive vocational development in order to achieve the 2020 goal.

Potential barriers to the implementation of the training are financial, institutional, cultural and social factors, as well as a lack of time, in addition to the fact that too few low-energy buildings are being built and too few low-energy renovations are carried out. Many of these barriers could be overcome if the demand for energy efficient buildings increased strongly.

The paper presents an analysis of the current status of the building sector, a review of current and planned strategies for training within the field of energy, in addition to an analysis of the skills that are required on the building site and a preliminary analysis of potential barriers and how to overcome them.

Introduction

The energy and climate objectives for 2020 demand major initiatives from the building sector. An important investment in this work is the improvement of skills within this sector of the labour market. The EU programme Intelligent Energy Europe has therefore initiated a project area known as BUILD UP Skills. It will run for 18 months from November 2011 and involves 20 countries across Europe, where each country runs their own project based on their country-specific conditions. Ten more countries joined during 2012. Twice a year all participants meet and exchange information and experience.

The aim is to establish a roadmap and platforms for vocational development and skills improvement for all those who work on building sites, i.e., tradesmen, construction workers, system installers and management. Further education primarily concerns the construction of energy-efficient buildings, as well as learning how to install systems for renewable energy and carry out low-energy building renovations. In Sweden the project will also include a review of basic training, since it is believed that this supports the improvement of skills within all of these areas.

One of the fundamental goals of the project and this study is to conduct an analysis of the current status of the building sector, to review current and planned strategies for education within

the field of energy, the skills which are required on the building site and how the barriers that exist can be overcome. Subsequent stages involve the production of a roadmap and platforms, the implementation of which will then be guaranteed. The entire study is presented in a separate report (Blomsterberg 2012).

Objectives and methodology

AIM

The aim of this study was to establish the current level of knowledge and the type and scope of vocational development required by skilled workers within the construction industry in order to achieve the energy targets for buildings in 2020. The most important vocational categories of workplace-based roles are included in the area of application.

The main operators that provide further training and education/qualification systems/certification for the building of energy-efficient building and plants for renewable energy are identified. The current status of the building sector and its workforce are also analysed, as the national strategies for energy and vocational development.

The skills gap between the current situation and the needs for 2020 as far as skills development is concerned is estimated.

An identification and preliminary analysis are made of lack of qualifications of the construction workers and potential barriers to the implementation of an improvement in skills and how to overcome them.

METHOD

Information was gathered through desk research and interviews/questionnaires with relevant market operators. The project group (Swedish Energy Agency, WSP consultants, Swedish Construction Federation, Trade Union for Construction Workers, NCC Construction, HVAC companies, Association of Swedish Regional Energy Agencies, Technical Research Institute of Sweden) and the reference group (33 organizations) assisted with the collation of the information and gave feedback on the results.

The work was divided up into a number of sub tasks:

- The current situation regarding the national system for vocational development within the building sector.
- The current existing education, qualification and certification system.
- The current (and planned) status of the building sector.
- The current (and planned) energy policy and strategy.
- The current (and planned) vocational development and training policy and strategy.
- An identification and preliminary analysis of barriers to training and how to overcome them.

TARGET GROUP

The target groups for this study are the building industry (property developers, building contractors, installation engineers, manufacturers, trade unions) and educators (public and private).

Characterisation of the building sector

GENERAL

Professional building in Sweden is carried out by a workforce that is relatively well-educated, as far as its consultants and operatives are concerned. However, according to Sweden's Building Commission, the level of education within the building sector is lower than elsewhere in the labour market (Swedish Agency for Public Management, 2009). The difference in the level of education primarily concerns the number within the building sector that has continued to study after leaving upper secondary school. The percentage is low, at only 8 per cent, while the corresponding figure for the labour market as a whole is 28 per cent. However, in the long term, skills levels in the sector are increasing, due to retirements, as the majority of new skilled workers have a three-year upper secondary school education and engineers who previously had an upper secondary school education are being replaced by engineers who have been educated at a vocational college or at a university college/university.

The building sector can be described as fragmented, in terms of its various branches and organizations (Swedish Agency for Public Management 2009). Within certain branches of the industry there is a lack of competition. A certain market concentration can be found in the market for building contractors. Material manufacturers are powerful and are often a part of international groups of companies. Internationalisation can also be seen in the increased number of foreign building trade companies operating in the Swedish market. On the other hand, competition from foreign companies has not increased in any significant manner in the installation engineers market (Swedish Agency for Public Management 2009).

An analysis of the prevalent market conditions states that foreign companies still face considerable entrance barriers, primarily in the form of informal contact between already established companies.

The building process is often described as fragmented, with a number of stages where each new stage is taken over by a new operator. The building process is usually divided up into six different stages:

- The planning stage
- The ideas and programme stage
- The design stage
- The purchasing stage
- The construction stage
- The property management stage

In 2010, the construction industry employed 305,000 workers and investments in construction, i.e., investments in new and renovated properties and investments in plant establishments, amounted to 31 billion Euro, which corresponded to 8 per cent of the GNP (Swedish Construction Federation 2011). The vocational categories within the construction industry which are encompassed by this study can be split into construction workers, plumbing and HVAC engineers, electrical installation engineers and others.

