BUILD UP Skills Finland

National Roadmap
Ensuring Energy Efficiency Competence in Construction

29 April 2013

BUILD UP SKILLS
ENERGY TRAINING FOR BUILDERS

Further information

More details on BUILD UP Skills Finland can be found at http://www.motiva.fi/toimialueet/kansainvalinen_toiminta/build_up_skills_finland/

More details on BUILD UP Skills can be found at www.buildupskills.eu

More details on the IEE programme can be found at http://ec.europa.eu/intelligentenergy

Foreword

Improving the energy know-how of construction workers is important and timely. The EU energy and climate targets for improved energy-efficiency of buildings mean in practice added thermal insulation of structures and more complex building technology systems, among other things, representing increasing challenges for the construction process. The entire industry needs more knowledge and new attitudes to improve work culture and create a healthy built environment.

In its strategy for the sustainable competitiveness of the construction sector and its enterprises, the European Commission has identified some challenges in the sector, such as the low performance of the value chain which is linked to the fragmentation of the sector, shortage of skilled labour, and modest investments in research and innovation. Construction industry is also extremely cyclical. As one short-term measure, the strategy mentions the BUILD UP Skills project funded by the Intelligent Energy Europe (IEE) programme. The BUILD UP Skills project has been given the goal of adjusting the systems regulating skills and qualification needs in the vocational training to include energy efficiency and renewable energy sources. The purpose of this work is to increase the number of qualified workers at construction sites (European Commission 2012).

The BUILD UP Skills Finland project has worked towards that goal in Finland in 2011-2013 with the participation of Motiva (co-ordinator), Työtehoseura, Amiedu, and Rateko. The project has been carried out under the guidance and support of a Strategic Advisory Group, consisting, in addition to the organizations responsible for the project management, of representatives of the Ministry of the Environment, Ministry of Employment and the Economy, National Board of Education, Confederation of Finnish Construction Industries, and Finnish Construction Trade Union.

The BUILD UP Skills Finland project proceeds in two phases. The purpose of the first phase (Pillar I) has been to analyse the current national status and to prepare a roadmap which could be used to train the construction work force to the extent that the 2020 targets can be achieved in that respect. Future plans (possibly in an IEE BUILD UP Skills Pillar II) include the implementation of the roadmap: updating current practices and creating new models for increasing and ensuring knowledge.

Contents

1. Executive summary

The European Union has agreed on a goal to improve energy efficiency, to reduce emissions, and to raise the share of renewable energy forms significantly by 2020 compared to 1990. If we want to reach that goal, substantial investments are needed to improve energy efficiency and to move towards renewable energy solutions. This roadmap, prepared under the BUILD UP Skills Finland project, describes what needs to be done by 2020 to develop and secure the professional skills of construction workers to ensure the know-how needed to attain these targets. The roadmap includes an action plan with explanations for energy-efficient construction skills and their attainment.

Among other things, the Status Quo analysis identified following shortages and challenges in terms of knowledge, its verification, and teaching:

» The building sector employs a large number of workers who need more skills or who have no training at all.
» Inadequate learning materials with incomplete or obsolete information, or completely lacking information on certain themes. The teaching and support materials of teachers were also found lacking.
» While the number of immigrant workers has grown significantly, few information packages and instructional materials have been prepared in foreign languages.
» Workers receive little encouragement to continue developing their skills and completing qualifications.

With regard to developing and securing professional skills, the roadmap focuses on three broader themes. These are: 1) development of learning and knowledge, 2) dissemination and verification of knowledge, and 3) supporting measures.

A need for improved knowledge was identified particularly in areas such as structural physics, thermal insulation, airtightness, moisture control, building technology, and renewable energy. Another major challenge was seen in overall management and lack of coordination between different operators. According to the analysis, the problem is not only with lacking energy know-how, but even the basic skills need improvement. A particular challenge concerns the training of those workers whose skills need updating the most.

In terms of technique or manual skills, energy-efficient construction or increasing use of renewable energy forms does not cause great changes in the competence requirements. Workers have always had to be able to read blueprints and carry out careful installations. However, energy-efficient construction does highlight the need for some skills more than before. Best practices for energy-efficient construction have to be defined and disseminated in order to identify the most important skills requirements that need to be developed. In the development of teaching, the following areas should be the focus of all worker groups:

- understanding the meaning of hygrothermal performance of structures as well as airtightness;
- understanding the mould and moisture risks linked to different materials and installations;
- understanding novel designs and instructions such as data models;
- understanding the performance of a property and its systems as a whole, knowing how to guide in its energy-efficient and moisture-safe use;
- bility to speak foreign languages, to understand cultural differences, and to collaborate with construction workers from different countries.

Key tasks related to learning and skills include development of teaching contents, review of curricula, development of teaching methods, and the amount of education needed. Table 1.1 shows measures and actions for securing the know-how needed for energy-efficient construction. The table also lists skills requirements for different occupations.

Table 1.1 . *Measures to meet skills requirements for energy-efficient construction. Our goal is to increase the knowledge of our vocational labour force (white area). First we have to identify and create the means for increasing knowledge (yellow frame). Next, these means have to be implemented in teaching, further education, and at construction sites (green frame). Development also needs guidance and support (blue frame).*

Co-ordination and assessment of impact 3.1
Information and communication 3.2
Increasing incentives 3.3

Dissemination of best practices of energy-efficient construction 2.1
Development of competences and skills demonstrations 2.2
Quality assurance criteria of energy-efficient construction 2.3

Identifying best practices of energy-efficient construction 1.1
Updating curricula, supplementing teaching materials, further education of teachers 1.2
Development of new teaching methods 1.3

Skills requirements for achieving energy targets, by occupation			
House builders must	**HVAC installers must**	**Electricians must**	**Automation installers must**
» understand heat and moisture technical performance of structures and importance of airtightness			
» understand mould and moisture risks linked to different materials and installations			
» be able to read novel designs and instructions, know how to use IT to read blueprints			
» know the correct use of insulation materials, wind screens, vapour barriers, and sealants; know how to install energy-saving materials and components	» master the installation of renewable energy systems, such as heat pumps, solar energy and heat, and bio fuel boilers	» set lighting control with energy-saving starting values	» set the parameters for heating and cooling appropriately to produce agreeable conditions while saving energy
» know how to install and control appropriate and energy-efficient weather protection, heating and drying methods at worksite	» know how to install heating systems and pipe and channel insulations in energy-efficient manner, to choose equipment considering energy efficiency	» know how to connect small power generation systems to the network, install new load control systems and reactive power compensation equipment	» secure parallel operation of control systems with monitoring and alarm systems, considering energy efficiency
» consider energy efficiency when operating machines and equipment and in worksite logistics	» take energy efficiency into account in piping and channelling (pressure loss) and in the layout of fans, pumps and valves	» understand how systems interact, consider thermal stress of other systems when installing sensors	» make sure that the follow-up and reporting systems work reliably
» know the special characteristics of energy efficiency in renovation work	» understand flow technology of ventilation channel installations, operation of ventilation machines (SFP), roof exhaust fans, cooling beams, fan coil units	» know how to guide users in the energy-efficient use of control systems	» know how to guide users in the energy-efficient use of control systems
» know how to guide users in the energy-efficient and moisture-safe use of property and its systems			
» collaborate with construction workers from different countries, speak foreign languages, understand cultural differences			

The education model of the Finnish vocational work force is based on basic vocational qualifications completed after the comprehensive school. Further education and skills demonstrations of those already employed, including training and education at the worksite, play an important role in furthering their skills.

Spreading know-how also requires changing attitudes. Stricter requirements for energy efficiency make the construction process more challenging than ever and introduce new kinds of quality risks. Workers need to have positive attitudes and we need sufficient assurance of their skills. Attitudes can be changed by training experienced workers as mentors and attitude builders. Workers are encouraged to educate themselves and acquire qualifications. However, enterprises still need their quality assurance systems to ensure an energy-efficient and high-quality final outcome.

Supporting measures form our third theme. The pace of tightening of the different obligations and regulations is fast, and the skills of the various operators need to be improved rapidly. The ability to summarize and communicate information on the latest research findings and best practices in our own and neighbouring countries is crucial for both energy efficiency and high quality.

Table 1.2 shows a summary of the roadmap: measures and actions, objectives, key stakeholders, timetable, and estimate of financing needs. Workshops have been organized to involve stakeholders in the creation of the roadmap. Stakeholders have had a great impact on the contents of the roadmap and have, at our request, provided comments on the draft for the roadmap. The Strategic Advisory Group has also actively participated in the work.

Table 1.2 *Summary of the roadmap. Letter symbols for stakeholders are described in Annex 2.*

	Themes and actions	Objectives and indicators	Progress indicator	Key stakeholders	Time-table	Estimate (€ 1,000)
1	Development of learning and knowledge	Raising the level of learning indicators: content and amount of new learning material, content and amount of further training of teachers and workers, number of worker training days		A, B, C, D, I, J	2013–2016	800–1,100
1.1	Identifying, documenting and further developing best practices in energy-efficient construction.	Forming a basis for future work. Preparing learning materials. Motivating parties for energy-efficient construction and its overall management.	Contents and volume of published material.	Associations of house building and building technology (C, D), universities and research institutes (I), educational organizations (J)	2013–2014	100–150
1.2	Updating curricula, supplementing teaching materials, further education of teachers.	Integrating best practices and results of latest research in teaching materials and vocational training. Motivating teachers to address energy issues.	Curriculum contents. Content and amount of produced learning material. Content and number of days for further education of teachers.	Ministry of Education and Culture (A), National Board of Education (A), associations of house building (C) and building technology (D), labour market organizations (B), educational organizations (J), teachers, students	2013–2016	400–600
1.3	Developing new teaching methods to support on-the-job learning. Utilizing information technology in teaching.	Improving quality of teaching, making learning more effective. Making participation more attractive for employers and employees. Developing teaching on learners' terms. Developing precision training.	Number of worker training days.	Educational organizations (J), National Board of Education (A),universities and research institutes (I), teachers, students	2015–2017	300–400
2	Dissemination of know-how, verification.	Raising the level of workers' skills Indicators: Number of graduates, amount of further training for mentors and workers, development in the number of complaints.		A, B, C, D, G, H, I, J	2013–2020	900–1,300
2.1	Dissemination of best practices in energy-efficient building.	Implementing best teaching methods, increasing awareness of energy-efficient construction. Employing mentors and attitude builders to promote knowledge.	Number of worker training days. Number of training days for mentors and attitude builders.	Ministry of the Environment (A), labour market organizations (B), developers (H), research institutes (I), schools (J), construction enterprises	2013–2020	500–700
2.2	Developing competences and skills demonstrations, encouraging workers to complete qualifications.	Increasing and securing the know-how of untrained workers and immigrant workers. Increasing the number of those completing qualifications.	Number of graduates.	National Board of Education (A), Ministry of Education and Culture (A), labour market organizations (B), educational organizations (J)	2015–2020	300–500
2.3	Including criteria of energy-efficient building in quality assurance of construction sites.	Improving the quality of energy-efficient building. Guidance of the workers. Ensuring the quality of their work regardless of qualifications.	Declining number of quality defects and complaints.	Certification organizations (G), associations (C, D), construction enterprises	2016–2018	100–150

3	Supporting measures	Steering and encouraging development Indicators: Indicators of sections 1-2,stakeholder satisfaction, visibility in media, number of graduates and training days		A, B, C, D, E, F	2013–2020	850–1,000
3.1	Assessing the effectiveness of measures, co-ordinating with other development programmes in the industry.	Steering development activities and resources towards high-leverage projects. Securing, sharing and implementing outcomes.	Indicators of sections 1-2. Measuring stakeholder satisfaction.	Ministry of Education and Culture, Ministry of the Environment (A), labour market organizations (B)	2013-2020	120–180
3.2	Communicating outcomes to stakeholders and media.	Transfer of energy-efficient building know-how to builders, clients, designers, and authorities. Increasing the support of stakeholder groups in energy-efficient construction.	Number of media hits, newspaper articles, TV minutes. Quality of public discussion. Visibility in stakeholder actions.	Ministries, Motiva (A), labour market organizations (B), associations (C, D, E, F)	2014-2020	400–500
3.3	Increasing incentives, motivating to developing knowledge and doing quality work.	Improving attitudes and reducing resistance to change, influencing attitudes, removing barriers to development.	Number of graduates. Number of training days for workers and attitude builders.	Ministry of Education and Culture, Ministry of Employment and the Economy (A), labour market organizations (B)	2014-2017	300–400
					Total 2,500–3,500	

STAKEHOLDERS
- This classification made for this present purpose only

A MINISTRIES, GOVERNMENT AGENCIES, NATIONAL PROGRAMMES

A1 Ministry of the Environment
A1.1 Motiva
A2 Ministry of Employment and the Economy
A3 Centre for Economic Development, Transport and the Environment
A4 National Board of Education
A4.1 Education and Training Committee
A4.2 Qualification Committee
A5 Ministry of Education and Culture
A6 Safety and Chemicals Agency, TUKES
A7 City Building Control
A8 Real Estate and Construction Forum, KIRA
A9 ERA17 Programme

B LABOUR MARKET ORGANIZATIONS

B1 Confederation of Finnish Construction Industries, RT
B2 Finnish Construction Trade Union
B3 Akava, Confederation of Unions for Professional and Managerial Staff
B4 Trade Union of Education OAJ, Trade Union of Vocational Educators OAO, Adult Educators' Union AKO, Vocational Teachers' Union AO
B5 Electrical Workers' Union
B6 Finnish Energy Industries, ET
B7 Electrical Employers, STTA

C HOUSE BUILDING ASSOCIATIONS

C1 Confederation of Finnish Construction Industries
C2 Association of Finnish Construction Product Industries, RTT
C3 Association of Mechanical Building Services Industries
C4 Concrete Association of Finland, BY
C4 Pientaloteollisuus PTT (Association of House Suppliers)

D BUILDING TECHNOLOGY ASSOCIATIONS

D1 Finnish Heat Pump Association, SULPU
D2 HVAC Technical Contractors, LVI-TU
D3 Heating Energy Association, LEY
D4 Finnish Refrigeration Enterprises Association, SKLL
D5 Oil and Gas Heating Association, ÖKY
D6 HVAC Technical Trade Association
D7 Oil Industry Service Centre
D8 Electrical Contractors' Association, STUL

E PROMOTION OF INDUSTRY AND BUSINESS

E1 Association for Promotion of Electrical Safety, STEK
E2 Bio Energy Society
E3 Solar Energy Society
E4 Finnish Association of HVAC Societies FINVAC
E5 Finnish Society of Automation, Building Autoation Division, BAFF
E6 Electrical Building Services Centre, STOK
E7 Finnish Energy Industries, ET
E8 Finnish Real Estate Federation
E9 Association of Finnish Local and Regional Authorities
E10 Real Estate Services Federation
E11 Finnish Real Estate Management Federation

F PERSONNEL ASSOCIATIONS AND COMPETENCES

F1 Finnish Association of HVAC Societies, SULVI
F2 VVS Föreningen i Finland
F3 Henkilö- ja yritysarviointi Seti Oy (Personnel and Enterprise Qualification Institution)
F4 Electrical Installation Safety Inspection, SÄTY
F5 Finnish Society of Senior and Master Electricians, SAMSY
F6 Finnish Construction Managers and Engineers, AMK RKL
F7 Society of Building Inspectors, RTY
F8 Finnish Association of Civil Engineers, RIL
F9 Finnish Society of HVAC Engineers, LIVI
F10 FISE Oy, Qualifications for professionals in building, HVAC, and real estate industries

G ENTERPRISE QUALIFICATIONS, STANDARDS

G1 Construction Quality Association, RALA
G2 Henkilö- ja yritysarviointi Seti Oy (Personnel and Enterprise Qualification Institution)
G3 Electrotechnical Standardization Association, SESKO

H BUILDING DEVELOPMENT AND DESIGN

H1 Building Developers Association, RTL
H2 Finnish Association of Consulting Firms, SKOL
H3 Building Development Association, RAKLI
H4 NSS Association of Finnish Electrical Designers
H5 Association of Finnish Construction Engineers and Architects, RIA
H6 Association of Finnish Architects' Offices, ATL
H7 Finnish Association of Architects, SAFA

I RESEARCH, INFORMATION SERVICES

I1 Technical Research Centre of Finland, VTT
I2 Universities of Technology
I3 Building Information Foundation / Building Information Ltd.
I4 Sähkötieto ry / Sähköinfo Oy (Electricity Information)

J EDUCATIONAL ORGANIZATIONS

J1 Vocational colleges
J2 Polytechnics
J3 RATEKO (Construction Industry Education Centre)
J4 Amiedu (Vocational Adult Education Centre)
J5 Real Estate Education Centre KIINKO
J6 TTS – Työtehoseura (a research, development and training institute)

2. Introduction

2.1 BUILD UP Skills Finland Project

BUILD UP Skills Finland is a project funded by the Intelligent Energy Europe with the aim to improve the competence of construction workers in all phases of the building process and in terms of energy efficiency in particular. Reducing energy consumption in buildings plays an important role in reaching both the European and our national energy-efficiency targets. Appropriate knowledge and competent workers together with a capable and careful implementation ensure the realization of energy efficiency in practice.

The aim of the BUILD UP Skills Finland project is to increase the number of qualified construction workers to make the practical work on construction sites contribute to the achieving of energy targets. New know-how and attitudes are required both on new construction sites and in renovation work.

Similar initiatives have been implemented in 30 European countries. In November 2011, 21 European countries formed their own national teams and began the work: Austria, Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland, Germany, Great-Britain, Hungary, Ireland, Italy, Latvia, the Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, and Sweden. In the summer of 2012, nine more countries joined the project: Croatia, the Czech Republic, France, Greece, Lithuania, Luxembourg, Macedonia, Malta, and Slovakia. Finland has worked together especially with Austria and Slovenia, exchanging views with the representatives of these countries during the various phases of the BUILD UP Skills project.

During the first phase of the BUILD UP Skills project, every country has first prepared a national analysis of the status quo (the Finnish “Analysis of the National Status Quo” report is here referred to as “Status Quo 2012”). The objective of the status quo analysis was to determine the need of and demand for skilled construction workers until 2020 and beyond and to identify skills shortages and barriers in various occupations. Once the analysis was done, key stakeholders were invited to participate in the planning of a roadmap.

The national consortium in charge of the implementation of the BUILD UP Skills Finland project includes Motiva, its coordinator commissioned by the Ministry of Employment and the Economy and the Ministry of the Environment, the Work Efficiency Institute, Amiedu, and Rateko.

2.2 Goals for the roadmap

EU has set three main goals for the roadmap:

- Identify measures to overcome barriers and skill gaps in the various professions to meet the 2020 targets in the building sector;
- Embed training on intelligent energy solutions through changes in the mainstream curricula and practice;
- Put in place the necessary measures to ensure that the added value of a more highly qualified workforce is recognized and the use of qualified workers is incentivized or made obligatory.

As key source data, the roadmap relies on the Status Quo 2012 prepared by the Work Efficiency Institute. The roadmap is based on the work done in workshops in which numerous representatives of the stakeholders of the Finnish building sector were invited. One goal of the collaboration is also to get the building sector committed to the implementation of the roadmap.

At the core of the roadmap is the improved competence of construction professionals, comprising the basic vocational training, adult vocational education as well as other forms of supplementary training and the need for their further development, including also issues such as motivation. The roadmap has been prepared for the years until 2020. Stakeholders include players in the construction and education sectors, training organizations, political decision makers, public authorities, special interest organizations, and private citizens interested in the issue. Construction is an aggregate formed by many parties. For example, stakeholders such as trainers, planners, customers and many others are linked indirectly to the roadmap.

One of the objectives of the roadmap has been that professional workforce should not become a barrier or a bottleneck in the fulfilment of our energy-saving objectives. In practice, this means that we have to have enough professional workers in each sector who have the appropriate skills and motivation to create high-quality energy-saving solutions. A key issue regarding the roadmap is to find a way to remove known skill gaps and potential barriers in various occupations.

2.3 Starting points of the roadmap

2.3.1 Energy objectives and strategies

European Union has set three main energy and emission objectives to be fulfilled by 2020:

- reducing greenhouse gas emissions by 20 per cent (base year 1990);
- reducing the consumption of primary energy by 20 per cent compared to base line;
- increasing the share of renewable energy to 20 per cent of total consumption.

These objectives are set at the EU level. They form a main framework for a European energy and climate policy for the 2010s. Finland aims for a share of 38 per cent for renewable energy by 2020, which is 9.5 percentage points higher than in 2005. Finland strives to reduce emissions in non-ETS sectors by 16% by 2020 compared to 2005 (Prime Minister's Office, 2012, 10).

Related national strategies include the Climate and Energy Strategy, the Strategy for Renovation, and the National Working Life Development Strategy.

The strategic implementation plan included in the government programme of the current administration mentions also the promotion of wood construction and adds: "*The energy efficiency of construction shall be improved by regulations and other guidelines as well as by creating incentives.*" (Council of State, 2011).