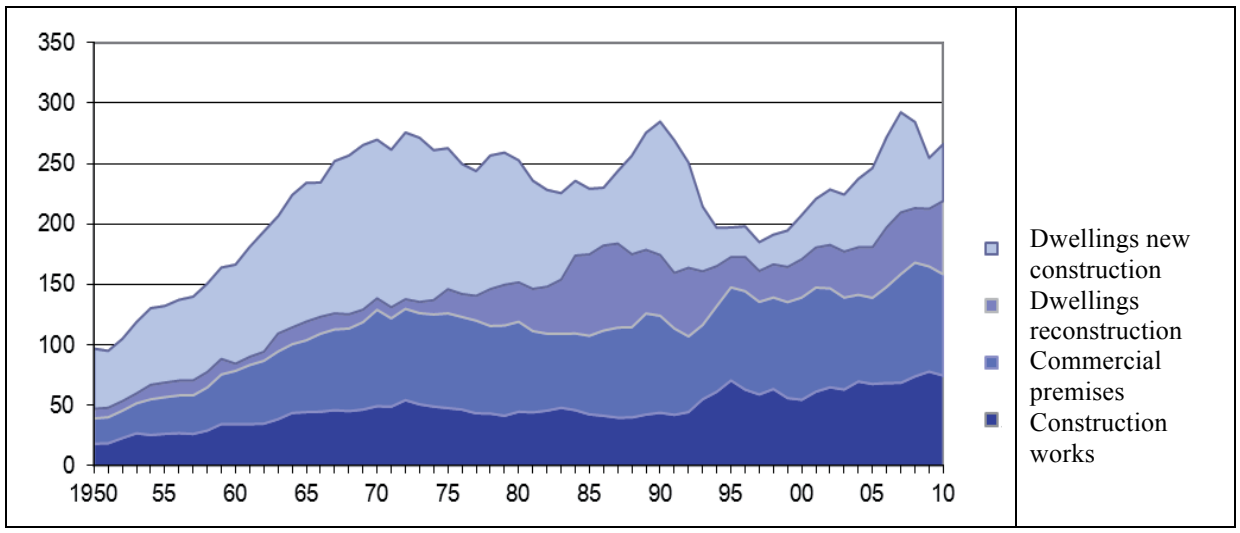


Figure 1. Total investment in construction from 1950 to 2010, billion Swedish crowns (Swedish Construction Federation 2011).

However, over the past 60 years, the percentage of the GNP was considerably higher in the 1960s – approximately 15 per cent. Investments in construction increased sharply during the 1950s and 1960s (see Figure 1). During the 1970s and into the 1980s, the Swedish economy experienced significant growth problems and the construction market stagnated. During the latter part of the 1980s, construction picked up again. The increase was followed, however, by a sharp downturn in the 1990s. Between 1990 and 1997, investments in construction reduced by 35 per cent. The industry recovered up until 2007 and the volume of investment at that time exceeded that recorded in the first half of the 1970s. After the financial crisis of autumn 2008, investments started to fall again. When the economy as a whole improved in 2010, investments in construction started to increase again.

Up until the start of the 1990s, house new builds and rebuilds was the clearly dominant submarket. Its share of the total invested in construction was 57 per cent in 1991–1992 but this then fell dramatically to just 25 per cent in 1995. The increase that took place during the 2000s was not however of the same level as in 1991–1992; in 2009–2010 it only accounted for 40 per cent of the total invested in construction. The investments in houses amounted to 13 billion Euro in 2010, of which 5.5 billion Euro was for new builds and 7 billion Euro was for rebuilds. Investments in new constructions, which grew steadily between 1997 and 2007, started to decline in 2008 and an upturn was not to be seen until 2010. On the other hand, investments in reconstructions increased during the whole 1997–2010 period.

The housing shortage in the middle of the 1960s resulted in a political initiative, the "million homes program". The programme led to a million homes being built in ten years, from 1965 to 1975. Many of these homes are currently in major need of renovation and are one of the reasons why investments in rebuilds have increased in recent years. According to Industrifakta (Industrial facts, which conducts market analyses of the building and property sectors), approximately 100,000 of the million homes programme's buildings' apartments need to be renovated (renewal of technical building functions, technical installations and energy use) within the next five years. A total of 320,000 of the million homes programme apartments require more or less extensive renovation. This represents an excellent opportunity to make these homes more energy-efficient. The introduction of tax reduction for construction services in household properties (ROT, renovation, reconstruction and addition, deductions) in December 2008 has also been of major importance to the continued upturn in investments in rebuilds. Unfortunately, this reduction does not comprise any incentive for energy-efficiency.

Commercial premises consist to a large degree of offices and shops, together with public premises such as schools and hospitals. Buildings used by manufacturing industries are also included in this submarket. Commercial premises increased their percentage gradually, from 22 per cent of the total investments in construction made in 1950 to over 40 per cent in 2000, after which the percentage sank and in 2010 it amounted to 31 per cent. Investments in commercial premises amounted to 10 billion Euro in 2010, of which 5.5 billion Euro was for private premises and 4 billion Euro was for public premises. Over the past 40 years, public investments have varied between 2.5–3.5 billion Euro per year, whilst private investments have fluctuated between 3.5–7 billion Euro per year. Private investments follow the state of the economy, to a large extent, whilst public investments are more stable.

THE MOST IMPORTANT ACTORS

The most important actors in the construction process are the developer/administrator, consultants/architects, contractors, manufacturers. These actors are represented within the various trade organizations. The property developer is more often than not the property owner. In total there are 99,115 property owners, of which 20,000 are tenant-owners' associations, 2,374 are public operations, 49,905 are limited companies, etc. There are approximately 40 property owners valued in excess of 1 billion Euro.