The current national Climate and Energy Strategy was completed in 2008. The 2008 strategy states, among other things, that the energy regulations for new construction shall be tightened, building renovation and related improvement of energy efficiency shall be supported, and the installation of residential water meters shall become mandatory in new buildings (Council of State, 2010, 4-5). These objectives have since been realized. The updated Climate and Energy Strategy includes the following construction-related themes: decision to draw up an energy efficiency act and a long-term strategy for improved energy efficiency in buildings within the timeframe of the Energy Efficiency Directive. The decision to promote small-scale electricity generation may also be expected to affect construction (Ministry of Employment and the Economy, 2013).

In the strategy plan for renovation 2007-2017, energy efficiency is included as part of building renovation. In the strategy, improving energy efficiency includes the following themes (Ministry of the Environment, 2007, 32):

» development of the assessment and measurement of energy efficiency and consumption;
» promotion of the use of energy certificates;
» improvement of the energy efficiency of structures and building technology;
» information management with emphasis on the viewpoints of life-cycle costs;
» economic instruments and regulations.

A key objective of the National Working Life Development Strategy, prepared for the years until 2020, is the extension of working careers of Finnish workers. This has its origin in the change of demographics showing that young population groups in Finland are clearly outnumbered by those nearing pension age. Well-qualified workforce is one of the focus areas of the National Working Life Development Strategy (Ministry of Employment and the Economy, 2012a).

Many EU directives already enacted or under preparation affect now or will affect in the coming years Finnish legislation, and thus, indirectly, construction. These include the Energy Performance of Buildings Directive (EPBD), the Renewable Energy Directive (RED), the Ecodesign Directive, and the Energy Efficiency Directive (EED). Related to these, Finland intends to enact a separate Climate Act addressing emission targets in the near future (Ministry of the Environment, 2013).

2.3.2 Starting points for developing energy efficiency in Finland

Finland is situated in the northern part of Europe. 71% of the building stock of Sweden (EU member state) and 58% of that of Norway (non-member state) lie south of Finland's southernmost latitude. All buildings of the other EU countries lie south of Finland (Säteri 2013). Weather conditions in Finland vary greatly between seasons. Winters pose considerable heating requirements. Winter-time energy efficiency requires good structural thermal insulation, energy-efficient heating and other building technology systems, and appropriate maintenance of premises and systems. Summers and autumns in Finland are warm and humid, so structural moisture resistance and mould prevention are of crucial importance in energy-efficient buildings.

The term energy efficiency covers energy consumption both during the construction phase (both in new construction and renovations) and over the life cycle of the finished building. On average, energy consumption over the life cycle has, so far, exceeded considerably that of the construction phase. Instead of specific legal guidelines for energy saving during building process, energy price and information together with various voluntary measures are used to reduce energy consumption during that time. When moving towards nearly-zero-energy construction, the proportion of building materials and construction work in energy consumption related to the life-cycle energy consumption increases while the share of energy consumption during the use of a building decreases.

Higher energy-efficiency goals for buildings require new know-how in matters such as appropriate thermal insulation and airtightness and ensuring the energy-efficient functioning of building technology systems. Thermographic cameras and airtightness testers are among the instruments whose results can be utilized to improve the energy efficiency of buildings. The energy efficiency of building process can be improved, for example, by energy-efficient heating and drying methods and by making building conditions less wasteful in terms of energy and materials. This may include the use of weather protection, where necessary, especially in winter.

Newly implemented stringent regulations covering new construction translate in practice into additional insulation in building casing and increased use of energy-saving building technology systems. In renovation work, additional roof insulation and replacement windows have in many cases meant investing in energy efficiency that makes economic sense as well. Added thermal insulation reduces heat loss through structures while leaving the outer parts of the casing cooler. This has been found to increase the risk of mould and condensation (Tampere University of Technology, Department of Civil Engineering, 2008; Lahdensivu et al. 2012).

Finland has provided instruction in low-energy building for new construction, renovation, as well as for building maintenance (see, for example, RIL (Finnish Association of Civil Engineers), 249-2009). Once nearly-zero-energy construction becomes a general requirement, the capability to do high-quality design and implementation together with responsible working methods must be expanded to the entire building sector. Workers' competence will, therefore, play an increasingly important role in the future. Carrying out energy-efficient construction as planned requires that construction be as technologically flawless as possible.

In addition to energy efficiency, the EU energy targets also cover increased use of renewable energy forms. The installation and maintenance of renewable-energy systems require knowledge in many areas of building technology. The choice of heating methods, for example, has a notable effect on greenhouse gases and energy use. Traditionally, most Finnish low-rise buildings have included the option of wood-fired heating. In the 21st century, heat pumps have become more common both in new construction and in renovation projects. We expect that small-scale energy generation, such as solar collectors and panels, property-specific wind power production or other use of bio energy, will become part of a growing number of private properties. Building or updating of heat recovery systems can be part of energy-efficient ventilation.

Energy-efficient concrete heating and structural drying methods, together with weather protection methods, can quickly translate into substantial energy savings on construction sites (see Hämäläinen 2012 & Toivari 2011). Moreover, the choice of materials and equipment, electric building automation systems and their appropriate control and correct use can have an impact on energy consumption in building and real estate sectors. Another key area in energy saving is the use of space; however, the construction process can only have a limited impact on energy saving.

To fulfil our energy targets, action is needed both in new construction and renovation work. The energy efficiency of new buildings has been improved by increasing minimum requirements for energy efficiency in building regulations, which has an impact on the practical construction work as well. The possibilities for energy saving in renovation work may be divided in five groups of measures, presented in Table 2.1. The purpose of the list of measures is to summarize the types of work involved in the improvement of energy efficiency in building renovation.

Table 2.1. *Measures impacting energy saving and emissions in building renovation. The purpose of the list is to outline the types of construction work involved in the improvement of energy efficiency in building renovation. (Based partly on Vihola & Heljo, 2011)*

1. Energy-saving measures in systematic renovation work
» Replacement of windows; increasing heat recovery in ventilation; additional wall and flat-roof insulation; increased metering of water usage; replacement of equipment, devices and lighting fixtures and improving their control; and, to a lesser extent, additional insulation of base floors and replacement of doors, etc.
2. Other, immediately feasible repairs
» Additional flat-roof insulation; sealing of doors, windows, base floors, walls, and roofs; installation and replacement of thermostatic radiator valves and other control devices; added automation; heat insulation of hot-water pipes in technical rooms; heat insulation of ventilation pipes in unheated spaces, etc.
3. Choice of heating methods
» Improved efficiency of heating systems; installation of hybrid systems; in some cases, installation of a new/replacement system, etc. The main heating system may also be complemented by various supporting elements, such as heat pumps and solar collectors or panels, and increasing the use of wood and bio fuels.
4. Controls and meters
» Measures such as eliminating causes for high inside temperature, such as draught, which may be reduced by balcony glazing, among other things; adding controls; repairing thermostats; reducing pressure and flow in water pipes; installing water meters, etc.
5. Choice and use of electric appliances and equipment
» Choice of more energy-efficient appliances, entertainment devices and lighting fixtures; applying modern, significantly more energy-efficient underfloor heating systems; improving cars' heat controls; considering the option of a hybrid or electric car; limiting the heating of electric saunas and preventing the overheating of other rooms at the same time; as well as many other issues linked to the use of electricity.

2.3.3 Trends in building regulation

The Finnish building regulations have been adjusted gradually many times in the recent past. Table 2.2. shows some details of the development in building regulations in different years.

Table 2.2. Development of requirements set in Finnish building regulations since 1985 (Ministry of the Environment, 2012)

U-value	C3/1985	C3/2003	C3/2007	C3/2010, D3/2012
External wall	0.28	0.25	0.24	0.17
Upper (roof) or base floor against outdoor air	0.22	0.16	0.15	0.09
Base floor towards crawl space	0.22	0.2	0.19	0.17
Structure against ground	0.36	0.25	0.24	0.16
Window or door	2.1 (0.7)	1.4	1.4	1.0
Roofwindow		1.5	1.5	1.0
Structure area of windows	max 15% of floor area, max 70% of exterval wall area	max 15% of floor area, max 50% of exterval wall area	max 15% of floor area, max 50% of exterval wall area	max 15% of floor area, max 50% of exterval wall area.

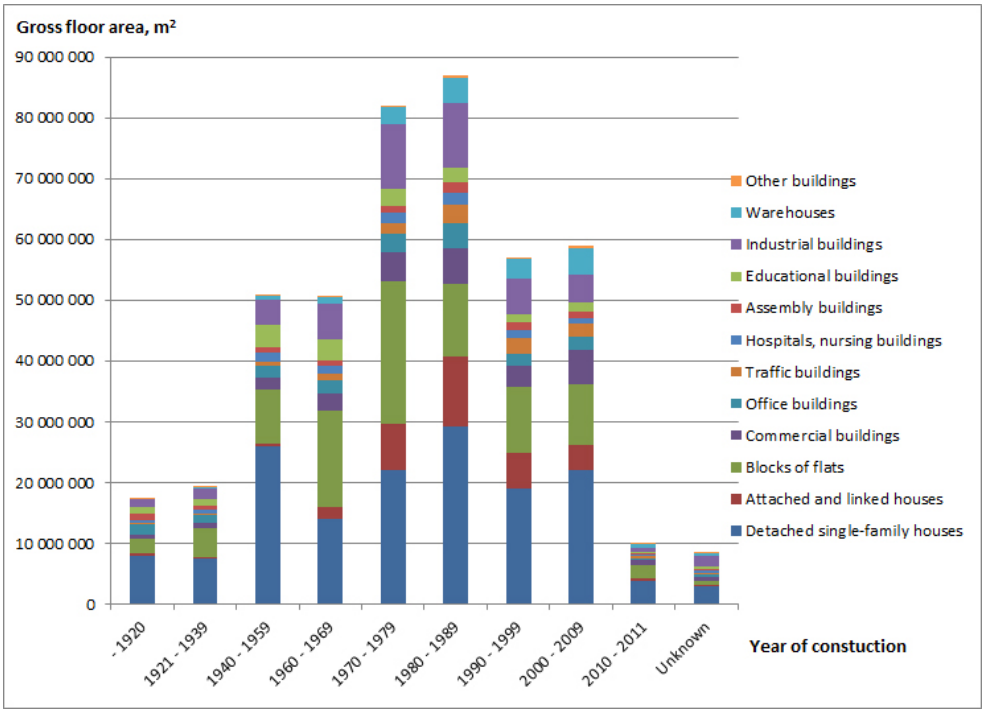
Central trends of the 2010s can be expected to focus on the efficiency of materials and tightening of the requirements for the overall energy efficiency of a building. A national programme concerning materials efficiency is already under preparation. Besides energy efficiency, nearly-zero-energy construction requires increased use of renewable energy forms. These issues are of importance with regards to both the quality and quantity of knowledge in building industry. The development of building regulations until 2020 is discussed in the roadmap for Finnish building regulations, which is expected to be published in 2013.