As mentioned previously, there are a number of larger operators, several of which are involved in the energy-efficiency work through their participation in the BELOK or BeBo purchaser

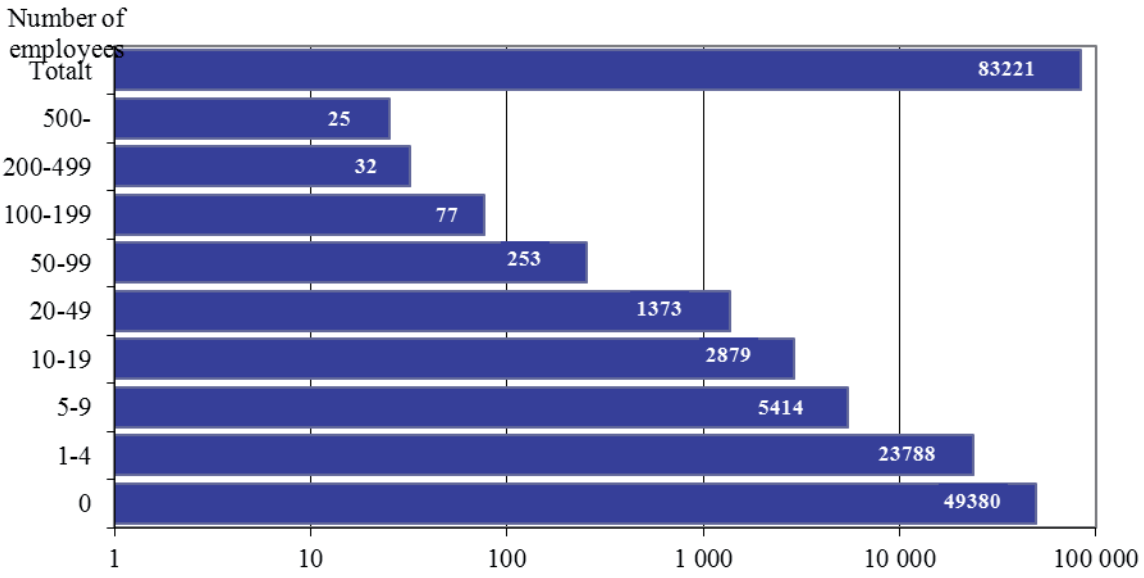


Figure 2. Number of employees vs. number of companies in the construction industry in 2010 (Swedish Construction Federation, 2011).

group. BELOK, the purchasing group for commercial premises, is a network and a collaboration between the Swedish Energy Agency and sixteen of Sweden's major property owners who are involved with commercial premises. The sixteen property owners are responsible for approximately 25 per cent of all commercial premises. BELOK's task is to be an objective party and to run development projects where energy-efficiency and environmental issues are common denominators amongst its members in their properties. BeBo, the purchasing group for homes, is a collaboration between the Swedish Energy Agency and Sweden's major property owners (approximately 18) involved with housing, who are responsible for approximately 70 per cent of all apartment blocks. The group has the same tasks as BELOK but for residential buildings.

In 2010 there were a total of 981,000 companies in Sweden, of which 83,000 were operational within the construction industry, i.e., 8 per cent of all businesses (see Figure 2) (Swedish Construction Federation 2011). Of the construction companies, 88 per cent had no more than 4 employees and these companies comprised 17 per cent of all employees in the construction industry. The ten largest construction companies have between 200 and 12,000 employees and an annual turnover of between 135–3,800 million Euro.

There are many small companies within the construction industry; consequently, a large number of the employees are self-employed. In 2010, the number of self-employed amounted to 21 per cent. White-collar workers constituted 20 per cent whilst blue-collar workers amounted to 59 per cent. It is no surprise that the number of blue-collar workers is as high as the construction industry is still an industry dominated by tradesmen.

THE WORKFORCE IN THE BUILDING SECTOR

The number gainfully employed within the construction industry has varied to a large degree over the past 20 years, from 320,000 in 1990 to approximately 220,000 during the period 1995 to 2000 (Swedish Construction Federation 2011). During the 2000s, the number gainfully employed within the construction industry has gradually increased; in 2010 it was 305,000 which correspond to 6.7 per cent of all those in gainful employment. The percentage of those employed within civil engineering construction is 20 per cent and the rest work within house construction. The largest single category of tradesmen is woodworkers, which comprise approximately 25 per cent. After this come installation electricians at approximately 15 per cent and plumbing and HVAC fitters at approximately 10 per cent. Within the wider concept of the building sector, including, inter alia, design work, the manufacture of building material and property management, the number of people gainfully employed amounts to over 500,000. More than one in ten of the Swedish labour market is operating within the building sector. The most crucial decisions regarding the energy performance of a building are made at the design stage and by people who fall outside of the target group for Build up Skills, namely purchasers, architects and technical consultants. It is naturally of great importance that the operatives implement the production in such a manner that the intentions are achieved. The majority of skilled workers which can influence energy aspects, approximately 100,000 skilled workers/tradesmen can be assumed to have an effect on how energy-efficient buildings will be when they are completed. Some of them can even affect how well the systems for renewable energy will work. Furthermore, approximately 25,000 engineers and technicians, the vast majority of which operate at building sites, as foremen, site managers, etc. will also have an effect on how well energy-efficiency measures and the systems for renewable energy come to work in practice.

TRADE UNIONS

A large proportion of the workforce within the building sector is members of a trade union organization. There are two major trade union organizations for skilled workers within the construction industry – Byggnads (The Swedish Association of Construction Workers) and Svenska Elektrikerförbundet (The

Swedish Association of Electricians). In supervisory roles that are closely related to production, membership in one of the trade union organizations Ledarna (the Leaders) or Unionen is common.

For university-educated engineers and civil engineers there is the trade union organization, the Swedish Association of Graduate Engineers, which has approximately 132,000 members.

MARKET DEVELOPMENT – GENERAL

The on-going downturn in the Swedish economy is dragging the construction industry down to a low level. Investments in housing are sinking this year (2012) as the amount of new builds is reduced. However, as early as next year, housing is expected to once again act as a catalyst for investments in construction. The positive development of investment in commercial premises prevents an even greater downturn from occurring this year and contributes to the upturn expected in 2013.

In Sweden, the downturn in the economy which started in the last quarter of 2011 is continuing. Weak global growth is slowing down foreign trade and households are keeping a tight rein on their spending. The effect of the slowing development of the GNP, which has arisen as a result of the debt crisis within the Euro-region, is expected to subside during the autumn and the Swedish economy should fare somewhat better in 2013.

The impaired pace of growth in the economy and the still pessimistic view of development held by householders means that the number of new homes under construction will be lower in 2012–2013 than last year. This year, the demand for services where a tax reduction for construction services in household properties has also declined, which has led to a fall in the level of investment for renovation. Next year, the repairs of the property owners to their rental stock should start to take effect, which will lead to the volume of rebuilds increasing, at the same time as investment in new builds should start to increase again.

There is still a major need for both new builds and the improvement of older housing stockInvestments in commercial premises are expected to increase during the forecast period. For the private construction of commercial premises, 2012 will however be an off year, as several projects will be postponed. Investment growth will not start until next year, when the state of the market is expected to improve. Public investment in commercial premises follows previously advised plans and continues to show positive growth throughout the whole forecast period.

MARKET DEVELOPMENT – LOW ENERGY BUILDINGS

There is still no national register in Sweden of low-energy and passive house buildings, and there is only limited information on the actual (measured) energy use of the existing low-energy buildings.

A study from 2010 (Andresen 2010) estimated that in Sweden less than 1 per cent of all building categories can be described as low-energy. This figure is however expected to rise sharply over the coming years. There are already a number of property developers/managers who are constructing low-energy buildings, i.e., ByggVesta (apartment blocks), Eksta Bostads AB (apartment blocks), and others carry out low-energy renovations, i.e., Alingsåshem (apartment blocks), Vasakronan (offices) and Göteborgs lokalförvaltning (schools). The same study provides figures for the number of buildings/apartments based on the various categories of buildings that were built in Sweden as passive houses, plus energy buildings or green buildings during the period 2005–2010. Homes were the most prevalent type of building that was built in accordance with the voluntary passive house criteria (Nollhus 2012). Out of the total number of homes built, only 0.6 per cent of detached or semi-detached houses/terraced houses and 0.8 per cent of apartment blocks were built as passive houses (a total of 1,070 completed units out of a total of 145,000 homes produced). Two detached houses were built as plus energy buildings. During the same period, four schools were built with the help of passive house technology, whilst over thirty offices were built as Green Buildings, which is an insignificant figure compared with the approx. 20,000 standard office buildings which were built.

Improving the energy-efficiency in existing building is also on the agenda for many property owners, research institutes and contractors. The figure for renovated apartments with considerably improved energy performance up until 2010 is, however, very low.

The introduction of real low-energy buildings into the Swedish market has been slow, but over the last two years, the market share has increased, according to a study from 2011 (Wahlström 2011). Of the homes built, the percentage of low-energy buildings was approximately 0.7 per cent in 2008, 2.2 per cent in 2009 and 7.2 per cent in 2010, according to the study. The majority of the new built low-energy buildings were apartment blocks.

The interest in real low-energy buildings is rather substantial at the moment and several projects are in the planning stage. Many operators within the building sector expect to encounter tougher demands with regards to energy-efficiency, both from authorities and private purchasers.

At the start of 2011, there were very few government subsidies encouraging the construction of energy-efficient buildings. Exceptions are subsidies for the installation of solar photovoltaic cells (max 60 per cent; from 2012, 45 per cent of the cost of the investment, or 0.2 million Euro) and solar panels (max 900 Euro per apartment or 0.35 million Euro per project). Furthermore, there are subsidies provided for the replacement of old oil-heated boilers or electric boilers with more energy-efficient heating systems. The Swedish Energy Agency has, since 2006, through various programmes, supported demonstration projects that can be used as examples of the construction of energy-efficient buildings and that have a great potential. The latest programme, LÅGAN (www.laganbygg.se), for buildings with very low energy use was started in 2010 in order to

- stimulate energy-efficient new and rebuilds,
- to make visible a national market for buildings with low-energy use,
- to help establish a wide national range of suppliers of products and services and to secure purchasers of such.

LÅGAN gives funding to demonstration projects and regional/local collaboration initiatives. The programme also focuses on providing support to the development of ideas through evaluating and disseminating information from demonstration projects.

An interesting initiative for public housing companies is the Skåne initiative (Skåne is a region in southern Sweden), an initiative launched by SABO-affiliated (SABO, Swedish Association of Public Housing Companies) companies in 2007. 80 companies have voted in favour of an objective that means that the companies involved shall reduce their energy use by 20 per cent between now and 2016. Participation in the initiative is voluntary and all housing companies in Sweden are welcome to become involved. At the start of 2012, 107 member companies with 393,568 homes had endorsed the initiative, i.e., more than half of all the homes under the auspices of SABO.

Examples of a regional stimulation of low-energy buildings can be found in e.g., Skåne, Stockholm, Östersund:

- Miljöbyggprogram syd (Environmental Construction Programme South Skåne), is a collaboration between the City of Malmö, Lund Municipality and Lund University.
- Stockholm's environmental programme for 2012–2015, has been produced by the City of Stockholm.
- In Östersund, it has been decided to support low-energy buildings with a financial incentive. If a building within the municipality is built in accordance with the Swedish passive house definition, charges are repaid in respect of building permits, maps, city plans and, where applicable, private water and sewage disposal.

Other incentives are the various environmental and energy systems/classification systems used for buildings. In Sweden, a number of different energy and environmental classification systems are used for buildings. The most common are Miljöbyggnad (Environmental construction), BREEAM and LEED. During 2011, the market for and interest in environmental classification systems for buildings and city districts have increased sharply. The different systems vary in their scope and the aspects that can be considered important for the safeguarding of sound environmental performance. The energy performance of the building is stated in all systems, but ambitions vary.