The above-mentioned targets put great pressure on the building and real estate sectors with respect to energy saving. The rapid change can be addressed only through significant research, development, and training projects. A notable change in attitudes is required at all levels of society to achieve the targets. Orders and regulations alone will not be sufficient to reach the targets; increased financial support, development activities and improved know-how are also required. The matter has been studied extensively, and now the material should be converted into an easily understandable form and used in every-day decision making at all levels of society. Best practices must be adopted more widely and supported by incentives, information, and campaigning. The public sector should also serve as a more visible example.

2.3.4 Finland's building stock

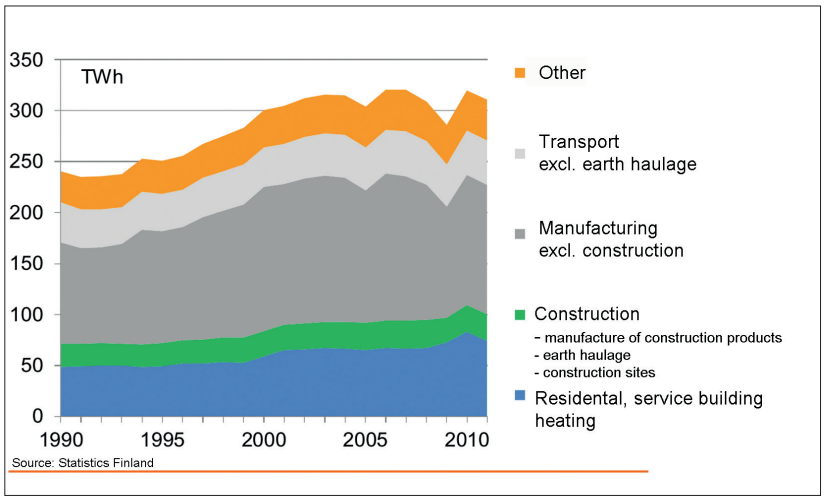
Compared to many other European countries, Finland's building stock is relatively young. In the 1970s and 1980s, there was a building boom in Finland (see Fig. 2.1). Due to its age structure, the Finnish building stock can be expected to require a great deal of renovation work in the 2010s. For example, houses built in the 1970s will need renovations of pipe systems promoting energy efficiency, and these efforts will be required and supported by the reform of the Land Use and Building Act that will enter into force in 2013, and by the decree on energy-efficiency requirements applied to building renovation (Government bill No. 81/2012).

Figure 2.1. *Finland's building stock by building type, construction year and floor area. Building stock statistics do not cover recreational buildings, which are not permanently occupied – in practice this means most of the holiday cottages. In 2011, there were 493,000 holiday cottages in Finland (Statistics Finland, 2012c).*



Newer building stock is clearly more energy efficient than the older buildings. Building regulations have been gradually tightened in the 2000s. The impact of these modifications is somewhat delayed due to the fact that regulations apply to the permitting phase. Therefore, there are still houses being finished according to earlier regulations even after newer ones have been implemented.

Figure 2.2. *Energy end-use in Finland (Vainio 2012).*



Construction takes up approx. 8% of the energy consumed in Finland: manufacturing of building products 4%, earth transports 3%, and work sites 1% (Vainio 2012). The statistics of energy end-use (Fig. 2.2) differ from the statistics of total consumption (cf. Fig. 2.3) in that the end-use statistics describe the amount of energy actually used by consumers. The statistics on energy end-use do not include energy consumption resulting from energy transmission and conversion losses.

Table 2.3. *Building heating systems in Finland (Statistics Finland, 2012a). Wood is a significant source of renewable energy in building heating systems in Finland. The share of heat pump energy also continues to grow.*

	Small scale combus-tion of wood	**Peat**	**Coal**	**Heavy fuel oil**	**Light fuel oil**	**Natural gas**	**Ambient energy**	**Energy sources total**	**District heat**	**Electricity**	**Space heating total**
	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
	1	2	3	4	5	6	7	8	9	10	11
2010											
Resindeltal buildings	16,217	150	3	106	6,469	547	2,758	26,250	19,780	13,371	59,401
Detached houses	14,056	142	3	-	5,117	128	2,636	22,081	2,030	9,435	33,546
Semidetached houses	144	3	-	-	561	161	8	878	3,050	1,995	5,923
Residental blocks of flats	100	6	-	106	739	258	14	1,222	14,700	1,111	17,033
Residental recreational buildings	1,917	0	0	-	53	0	100	2,069	0	830	2,899
Commercial and public buildings	972	36	-	1,111	2,442	333	267	5,161	12,730	2,491	20,382
Industrial buildings	611	122	-	2,597	1,850	656	19	5,856	3,620	3,233	12,709
Agricultural buildings	1,667	197	-	414	1,317	44	8	3,647	140	902	4,689
Total	**19,467**	**506**	**3**	**4,228**	**12,078**	**1,581**	**3,053**	**40,914**	**36,270**	**19,997**	**97,181**

Heating of residential and service buildings accounts for approx. 26% of the energy end-use in Finland. In addition to these, production buildings also require heating, but it is treated separately in statistics. It has been estimated that the energy use of buildings in Finland accounts for almost 40%, including not only the heating of residential, service, and production buildings, but also the consumption of the electric energy in these buildings (Heljo et al. 2005). Of all the renewable energy forms, wood plays an important role in heating Finnish buildings (see Table 2.3).

2.3.5 Vocational education system

In 2012, vocational training in construction was provided by 113 school units. Of these educational units, 106 offered courses in Finnish and 7 in Swedish. Counting also vocational institutions offering curricula in electrical and automation technology, the total number of schools with this type of vocational education rises to 129 units (2012). The total number of organizations offering vocational training in these subjects is however just 80, as some of them cover several school units. In addition, there are 25 vocational adult education centres in these fields (connected to 14 organizations) as well as 20 vocational specialized and special education institutions (connected to 9 organizations) (Koulutusnetti 2012). Many of these institutions have only a very limited number of students in these specific fields.

The basis for the Finnish vocational education system is formed by basic vocational qualifications. The basic vocational qualification, first degree, consists of 120 study weeks and takes, as a rule, three years to accomplish. The basic vocational qualification can be taken in a vocational institution, or in connection with apprenticeship or labour market training. Adults may also take basic vocational qualifications in adult vocational training and prove their knowledge in a vocational skills demonstration once they have accumulated the necessary work experience in the field.

In addition to basic vocational qualifications, first degree, the vocational qualifications are another way to prove one's knowledge, with specialist qualifications showing specialized learning (see Table 2.4). Vocational qualifications and specialist qualifications are taken in a vocational skills demonstration. Students aiming for vocational qualifications are expected to have taken a basic vocational qualification, first degree, or accumulated the necessary skills and knowledge through work. Adult vocational students can expect to spend 1.5-2 years earning their degree. Vocational qualifications and specialist qualifications take 1-3 years. Generally, vocational skills demonstrations also require some preparatory training. The skills demonstration system offers adult students a flexible way to prove, refresh, and maintain their vocational competence, or prepare for a new career when job descriptions change. The skills demonstration enables the national, qualitative recognition of a candidate's vocational competence regardless of whether it was earned through work experience, studies, or other activities.

Table 2.4. *Number of construction, electrical, and automation engineering qualifications taken in 2010 (Statistics Finland 2012b, School statistics). Due to the degree reform, electrical engineering qualifications have been included in this table. Graduates of electrical and automation engineering often find employment outside the building sector.*

Main basic degrees	**New students**	**Total No. of students**	**Qualifications**
Construction engineering, basic vocational qualification, first degree	4,114	10,294	2,692
Building technology, basic vocational qualification, first degree	1,986	5,120	1,456
Electrical engineering, basic vocational qualification, first degree	212	4,940	3,523
Electrical and automation engineering, basic vocational qualification, first degree	3,352	6,255	148
Total	9,664	26,609	7,819
Vocational qualifications	**New students**	**Total No. of students**	**Qualifications**
Construction engineering, vocational qualification	1 138	1 626	324
Electrical engineering, vocational qualification	332	634	106
Construction production, vocational qualification	101	182	18
Pipe fitting, vocational qualification	78	111	11
Heating systems installation, vocational qualification	332	367	0
Ventilation systems installation, vocational qualification	14	23	3
Construction work, vocational qualification	8	8	0
Vocational specialist qualifications	**New students**	**Total No. of students**	**Qualifications**
Construction engineering, specialist qualification (SQ)	86	129	25
Construction supervisor, SQ	30	59	16
Master electrician, SQ	7	35	5
Ventilation systems installer, SQ	5	23	4
Plumber, SQ	2	21	4

Finland also provides shorter-duration training for specific professional jobs. This often takes the form of labour market training, such as the training for heat pump installation, which includes selected parts of the vocational qualification programme for heat pump installers and concludes with a skills demonstration. The length of labour market training may vary significantly depending on the field, goals, and the previous qualifications of a student. In 2011, the average duration of labour market training was 5.2 months. These studies typically consist of a certain part of a vocational qualification exam. In statistics, the labour market training in the fields of construction and mining is combined. In 2011, a total of 3,544 people participated in such training in these fields (Ministry of Employment and the Economy, 2012b).

In construction, various short-term precision training opportunities are also provided to supplement and update the skills of people already working in the industry. This type of training may only take a few hours, days, or weeks. Precision training is a particularly good way for people already fully employed to update and further their skills. Some of these training courses may lead to certification, while some may be mandatory to maintain one's qualification. One of the most popular short-term training programmes in Finland is the training for occupational safety card, which is typically required at construction sites. The occupational safety card is valid for a period of five years, after which new training is required. First aid training is also common. In electrotechnical sector, maintaining one's qualification requires electrical safety training, among other things.

2.3.6 Building sector workforce

Statistics Finland divides construction workforce in three main categories: building construction, earth construction and water engineering, and specialized building operations. Building sector workforce by occupation is shown in Table 2.5. Energy targets are linked to some occupations more than to others.