Existing vocational education and training provisions

The most important providers of basic training for skilled workers within the construction industry are upper secondary schools (both public and private schools), independent training providers and educations within vocational colleges. The independent training providers seem to work largely within labour market education, adult education at upper secondary level and to some extent within vocational college. In vocational colleges, both in-depth training for skilled workers and also supervisor training are conducted. There are also training companies that work with continuing professional development within the building sector.

National policies and strategies related to the EU 2020 targets for buildings

Sweden has had an active energy policy for some considerable time with informative, financial and normative means of control (Swedish Energy Agency 2010). A number of means of control and promotional measures affect the consumption of energy and the emission of greenhouse gases from homes and commercial premises. The Swedish National Board of Housing, Building and Planning's building regulations (The Planning and Building Ordinance, BBR – the Board's building regulations, and BÄR – the Board's regulations for alterations) are a central means of control for the energy use of buildings. One means of control closely connected to the Board's building regulations is the energy declarations. Other important means of control are the energy and carbon dioxide taxes. Buildings are fully covered by these taxes that provide financial incentives to implement energy-efficient measures and phase out the use of fossil fuels. The introduction of the municipal property charge for homes since 2008 leads to fewer property owners than before receiving increased charges when they carry out energy investments that lead to one-family houses and apartment blocks having an higher taxation value.

The Swedish Riksdag (parliament) has adopted the EU's climate and energy policy targets that shall be achieved by 2020, known as the "20-20-20" targets. The EU's 20-20-20 target implies that we shall reduce our climatic –impact by 20 per cent, achieve another 20 per cent through the use of renewable energy and streamline our energy use by 20 per cent, all by 2020. In this context, buildings play a key role, something that was underlined in the Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings. The directive states that national plans for nearly zero energy buildings should be established. In accordance with article 9 of the directive, regarding the energy performance of buildings, the member states shall ensure that all new buildings are nearly zero energy buildings, no later than 31 December 2020. In addition to this, the member states shall, in accordance with article 7, take the necessary measures to ensure that, when buildings undergo major renovation, the energy performance of the building, or the renovated part of the building, is improved so that it fulfils the minimum requirements to the extent that is technically, functionally and economically feasible. The requirements shall be applied to the renovated building or the renovated part of the building in its entirety.

In accordance with the Swedish Energy Agency (Swedish Energy Agency 2010), the national strategy for nearly zero energy buildings shall significantly contribute to the achievement or exceeding of society's energy and environmental targets. The requirements for the specific energy use of the buildings should be made considerably more stringent, in relation to present requirements. In addition to energy requirements, other requirements regarding the technical qualities of the building shall also be satisfied. The general energy requirements for nearly zero energy buildings should, in accordance with EPBD2 be, in order of priority:

1. Very energy-efficient outer shell.
2. Very energy-efficient building services installations.
3. A large proportion of the energy required shall be renewable.

The Government has drawn up a communication based on, inter alia, information provided by the Swedish Energy Agency, in which in principle current nearly zero energy buildings are defined as those that satisfy the energy requirements found in the current regulations of the Swedish National Board of

Housing, Building and Planning. Closer adherence to these regulations is to be progressively implemented, with checks to be carried out in 2015. A number of promotional measures to facilitate the implementation of the requirement for near zero-energy buildings are proposed, i.e. more demonstration projects and initiatives that improve the skills of certain key groups.

BUILDING CODE

According to Swedish building code, buildings shall be designed in such a manner that energy use is restricted through low heat loss, low cooling requirements, efficient use of heat and cooling and efficient use of electricity. Fundamental regulations and general advice are provided in the building regulations for ventilation, thermal comfort and moisture control (BBR 2012). The various regulations and general advice usually result in well-insulated buildings with controlled ventilation and heat recovery.

Homes shall be designed so that the specific energy use in the building does not exceed 90 kWh per m² (heated usable) floor area and year in the southern climate zone, 110 kWh per m² floor area and year in the central climate zone and 130 kWh per m² floor area and year in the northern climate zone. For homes with electric heating as the main source of heat, the specific energy use in the building shall be 35 kWh per m² floor area and year lower than the above requirements. Energy use includes the energy supplied to a building (often known as purchased energy) for heating, comfort cooling, hot water, fans and pumps. Household electricity is not included. The specific energy use in buildings can be reduced with energy from thermal solar panels and solar photovoltaic cells that are installed in the building. The average heat transfer coefficient shall be lower than 0.4 W/m²K.

Commercial premises shall be designed so that the specific energy use in the building does not exceed 80 kWh per m² (heated usable) floor area and year in the southern climate zone, 100 kWh per m² floor area and year in the central climate zone and 120 kWh per m² floor area and year in the northern climate zone. For buildings with electric heating as the main source of warmth, the specific energy use in the building shall be 25 kWh per m² floor area and year lower than the above requirements. Energy use includes the energy supplied to a building (often known as purchased energy) for heating, comfort cooling, hot water, fans and pumps. Operational electricity e.g. for office equipment is not included. The average heat transfer coefficient shall be lower than 0.6 W/m²K.

In principle, the same requirements apply to alterations to a building as apply to the construction of a new building. When making alterations to a building, one should always consider the scope of the alterations and the conditions in the building upon application of the requirements. The requirements for new buildings are never directly applicable upon alteration of a building. If a major part of a building is obviously renewed, then the requirements applicable to a new building may apply, if this is not unreasonable. Preservation of architecture and historical value must be taken into consideration. Reasonable U-factor requirements are given for major renovations in the building standards.