The current trend in Finland shows the age groups ready to enter employment being clearly outnumbered by those nearing retirement (Ministry of Finance, 2012, 30). Partly due to the declining age groups, there are plans to significantly reduce the number of admissions to vocational secondary education and polytechnics. At the same time, efforts are made to reduce youth unemployment and marginalisation by providing training and early intervention (Ministry of Finance, 2012, 30) already at the early stages of unemployment. The government programme outlines that all young people under 25 and all recent graduates under 30 will be provided with a job or a training opportunity, study placement, workshop or rehabilitation placement no later than three months after the start of unemployment by 2013 (Ministry of Employment and the Economy, 2013). This includes a training or education guarantee: all comprehensive school graduates are guaranteed admission to further training. The goal is that 90 per cent of 20-24 year olds should have a post-comprehensive school degree by 2020 (Ministry of Education and Culture, 2012b).

In the next few years, the number of students with immigration backgrounds may grow in vocational construction training as well. Efforts are made to improve the employment of immigrants, which is now lower than that of the general population, by means of language and vocational training (Ministry of Finance, 2012, 32). Labour mobility in the construction industry is already higher than in many other sectors, with some 25,000-30,000 foreign workers (according to a survey by the Confederation of Finnish Construction Industries in 2011) forming a significant percentage of the entire construction workforce in Finland. The trend in the foreign workforce numbers will play a role in determining how much and what kind of training will be required in Finland by 2020. Foreign workforce is expected to continue to grow in the next few years (Confederation of Finnish Construction Industries, 2011).

Table 2.5. *Building sector employees in Finland in 2010 (Source: Statistics Finland)*

Building construction	**51,585**
Real estate development and project management	1,041
Construction of residential and other buildings	50,544
Earth construction and water engineering	**15,624**
Specialized building operations	**78,091**
Demolition and preparation of construction sites	15,743
Electrical, water pipe, and other installations	36,808
Electrical installations	14,576
Heat, water pipe, and ventilation installations	18,960
Other building installations	3,273
Heat, noise, and vibration insulation	1,653
Installation of lifts and escalators	1,072
Non-categorized building installation	548
Finishing of buildings and structures	**11,430**
Plastering	286
Carpentry installations	2,706
Floor and wall covering	2,219
Painting and glazing	6,082
Painting	4,965
Glazing	1,117
Other specialized building operations	**14,109**
Construction equipment rental with operators	1,813
Other non-categorized specialized building operations	9,789
Total employees	***145,300***

The construction sector is characterized by a large number of small businesses, typically with only 1-5 employees. Conversely, the number of large enterprises is small, and sub-contractors are used widely. During the different phases of construction, a work site may be occupied by workers from many different businesses. Of all the people employed in construction, approx. 23% are estimated to be entrepreneurs, 57% salaried workers, and 20% salaried clerical employees (Confederation of Finnish Construction Industries, 2011).

Large construction companies offer some internal training. As to the smaller employers, skills development usually requires that workers become active on their own behalf, although there are a few exceptions to the rule.

2.3.7 Conclusions of Status Quo 2012 and known obstacles to achieving energy-saving targets by 2020

Status Quo 2012 concluded that nearly all construction sector employees could benefit from some type of further training and that energy issues should be included as a cross-cutting theme in all curricula of both basic and further education. The need for short-duration precision training was especially evident.

The status quo analysis identified the need for improved skills especially in areas such as structural physics, heat insulation, the airtightness, moisture control and pipe fitting of buildings, and renewable energy. Another important theme was overall management and lack of coordination between players. According to the Status Quo 2012 analysis, the problem is not only with insufficient energy know-how; even the basic skills need improvement. Therefore, in addition to the training in energy know-how made necessary by the new challenges, Status Quo 2012 recommends increased emphasis on refreshing basic skills. A special, related challenge was seen in attracting back to training those who need basic and further education the most (Status Quo 2012, 78).

With respect to certificates and qualifications, Status Quo 2012 did not suggest any material changes to the current status. It mentions that many different certificates are already in use in Finland. Any new qualifications were deemed to have the potential of leading to qualification inflation unless a new qualification offers economic benefits to the qualified. Coordination of qualifications was deemed to be insufficient. The report mentions the idea that energy-efficiency issues may be included in the selection of existing card training courses (Status Quo 2012, 68).

In the Status Quo 2012, an obstacle to the transfer, training, and education of energy-efficient construction skills was seen in the fact that worksite attitudes towards these are not always very positive. The pressure caused by rush, lack of supervision, and problems with sub-contractor models was also discussed. An additional threat to training was seen in the possibility that even if a business invests in training, a contract may be lost in a bidding contest to a competitor whose workers do not have the necessary skills (Status Quo 2012, 71-74).

Construction training may also be misdirected, and it may be difficult to find the right people for the training. Interest in further education among current workers was deemed to be modest, and the common view that construction workers do not even need skills and that anybody can work in construction, was seen as a barrier to further training (Status Quo 2012, 74-75).

An important problem in terms of skills improvement was seen in the inadequacy of learning materials which completely ignore some topics. Status Quo 2012 also acknowledges the fact that construction workers and trainers are growing older, and many will retire in the next few decades. This may, of course, also present an opportunity to improve the current attitudes. In terms of training for foreign workers, insufficient availability of learning materials in foreign languages was found to be an obstacle (Status Quo 2012, 75).

According to a study carried out by the Finnish Meteorological Institute in 2011, climate change may reduce the total consumption of purchased energy by buildings by 4-7 per cent between 2012 and 2030, which would contribute to meeting our energy-saving targets. Based on this calculation, a single-family home would require 10 per cent less heat over that period. Even with the 17-19 per cent increase in need for cooling due to climate change, the total consumption would decline (Jylhä et al. 2011).

Greenhouse gas emissions associated with buildings have their main source in energy generation. The methods of power generation play a key role in the reduction of greenhouse gas emissions, i.e. how the electricity used by buildings is generated. The number of decision-makers in the Finnish construction and real estate sectors is in tens of thousands – millions if private households are included. Therefore, many changes take place only slowly and many decisions are realized with a decades-long delay. On the energy generation side, the number of operators is limited and the decisions made there can influence the amount of greenhouse gases rapidly.

Figure 2.3. *Total energy consumption by energy source in Finland (Statistics Finland 2013). Energy consumption has been around 1400 PJ during the past few years.*

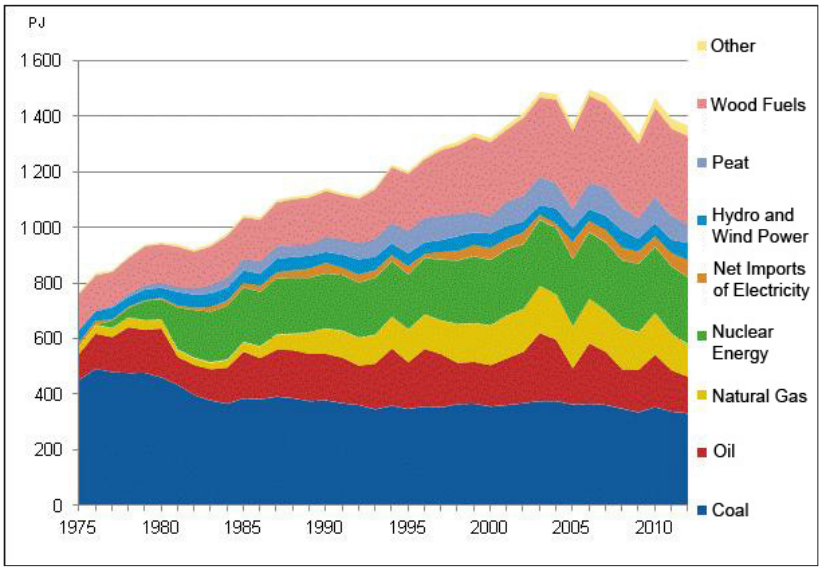


Table 2.6. *Open-ended answers given in the Status Quo (2012) survey:*

Skill shortages in energy-efficient building:
» In terms of work site practices, the company acting as the main contractor must take a leading role in order to ensure that building and construction technologies are compatible.
» There is not sufficient understanding of the big picture and relaying information between different parties.
» There is not enough time or competence to deal with energy issues at work sites.
» The biggest problem is that money tends to dictate too much in construction and that decisions are made without expert input.
» A key factor influencing the level of know-how and information is internal communication and how it reaches all employees. Communication plays a crucial role in a successful outcome.
» It would be useful to create a practical training package for the correct construction of lead-throughs in the outer frame, including the sealing and insulation of different brackets, metal window structures, etc. Incorrect lead-throughs are expensive to locate and repair. Sometimes they are the cause of mould damage.
» Energy-efficient building must be made to last. A building must be screened as to the risks to comfort, health, and energy efficiency, and the screening recorded for maintenance personnel. Maintenance measures must be self-audited every year.
» Practical implementation of plans was found to be the biggest challenge. In other words, there was not enough communication between designers and installers, which meant that supervisors had to intervene in installation work more often than really would have been necessary. This generates unnecessary work and increases the likelihood of mistakes.
» Overall, energy efficiency takes the quality aspects of construction to an entirely new level demanding high quality in all parts of construction. The problem with quality control and implementation is that projects and tasks are so fragmented that the so-called ultimate responsibility is hard to define.

2.4 Boundaries and interfaces with other programmes

The BUILD UP Skills project is intended mainly for professional workers in the construction industry and their competence requirements. The project examines some elements directly or indirectly affecting the competence of professionals and their performance, such as issues related to motivation and the qualification of their teachers.

The BUILD UP Skills project interfaces with the programme ERA17 for an Energy-Smart Built Environment 2017. The aim of ERA17 for Finland is to achieve the 2020 emission targets ahead of schedule in 2017, in time for Finland's 100th anniversary. Under ERA17, various cities have prepared roadmaps for implementation of smarter building practices. The roadmap for building regulations for 2020, which is being prepared under this programme, is also related to the BUILD UP Skills project. Education and development form one of the four main themes under scrutiny in the ROTI 2013 report on the state of the built environment. The report calls for further development of professionals' continuing training models and implementation.

Other interfaces include the Tee Parannus! communication programme, which aims to promote systematic and cost- as well as energy-efficient building renovation and restorations in the built environment (http://www.teeparannus.fi/), and the Moisture and Mould Programme (www.hometalkoot.fi) being run in 2010-2014, with the aim of decreasing the health hazards caused by moisture damage in buildings and developing methods to prevent and repair moisture and mould damage.