The current building standards have recently been updated – in January 2012. It is currently unknown when the next updating will be carried out. As advice in the current buildings standards, a definition is provided where a low-energy building is a building with an energy use of no more than 75 per cent of the requirements of the building standards and, for a building with very low energy use, the maximum energy use shall be no higher than 50 per cent of the requirements of the building standards.

THE CONTRIBUTION OF THE BUILDING SECTOR

For Sweden, the objective is that approximately half of the "20-20-20" target shall be achieved within buildings, i.e. homes and commercial premises (Government 2011). The target for 2020 will thus be a reduction in energy use in buildings of approximately 25 per cent, compared with 1995 levels. The dependence on fossil fuels for energy usage in the building sector shall have been broken by the year 2020, at the same time as the percentage of renewable energy shall continually increase (Swedish Energy Agency 2010).

VOCATIONAL EDUCATION AND TRAINING

There are as yet no declared policies or strategies for vocational training, in respect of the 2020 energy targets for buildings. There are no specifically declared training targets for the production of energy-efficient buildings included in the training of skilled workers within the construction industry. On the other hand, guidance documents contain general formulations concerning sustainable development and a certain degree of concretising can be found in subject and course plans. It can therefore be claimed that there is a case for these issues being included in the vocational training but the scope to which they should be included is not specified.

Within the three construction-orientated upper secondary school programmes: Building and construction; Plumbing, HVAC and property; and the Electricity and energy programme, there is an optional course available as part of the closer study programme. The course can therefore hardly be thought to reach enough pupils. The course "Environment and energy", on energy-efficiency connected corporate identification numbers, buildings and renewable energy has been in existence since 2011.

Energy efficiency and renewable energy in vocational education and training

NATIONAL EDUCATION

Training elements that have a particularly pronounced connection to energy-efficient building are still not included in the compulsory parts of the training of skilled workers in the building industry. As shown below, there are only generic formulations in the three programmes' qualitative targets that have a connection to sustainable building and energy aspects. With these formulations, it is possible to conclude that the students might already gain general expertise involving the qualifications required to participate as a skilled worker in a project with energy efficient buildings. In the more advanced programme structure, there is a basis in the subjects and curricula for certain parts of the knowledge content necessary for energy efficient buildings.

In the qualitative target for the Building and Construction Programme, the following general goal formulations are included:

> The education will develop the students' knowledge of and skills in building and construction with, for example, new construction, remodelling and renovation. As building and construction work impacts society's infrastructure and the environments in which they reside, the education should impart knowledge of a rational, safe and environmentally sustainable building.
>
> The students should be able to select, use and maintain materials, tools and machines with regard to safety as well as environment, quality and economy, both when it applies to production and life-cycle costs.

Excerpts from the qualitative target for the HVAC and Real Estate Management: "This programme will also provide students with knowledge of automatic control and energy optimisation of constructions as well as develop their ability to think systematically. The students will be given the opportunity to see how efficient energy use leads to sustainable development. New construction, conversion of the existing building components, repair, maintenance and installation all require knowledge of the systems and products that are most energy efficient and how to work with the best possibly environmental impact in mind."

Excerpt from the Electrical and Energy Programme "the education should provide knowledge on electricity and energy technology and automation, as well as the skills to perform tasks in these fields." Examples of vocational output are automation technicians – real estate.

Addition concretisation is found in mandatory subjects and curricula, without these having been designed with a special focus on energy efficient buildings.

In the subject plan for the programme-common subject Building and Construction, it includes, for example, the following wording; "The teachings should give the students the possibility to develop knowledge of the industry's responsibility for sustainable development." In the course Building and Construction 2, it includes the content formulations: " The building and construction industry's role in society and sustainable development. Use of resources, linked to sustainable development and corporate profitability. For example, the handling of materials, storage, minimising of waste and the sorting of construction waste."

Within the specialization Building construction, the course Building construction 1 includes the following content: "Energy efficient building construction and building methods." Prospective skilled workers from this specialization can be expected to participate in the work with energy efficient buildings. In the courses that involve a more in-depth education with a targeted profession in mind, they include knowledge on, for example, insulation work which provides an additional level of detail necessary with regard to efficient insulation.

There are also more general courses that upper secondary school can offer with a more in-depth programme education. Within the Building and Construction and Electrical and Energy- Programmes, as well as HVAC and Real Estate Management, the students will, from 2012, be able to take the general course Environment and Energy Knowledge if the school chooses to offer it. This course includes:

- Renewable and non-renewable energy sources and their origins and use.
- Energy and resource use in relation to foodstuffs, housing, transport and general consumption.
- Energy and resource efficiency through, for example, measurement technology, choice of materials and other technical solutions.
- Energy principles, energy quality and efficiency as well as physical and chemical calculation and reasoning.

It remains to be seen how many students will take this course.

LOCAL COURSE AND TRAINING PROGRAMMES

Passive House Centre in Alingsås organises the course Passive house builder for construction workers. The course provides general and broad basic knowledge of the building of passive houses and energy efficient buildings. Aside from energy efficiency, you learn to regard the building as a system where good indoor environment and good durability are important properties. The participants should gain a full understanding of energy-efficient building and the requirements of quality and control that are needed, knowledge of the problems that may arise and how they can be prevented, and knowledge of building as a system. The course takes two days. Day 1 includes the passive house concept, building as a system, certification and requirements, airtightness, moisture, thermal bridges, windows and doors in passive houses, ventilation. Day 2 includes a practical workshop (pressurization, thermography and moisture measurement), review, discussions and plan, evaluation and a theoretical and practical exam. The number of participants is 20–25 per year. Reportedly, there is also internal company training for passive house projects.