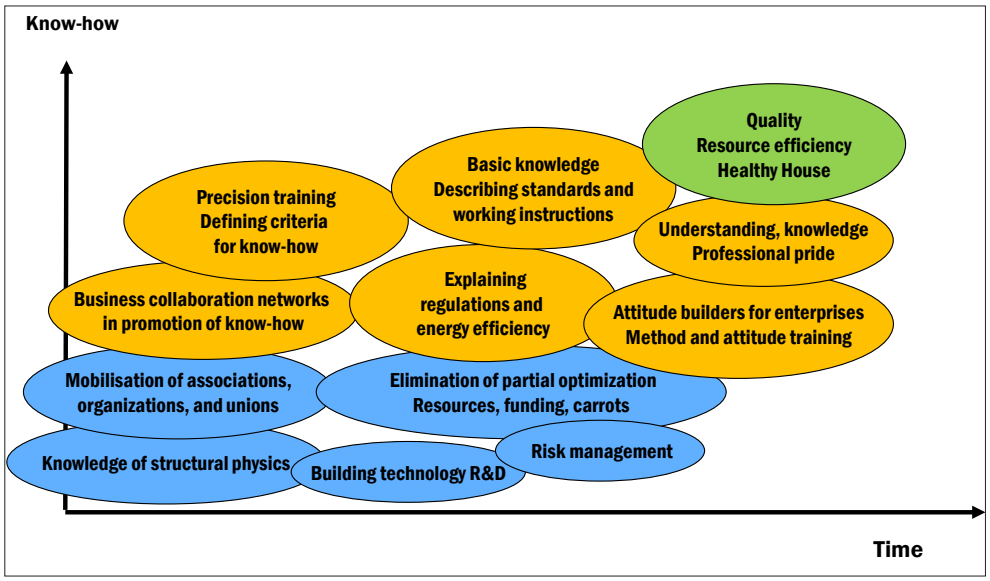
To support measures promoting the BUILD UP Skills programme, the Intelligent Energy Europe (IEE) programme accepts applications for BUILD UP Skills Pillar II financing (04/2013 and 11/2013) to support projects promoting issues related to the action programme.

3. Competence development and verification until 2020

The Status Quo 2012 analysis identified a need for improved skills especially in areas such as structural physics, heat insulation, airtightness, moisture control, pipe fitting, and renewable energy. Another important theme was overall management and lack of coordination between different operators. According to the analysis, the problem is not only with lacking energy know-how, but even the basic skills need improvement. Therefore, in addition to the training in energy know-how made necessary by the new challenges, the Status Quo 2012 analyses recommends increased emphasis on refreshing basic skills. A special, related challenge was seen in attracting back to training those who need basic and further education the most (Status Quo 2012, 78).

The goal of this development work is to significantly increase know-how by 2020. A recent study of structural physics is a good starting point for increasing know-how in all areas of construction. Filtering essential knowledge for different needs will demand a great deal of forethought and focus on spreading the know-how effectively. Our goal is a high-quality construction process which balances energy know-how with other objectives (see Fig. 3.1). To reach that goal requires broad collaboration of the many operators concerned.

Figure 3.1. *Areas of know-how, discussed in the BUILD UP Skills workshop (BUILD UP Skills Finland Workshop 19.11.2012).*



3.1 Skill needs and training

3.1.1 Demand for workers and number of trainees

In new construction, the effect of tighter energy-efficiency requirements and renewable-energy objectives on the total number of construction workers is expected to be fairly modest. The energy-efficiency targets will impact the choice of materials and equipment but less the amount of work, unlike in building renovation. The effect on renovation work may be greater. It has been estimated that the implementation of the technical and economic energy-efficiency measures by 2020 would require additional annual investments of approx. EUR 500 or 600 million in building renovation, which is believed to mean 8,000-10,000 new jobs directly or indirectly, and half of these (4,000-5,000) would be in construction (Luoma et al. 2012, 5-7). Energy-efficiency improvements are not separate from the rest of construction, but often combined with other repairs.

The sector employs some 25,000-30,000 foreign workers (Confederation of Finnish Construction Industries, 2011). Thousands of professionals retire each year. Since the construction site is one of the heaviest working environments, some graduates in the field pursue other kinds of jobs during their careers or leave their employment early. As a cyclical industry, construction also sometimes forces workers to change their occupations when there is not enough work available in the construction sector.

The numbers of new students or even those of graduates do not give a reliable figure for new professional employees starting in the construction industry. A significant percentage will drop out before graduating (see Table 2.5). The three-year basic vocational qualification gives a general qualification for further education at a polytechnic or university, and some vocational students continue their studies either immediately after graduation or later.

It is very difficult to estimate how many new professionals should be trained for the construction sector. It depends not only on future construction volumes and economic cycles, but also on the number of new admissions and graduations, of those leaving the field, those returning to it, or retiring, and also, essentially, on the future numbers of foreign workers in Finland. Regional differences have been great in the past, and may continue to be so in the future. Due to the cyclical nature of construction, the demand for workers may vary significantly in a short term. At the same time as some parts of the country experience a great shortage of builders, others may suffer from a high rate of unemployment. A general trend in Finland points to an increase in building renovation and in its share of all construction work (Status Quo 2012).

The total number of new admissions to vocational training will be reduced in Finland due to decline in younger population groups. Plans include a relatively small reduction in the admissions to basic construction training compared to other fields (all in all 28 from the current numbers) while vocational training in electrical and automation technology could be reduced rather heavily, i.e. by 470 admissions (17% compared to 2009). In electrical and automation technology, the focus is shifting from vocational training towards polytechnics (Ministry of Education and Culture, 2012a), the reference level being that of 2009.

Increased use of foreign workforce translates into special requirements for the construction know-how. In addition to language issues, the planning, management, and building cultures vary widely between different countries. Language skills and understanding different cultures will play an increasingly important role in further education.

3.1.2 Skills requirements for house builders

The structural functioning of an energy-efficient building as planned requires appropriate moisture control, airtightness, and properly working building technology, among other things. New construction materials are being continually developed, designed to meet the energy-efficiency requirements as well.

For energy and quality reasons, future construction site production planning may need to include new kinds of plans which workers will have to know how to implement. Such new plans may include those for construction site climate control, implementation and measuring of airtightness, installation of thermal insulation, prevention of thermal bridges, heating and drying, as well as keeping the building dry. At construction sites, the use of weather and space-specific protection will increase and the choice of equipment will emphasize energy efficiency when it comes to processes such as heating and drying concrete structures, for example.

In house building, the most important new skills required will relate to the building envelope. Structures are expanded and the requirements for thermal insulation and tightness are increased. Planning and architectural trends have also added to the degree of difficulty of construction. Plans are often inadequate, and the final planning may in practice easily be left for the installers and supervisors at the worksite to do, which is not an ideal situation. Increasing insulation thickness may lead to risky wall, roof, and base floor structures, if done incorrectly. Energy-efficient construction imposes additional requirements for work quality.

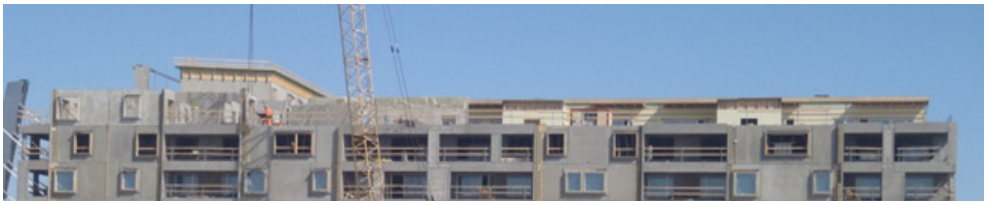


Figure 3.2. *Degree of difficulty in construction has increased in recent years. For example, the modern top floor terrace solutions are very challenging in terms of thermal, moisture and water insulation. New know-how and attitudes are required of builders to produce a good final result.*

Builders will have to work more carefully than ever because structures tolerate less moisture strain than before. Due to the climate change, moisture strain is expected to increase particularly in winter-time (Jylhä et al. 2011) and the periods favourable for mould growth to become longer. In order to secure high-quality work, the installation of thermal and moisture insulation requires a positive attitude, but installers must also understand the basics of structural physics. One of the proposals made foresees a professional qualification for envelope builders, which would assure that workers would have the necessary skills to avoid faulty structures even where designs are less than perfect.

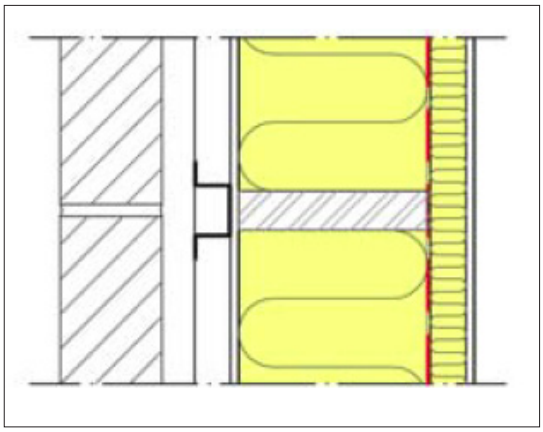


Figure 3.3. *As an outcome of the FRAME project conducted earlier in Finland, it has been proposed that to secure ventilation and to prevent rain water entering the timber frame of a tall brick-lined façade (over 10m), a steel plate should be placed between the timber frame and the brick lining. This is an example of structures that add to the skills requirements of house builders. (Image: Lahdensivu et al. 2012)*

Designing for moisture-technical functioning of envelope structures has become more challenging. Latest studies have questioned some structural solutions that used to be considered sound (see Lahdensivu et al. 2012). High, brick-lined facades, for example, do not seem to work so well in extreme weather conditions. In certain conditions, there is an excessive risk of mould growth. Likewise, some design solutions for ventilated base floors and roofs need to be changed for energy-efficient buildings. Load-bearing wood structures will need additional thermal insulation. Installers will have to be understanding and have the right kind of attitude because installation spaces may be tight in ventilated crawl spaces and attics. On the other hand, the work can be made smoother with a good planning of the installation order. It may be necessary to unlearn some old ways of working.

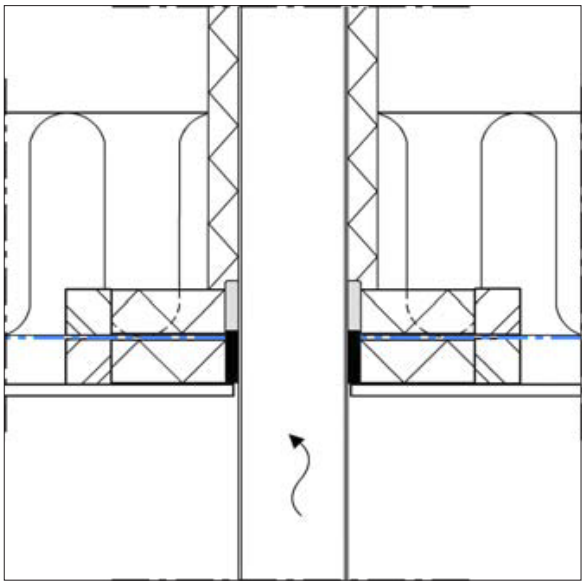


Figure 3.4. *Making building technology lead-throughs in thermal and moisture insulation is a typical task requiring know-how and care. New products have been developed for making lead-throughs. Workers need information about new products and their correct installation. (Image: Lahdensivu et al. 2012)*

The installation of wind screens also requires more careful work than before. Ensuring ventilation of the structures is basically simple. At a worksite, it may sometimes be necessary to work in a situation with conflicting design solutions. For example, the top floor terrace solutions, which have become increasingly common in recent years, are very challenging to design and build taking account of all requirements.