Individual operators may have their own educations, e.g., the contractor NCC has a "Moisture and energy training" of four hours for production staff including: Ongoing climate change, Design of low energy/passive houses, Airtightness, Moisture security, Construction details regarding moisture and tightness, thermal bridges and also lead-throughs.

An example of the individual educations is the one-year continuing education for construction workers "Conversions and renovations for building craftsmen" at Nässjö Academy. The education is for construction workers who want to specialise in renovations and conversions of modern houses and apartments. The subjects are addressed are, for example, energy efficiency, conversion technology, economy, work environment, reception and design.

Other examples include the higher vocational education school in Härnösand, where a two-year education in solar photovoltaic cell installation is offered.

Within a recently started and ongoing project, the aim is to produce continuing vocational development for skilled workers within the building industry. Passive House Centre Västra Götaland (PHC) and SP Technical Research Institute of Sweden (SP) shall, within the project "Capacity building of skilled workers", develop a vocational development programme within the field of energy-efficient building, based on the education of trainers. Knowledge dissemination will therefore largely be conducted through internal training within contracting companies, using course material developed within the project. This procedure creates the possibility to cost-effectively and speedily disseminate knowledge to a large proportion of skilled workers

in the building sector. The overall project objective is to develop a vocational development programme within energy-efficient building for skilled workers. This work consists mainly of two parts: the development of a continuing vocational development course for trainers at contracting companies and also the production of training material for this course.

The overall goal of the project is to train approximately 30 trainers engaged in contracting companies with resources to maintain 2–3 internal training sessions during 2012. Through this procedure, one thousand skilled workers should have received training within a few years. The goal is to continue the education of trainers after this project has concluded with the help of the course material. This work will however be funded by course fees. The aim is to reach out to a greater section of Sweden's skilled workers within the building industry by 2019. The contractors NCC, Skanska, PEAB, the property owner Poseidon, and the Swedish Construction Federation are participants/co-financiers of the project.

The management of skilled workers may also require continuing vocational development. At Stockholm Vocational Institute of Technology, there is an education in Low-energy buildings Engineer, 400 HVE credits, Stockholm (80 weeks). The education is aimed at working as, for example, Construction (Project) Manager.

Competence shortfall and requirements

In separate study skilled workers suggested the following problems and barriers at construction sites to energy-efficient building (Blomsterberg 2012b):

- Complicated solutions in energy-efficient building (can be perceived or real problems).
- Engineering drawings (blueprints) for energy-efficient building (implies probably that the drawings may be improved).
- New technical solutions in energy-efficient building.
- Technology to improve high airtightness in energy-efficient building.
- New products and materials in energy-efficient building.
- Prejudices against energy-efficient building.
- Suitable materials for energy-efficient building.
- Accuracy requirements for energy-efficient building.
- The order of various operations in energy-efficient building.

In previous sections it was established that the national education of skilled workers does not include mandatory elements of energy-efficient building. There are only a few general energy formulations in the qualitative targets. Therefore, basic education and continuing vocational development initiatives need to be developed in order to provide a general and broad base knowledge in the building of energy-efficient buildings and low-energy renovations, as well as renewable energy sources and systems (Blomsterberg 2012b, Dehlin 2012). Aside from energy efficiency, you should learn to regard the building as a system where good indoor environment and good durability are important properties. The aim should be to gain a full understanding of energy-efficient building and the requirements of quality and control that are needed, knowledge of the problems that may arise and how they can be prevented, and knowledge of building as a system. The various vocational groups involved within building production must understand how they contribute to energy efficiency and how their work impacts the work of others. The keywords for the finished buildings are a very well insulated and airtight building envelope with negligible thermal bridges, very energy-efficient installations and that a large proportion of the energy needed is renewable.

A low-energy building must be constructed with high quality. This requires a focus on quality, where an important departure point is a holistic view including theoretical and practical aspects. At the same time, it requires an insight into the practical problems connected with the building process and production.

In addition to the above-mentioned basic knowledge, more in-depth expertise needs related to the various professions.

Building site management will also need to undergo the same training. This group represents an unknown portion of 25,000 engineers, 15,000 according to a rough estimate.

Potential barriers to training and how to overcome them

By barriers, it is primarily referring to barriers to the implementation of raised expertise among workers on construction sites. This can apply to both the availability of training and the ensuring of attendance in training. These barriers can be classified in categories such as laws/regulations, economic, institutional, cultural, social, and educational.

Barriers due to any deficiencies in qualifications of construction workers are described in previous chapters.

SUPPLEMENTATION OF BASIC EDUCATION

Laws/regulations: Assumed not to pose any barrier.

Economic: Who pays for the development of the supplementation?

Institutional: Who is responsible for the development of the supplementation? Programme committees for the upper secondary schools can initiate the supplementation, but the Swedish National Agency for Education can question the rationale for changing the existing subject/course plans. Many Departments have interests regarding new low-energy buildings and low-energy renovations, e.g., the Department of Education, the Ministry of Employment and the Ministry of Enterprise, Energy and Communications, and coordination between them may cause some difficulties.

Educational: Shortage of instructors/teachers with expertise in the area of energy-efficient building.

Other: Currently, there are too few low-energy buildings being built and too few low-energy renovations being conducted, that is to say, the demand for low-energy expertise exists but not to the extent to achieve 20-20-20.

To help overcome the barriers, a broad reference and steering group has been formed to influence all relevant stakeholders to endorse the developed roadmap. Two actions are suggested in the roadmap (Tullstedt 2013), which the Swedish National Agency for Education and the Swedish National Agency for Higher Vocational Education support:

- Changed and/or supplemented governing documents from the Swedish National Agency for Education in combination with overhaul of textbooks and teaching aids and further education of vocational teachers.
- Within the vocational colleges, regarding training of future supervisors, compulsory requirements for energy related content, after consultation with the building trade.

In the future the developers/clients should require that on-site skilled workers and supervisors have had basic training in energy efficiency and renewable energy. This is supported by the organization the Developers (of construction projects). How to increase the energy efficiency in new construction and renovation is beyond the scope of this study.

CONTINUING VOCATIONAL DEVELOPMENT

Laws/regulations: Assumed not to pose any barrier.

Economic: The major construction companies should have an economy that allows for continuing vocational training of skilled workers. There are, however, a large number of small construction companies that may have limited economic possibilities. So far, very few skilled workers have been offered the opportunity for continuing vocational development.

Institutional: Unclear who will provide the training. Continuing vocational development should as up to now be possible to be provided by various current providers,, but they probably do not have the sufficient capacity. Currently, continuing vocational development is conducted internally within the larger companies, within trade organizations' training operations and under the auspices of installers and material suppliers.

Cultural: Unknown number of foreign skilled workers and foreign contractors who have a limited knowledge of Swedish. The number is, however, not yet that high.

Social: Motivation is probably lacking for many construction companies so long as there are not a sufficient amount of low-energy buildings being built or many low-energy renovations.

Educational: Shortage of instructors with expertise in the area of energy-efficient building. Prejudices against energy-efficient building (Blomsterberg 2012b). Knowledge of educational opportunities is low (Dehlin 2012). Low demands for continuing vocational development (Dehlin 2012).

Other: Lack of time to participate in training. Currently, there are too few low-energy buildings being built and too few low-energy renovations being conducted, that is to say, the demand for low-energy expertise exists but not to the extent to achieve 20-20-20.

To help overcome the barriers, a broad reference and steering group has been formed to influence all relevant stakeholders to endorse the developed roadmap.

A survey shows a great interest in continuing vocational development among civil servants and skilled workers (Dehlin 2012).

According to the roadmap (Tullstedt 2013) to overcome the barriers what is needed is criteria for the procurement of construction projects regarding the training of on-site workers and supervisors and the introduction of information meetings with all involved operators, clients, planners, project managers, supervisors, and not the least skilled workers. The intention is that these criteria should be the basis for the procurement of construction projects with an element of energy efficiency.

Conclusions

This study presents an analysis of the current status of the building sector, a review of current and planned strategies for training within the field of energy, in addition to an analysis of the skills that are required on the building site and a preliminary analysis of potential barriers and how to overcome them. Subsequent stages involve the production of a roadmap and platforms, the implementation of which will then be guaranteed.

The workforce of the Swedish building sector is relatively well-educated, as far as its consultants and constructors are concerned. However, the building sector is, to a certain extent, fragmented into different branches and organizations. Internationalisation can be seen in the growing number (from a low level) of foreign building trade companies and an increase in foreign workers on Swedish building sites. The foreign workers might have a different level of education from the Swedish ones. Internationalisation can also be seen through the fact that it has become easier in recent years to import building material and that an ever increasing number of low-price building material distributors have established themselves in the Swedish market.

The proportion of low-energy buildings in new production is still low, on average under 2 per cent, or 350 apartments per year and, on average, under 0.25 per cent or 8 commercial premises per year, over the last ten years. This percentage is expected to rise in the coming years – in 2010, 7 per cent of new homes were low-energy buildings. Up to now, the number of annually renovated apartments is 24,000, but in only a very small number of these has the energy performance been considerably improved. Many operators within the building sector believe however that there will be an increasing demand for energy-efficiency, both from authorities and private purchasers. There are few grants available for energy-efficient building. Those that do exist are for the installation of solar cells and panels. The results up to now show that the total energy use for heat and hot water in buildings has not changed, despite the increase in terms of square metres floor area. On the other hand, electrical use, primarily in commercial premises, has been on the increase since the 1970s.

Since a great deal of time will pass before all buildings are replaced with new buildings, more existing building must be made energy-efficient so that the overall climate goals can be achieved.

The majority of skilled workers need further training with respect to new low-energy buildings, the low-energy renovation of buildings and the use of renewable energy. This training should result in a general understanding of energy efficiency and renewable energy related to buildings. In-depth expertise related to the various professions is also needed. In the long term, all such workers will have to undergo vocational development for these subjects. If all new build is to satisfy the requirements for low-energy use, and all renovations are to be improved so that they meet the minimum requirements with regard to energy performance in 2020, this means that approximately 100,000 craftsmen will have to undergo vocational development within the next 8 years. According to a first analysis an acceptable period for education is thought to be 1–3 whole days. At least 500 specially trained instructors will be required for this. The basic training for skilled workers needs to be supplemented with training related to low-energy buildings. At

least 1,500 instructors will be required for this. Building site management will also need to undergo similar vocational development. This group consists of approximately 15,000 technicians/engineers. However, a building will not be energy-efficient if not requirements are made and if not planned and designed to be energy-efficient.

In conclusion, therefore, the roadmap suggests three types of activities:

- Skills development for on-site workers and supervisors
- Changes in the construction vocational training
- Information activities to e.g. clients/builders

Potential barriers to the implementation of the training are financial (where is the funding coming from?), institutional (who is responsible for providing the training?), cultural (foreign labour) and social (motivation) factors, as well as a lack of time, in addition to the fact that too few low-energy buildings are being built or are carrying out low-energy renovations. However, a slight increase is noticeable. Many of these barriers could be overcome if the demand for energy efficient buildings, new and renovation increased strongly.

In order to create incentives for training the developers/clients should require that on-site skilled workers and supervisors have had basic training in energy efficiency and renewable energy. How to increase the energy efficiency in new construction and renovation is beyond the scope of this study.

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