The basic principle is that builders must do their work according to the design plans. This, however, is only possible if the designs have been made technically feasible for the installer. Workers are responsible for a careful installation. Thermal insulation, for example, must be installed without leaving any gaps between insulation material and structures. Moisture barrier sheets must overlap sufficiently and be sealed with tape. Lead-throughs have to be sealed carefully. Moisture barriers must not have any unnecessary holes or unsealed lead-throughs.

Figure 3.5. *On the one hand, energy-saving wall solutions are being sought while at the same time thermal bridges and other energy-losing solutions are being designed.*

At construction sites, most of the energy used goes to heating needed for concrete strength development and drying structures. Heating energy is in particularly high demand in winter construction (see Hämäläinen, 2012). For strength development, traditional embedded-wire heating is the cheapest and most efficient method. Information gathered from worksites indicates that there are no longer enough workers who master the art of embedded-wire heating. Increased heat recovery when using heat containers would be an efficient and quick way to reduce construction site energy consumption.

Älä lämmitä harakoille!

Asenna ikkunat tai suojaa ikkuna-aukot nopeasti. Käytä väliaikaisia ovia. Tee isoihin aukkoihin väliaikaisia seiniä.

Suuntaa lämmitystä talon kulmiin ja rajoita vetoa hissikuiluissa ja porrashuoneissa.

Isot aukot umpeen
– tuuma riittää tuuletukseen.

Figure 3.6. *A construction site offers op-portunities for energy saving especially in heating and drying of structures. Instructions must be easy to understand and remember.*

"Don't heat the outdoors!

Install windows or cover window openings quickly. Use temporary doors. Cover large openings with temporary walls.

Direct heat to house corners and reduce draught in lift shafts and staircases.

Close large openings - an inch is enough for ventilation."

When drying structures, it is important to understand the principles of concrete drying and the role played by drying conditions. When the air temperature at a worksite is about 20 degrees and the relative humidity around 50%, the drying of concrete is efficient and work conditions favourable. The above conditions require proper ventilation. In practice, windows must be installed or their openings covered with plastic. For door openings, plastic is not enough, but temporary doors with frames have to be installed, although some gaps are allowed. As a rule, large openings have to be closed with an inch left for ventilation. In practice, construction sites are sometimes heated while there are large uncovered openings in the envelope, but this is not energy efficient. Once concrete has dried, it must not be watered. Weather protection should be carefully dried, and water should be removed from arches with water vacuums and pumps. Gas heating with fans and radiators may not be a good heating method during the indoor construction phase due to the large quantity of water vapour produced by gas. It takes energy to remove it.

Table 3.1. *Identified skills needs for house builders*

House builders must
» understand heat and moisture technical performance of structures and importance of airtightness;
» understand mould and moisture risks linked to different materials and installations;
» be able to read novel designs and instructions, know how to use IT to read blueprints;
» know the correct use of insulation materials, wind screens, vapour barriers, and sealants; know how to install energy-saving materials and components;
» know how to install and control appropriate and energy-efficient weather protection, heating and drying methods at worksite;
» consider energy efficiency when operating machines and equipment and in worksite logistics;
» know the special characteristics of energy efficiency in renovation work;
» know how to guide users in the energy-efficient and moisture-safe use of property and its systems, and
» collaborate with construction workers from different countries, speak foreign languages, understand cultural differences

Construction professionals form the last link in a long chain of collaboration. If mistakes were made at earlier stages of the chain, it may be nearly impossible to correct them during the construction phase. To enable high-quality construction, workers should be given good designs with sufficient details. Workers must be able to understand what the plans describe. The most important thing is to strive for a careful implementation, especially in those most difficult or “nearly-impossible” details. The new structures in an ever more demanding climate are less forgiving in terms of mistakes than structures used to be. Energy targets do not impose new demands on craftsmanship, but it does take professional pride to do careful work that meets all quality requirements. With the technological development, new devices and tools may be expected, the use of which needs to be learned. Learning to use new tools is part of normal updating of the skills of construction workers.

3.1.3 Skills requirements for building technology installers

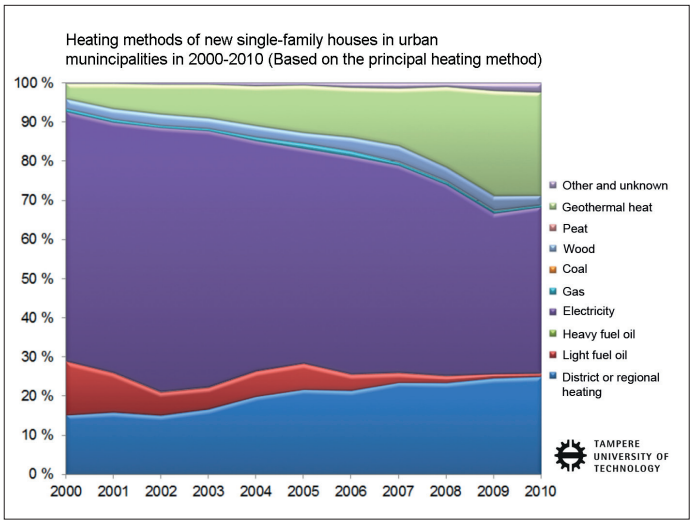
The use of building technology has increased significantly in the production of blocks of flats and other buildings. Heat recovery has gained importance in mechanical extract and input ventilation. The effect of indoor climate conditions on health and comfort has been widely recognized, which has also increased the interest in building technology system installations, such as cooling. Public buildings must be nearly-zero-energy buildings (nZEB) from 2019 on, and other buildings soon after. Apart from highly energy-efficient building technology, the need for purchased energy can be reduced by local generation of renewable energy. This will increase the use of building-specific heat pump systems, solar heat and solar electricity systems as well as different bio energy systems.

The importance of building technology, electronic building technology, and automation will increase. Improved energy efficiency requires systems with room-specific controls. Buildings will have more building technology, channel insulation, new energy-saving and heating solutions, such as heat pumps, but also power generation (wood/bio energy, solar collectors and panels, residential wind power use). The controls and adjustment mechanisms of automation must work properly. Appropriate methods and knowledge-able use of automation, controls, and adjustment mechanisms of the systems are key to building maintenance and energy-use monitoring. Planning and implementation must be done in a way that makes an installation of property-specific energy systems at a later time as easy and cost-efficient as possible. As an example, a south-facing roof should be left free of lead-throughs or they should be bundled so that room is left for later installations of solar panels and collectors.

Just as for other construction details, sufficient planning and design are a prerequisite for the efficient installation of building technology at the worksite. Building technology design will have to meet new requirements in the future, and the increase in electronic building technology will have to be taken into account in worksite processes. The alignment of plans is the duty of the entire design team, with the head designer taking the overall responsibility. In practice, the planning and aligning of the installation order will require more advance planning and collaboration of contractors. Energy-efficient building technology systems require a right choice of devices and minimal loss of pres-sure both in ventilation channels and liquid circulation circuits. Electricity must be used as efficiently as possible. This will be evident in the appropriate control, adjustment and reporting of building technology as well as in lighting and the energy efficiency of electric appliances and devices.

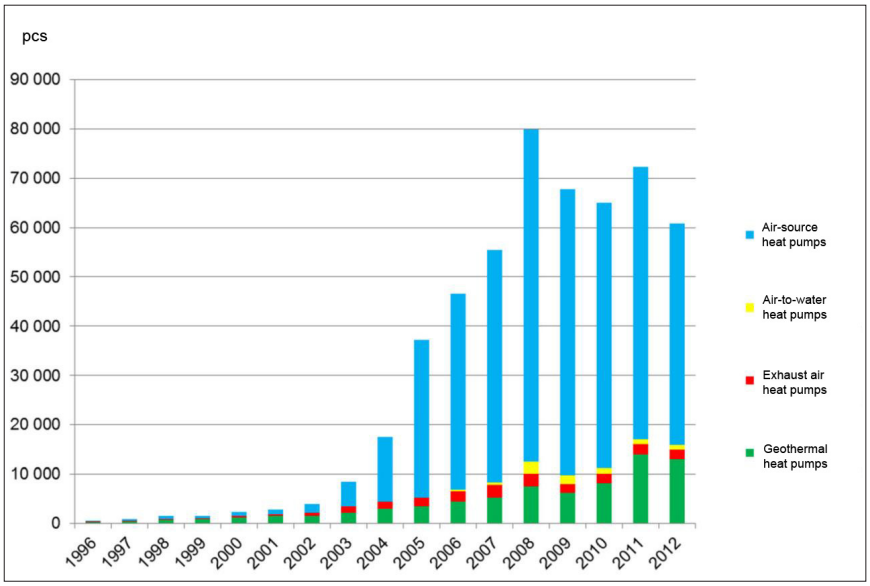
At the construction site, the installation of new systems will require more knowledge and understanding of the functioning and joint use of systems. This entails ensuring systematically that all operations run smoothly during the entire construction phase. A concrete objective is to make sure that we have a sufficient number of installers who master building technology and electronic building technology, can interpret plans and drawings and implement them correctly.

Figure 3.7. *Heating methods of new single-family houses in urban municipalities in 2000-2010, based on the principal heating method. (Vihola & Heljo, 2012)*



In energy-efficient building, the choice of heating method is the principal factor affecting the amount of energy used and the use of renewable energy. Figure 3.7 shows the development of the choice of heating method in single-family homes up to 2010. The popularity of oil heating in new construction has crashed in the 21st century. Its place in the single-family homes of urban areas has been taken by various heat pump solutions. In blocks of flats, district heating has kept its dominant position as the main heating method, with a 95% share of all heating choices in new construction (Vihola & Heljo, 2012). Once the energy consumption in residential buildings has been reduced sufficiently thanks to more efficient building technology and energy-efficient structural solutions, electric heating may, because of its low investment cost, increase its share somewhat. The above statistics do not show the increase in the share of air-source heat pumps because they show only the primary heating methods. Wood-fired heating also plays a significant role as a secondary heating method in single-family houses. The change in heating methods makes itself visible in the work involved in building technology.

Figure 3.8. *Annual sales of heat pumps in Finland (Finnish Heat Pump Association, 2013).*



Of all heat pumps, especially the share of air-source heat pumps has grown strongly in the 21st century (see Fig. 3.8), which means that the related installation work has also increased. While the total number of heat pumps continues to grow rapidly, the number of installations has levelled off at some 70,000. With the great number of different heat pump products, the training by manufacturers plays an important role in making sure that the right products are used in the right places and that they are installed the right way.

Residential water meters have been made mandatory for measuring the use of hot and cold water in new properties with more than one housing unit (Ministry of the Environment, 2010, valid as of 3.1.2011). Energy regulations for new construction have been made stricter while moving to a total energy model (Finnish Building Code D2 & D3, as of 1.7.2012). In practice, this has led to more energy-efficient building technology solutions, among other things. The Act on Energy Certification together with new energy-efficiency requirements for renovations will enter into force in 2013. These will mandate investing in energy efficiency in renovation construction when improved energy efficiency is technically, functionally, and economically possible (Ministry of the Environment, 2012).

Skills requirements for HVAC installers

It is important that HVAC installers get well-prepared designs that are easy to understand. The increasing number of building technology systems requires new tasks of their users. At the commissioning stage, installers, designers, and users have to work together to get the buildings and systems to work as desired. The importance of the adjustment and measuring of the systems will grow.

The actual professional skills of installers include – in addition to the basic skills required in their occupation – knowing the principles of installing moisture, heat and water barriers and the risks and consequences of errors in the installation of their lead-throughs. Due to the climate change, the current and future envelope structures are estimated to have to endure greater moisture strain while the thicker insulation causes structural temperatures to fall. Moisture does not evaporate as quickly as before. As before, careful work will be especially important in making lead-throughs in structures and in insulating pipes and ventilation channels.

Table 3.2. *Identified skills needs for HVAC installers*

HVAC installers must
» understand heat and moisture technical performance of structures and importance of airtightness;
» understand mould and moisture risks linked to different materials and installations;
» be able to read novel designs and instructions, know how to use IT to read blueprints;
» master the installation of renewable energy systems, such as heat pumps, solar energy and heat, and bio fuel boilers;
» know how to install heating systems and pipe and channel insulations in energy-efficient manner, to choose equipment considering energy efficiency;
» take energy efficiency into account in piping and channelling (pressure loss) and in the layout of fans, pumps and valves;
» understand flow technology of ventilation channel installations, operation of ventilation machines (SFP), roof exhaust fans, cooling beams, fan coil units;
» know how to guide users in the energy-efficient and moisture-safe use of property and its systems, and
» collaborate with construction workers from different countries, speak foreign languages, understand cultural differences.

The current requirements for building technology installers do not include the making of lead-throughs, as this is usually the job of a contractor. Lead-throughs from heated to unheated spaces need special attention, including lead-throughs installed in the walls of ventilation machine rooms and roofs of single-family houses. Although the making of lead-throughs (cutting and sealing of an opening) is generally the responsibility of the builder, it would be good if HVAC installers also knew the proper way to do it. Condensation barriers and the correct way to install them will also be even more important in the future.

Skills requirements for electricians

Energy-saving measures can have an effect on electric installations through various mechanisms. One important aspect is the use of smart grids to steer energy consumption and generation towards renewable energy. The generation of renewable energy fluctuates greatly so energy consumption will have to be directed towards periods with plenty of inexpensive energy available (such as emission-free wind power). Likewise, there will be attempts to cut electricity use at times when consumption is at its highest. Peak demand energy requirements are usually covered by using fossil fuels. Load peaks may be reduced by controlling loads. In single-family houses, for example, water heating today often takes place at time-dependent rates, steering demand towards periods of lower consumption. The Energy Efficiency Directive adopted at the end of 2012 (2012/27/EU) also guides towards load control in other activities. The goal is to have the majority of electricity network customers linked to hourly metering and remote meter reading and to enable the sale of small-scale power generation to the electricity network (Ministry of Employment and the Economy, 2010). For electrical installations, this means in practice that the characteristics of load control may become an important issue for the electrical systems of properties.

The energy targets also include the promotion of small-scale electricity generation, such as the use of solar panels, wind and hydro power plants as well as bio energy equipment. Their connection to the electricity network means new challenges for the installers. Timers, motion detectors, and twilight switches become more common as means to save energy, and this too is evident in installation work.

The skills required of electricians include the ability to read drawings and to follow instructions. Electricians can influence energy consumption through seemingly small details. An appropriate lighting layout, for example, is important to fully accomplish the desired lighting power. It is also important to understand when placing other devices that electrical devices and appliances can affect thermostats and sensors. The placement of devices and appliances is closely linked to adjustment and automation. An electrician must have the basic knowledge of controlling the power consumption of systems. Electricians, too, must know how to seal lead-throughs. The skills requirements for electricians and their rights of installation vary depending on the qualifications of each worker.

Table 3.3. *Identified skills needs for electricians*

Electricians must
» understand heat and moisture technical performance of structures and importance of airtightness; » understand mould and moisture risks linked to different materials and installations; » be able to read novel designs and instructions, know how to use IT to read blueprints; » set lighting control with energy-saving starting values; » know how to connect small power generation systems to the network, install new load control systems and reactive power compensation equipment; » understand how systems interact, consider thermal stress of other systems when installing sensors; » know how to guide users in the energy-efficient use of control systems; » know how to guide users in the energy-efficient and moisture-safe use of property and its systems, and » collaborate with construction workers from different countries, speak foreign languages, understand cultural differences.

Skills requirements for automation installers

Automation installers are responsible for installing control systems that have a great effect on the energy consumption of a property and they set the starting values for HVAC system controls. Successful metering and control of the systems have a significant impact on the future energy use of a property. Correct placement and functioning of sensors are key to energy efficiency.

The control of need-based ventilation and cooling requires properly working devices and optimization of control circuits. Smooth operation of the systems is verified with extensive functional tests and tests of simultaneous use. The single most important task is to ensure conditions that meet the goal and to prevent any cross effects of control circuits, such as simultaneous heating and cooling. Follow-up and reporting as well as understanding their importance are also central components, requiring further development.

Table 3.4. *Identified skills needs for automation installers*

Automation installers must
» understand heat and moisture technical performance of structures and importance of airtightness; » understand mould and moisture risks linked to different materials and installations; » be able to read novel designs and instructions, know how to use IT to read blueprints; » set the parameters for heating and cooling appropriately to produce agreeable conditions while saving energy; » secure parallel operation of control systems with monitoring and alarm systems, considering energy efficiency; » make sure that the follow-up and reporting systems work reliably; » know how to guide users in the energy-efficient use of control systems; » know how to guide users in the energy-efficient and moisture-safe use of property and its systems, and » collaborate with construction workers from different countries, speak foreign languages, understand cultural differences.

3.1.4 Development of teaching methods

The parties to the roadmap have largely agreed that different forms of short-term precision training could be a key instrument in bringing energy issues to the forefront. They have the advantage of quickly impacting those already working at construction sites. By short-duration precision training we mean training in some specific theme whose duration may vary from one hour to a couple of working days. This kind of training has the advantage of quickly impacting those already working at construction sites. By comparison, basic vocational training through which most of construction vocational qualifications are earned in Finland is a much slower channel of influence. It affects primarily the training contents of new workers. As to the changes made to the curricula of basic vocational training, it may take years before students receiving the new training start working in practice, which limits the possibility to influence the practical work processes at construction sites as early as by 2020. In terms of developing long-term knowledge base, changes are needed in that training as well.

The problem of overlapping has been linked to many cases of current precision training. In such cases, too much time is spent teaching material students already master while some other, less well-known topics may not be addressed at all. In order to attract participants, training should consider the starting level of the target audience sufficiently. This applies to both working professionals, teachers at vocational institutions, and other operators in the field. Development of work culture should be included in the teaching. It is not easy to provide sufficient time for further training for those already employed, so training aimed at workers is usually designed to take as little time as possible. Government austerity measures, which include cuts in education, are adding to the uncertainty.

Further education of those already employed should be carried out in a way that makes it easy for the trainees to adopt and achieve; training at the work site would be one way to accomplish that. It could therefore be worthwhile to consider and develop new training methods such as training containers and video presentations in break rooms. Tools such as the environmental meter of building construction, which include an environmental review of a worksite, may work as teaching instruments as well. During a review of a worksite tour, which is part of the environmental metering of building construction, and its results it is possible to increase environmental awareness considerably in two hours while reducing prejudices against environmental and energy issues.

The survey conducted for the Status Quo Report of the BUILD UP Skills Finland addressed some shortages and training needs related to following topics (Status Quo 2012):

- *Communication between different worker groups.*
- *Mutual interaction between building parties.*
- *Improving overall management.*
- *Understanding the big picture and one's role in it (the weakest link is decisive).*
- *One should know why something is done the way it is done.*
- *The effect of the quality of one's work on the whole project.*
- *Training projects related to worksite quality should be developed.*
- *The significance of one's work quality to the overall energy efficiency at all occupational levels must be made clear and its realization assured by training.*
- *This means an appropriate amount of theory and, above all, plenty of experience by doing.*

The above answers show that, in addition to installation techniques, actual everyday work requires many other skills as well. For example, job planning, communication, and – especially in building renovation – service skills have been emphasized.

Numerous suggestions to improve the skills of construction site workers have been made in workshops. Some of these have been summarized below.

Worksite as learning environment

- joint training events for management and workers on the one hand, and management and planners on the other with experiments forming a basis for further training;
- workers should be included in environmental reviews, and a review of structural energy efficiency added to the environmental meter;
- on-the-job learning, training containers, ("try-out rooms"), mentoring;
- information bulletins on building regulations;
- product and device manufacturers' instructions and research data should be made available and known at worksites;
- internal training programmes of companies;
- highlighting success, competitions.

Multimedia and online learning

- videos, new teaching methods, (such as using tablets at worksites);
- online materials, including issues related to finding correct planning and technical solutions;
- teaching videos, multimedia presentations in break rooms in different languages, silent films, including:
  - installation of thermal insulation and vapour barriers,
  - correct construction of lead-throughs,
  - insulation of protruding support elements,
  - sealing of windows, insulation of metal windows.

Developing the skills of foreign workforce

- developing and utilizing multimedia materials for foreign workers;
- preparing materials in multiple languages;
- utilizing Building Information Modelling explosion views;
- for foreign students, benchmarking of teaching methods based elsewhere in Europe;
- work cards (RATU) in multiple languages, also for foreign workers;
- translation of text books and instructions (quality requirements, building information cards, electrical information cards);
- using instruction in cartoon format (a picture tells a lot without the need for translation).

The key objective of the roadmap must be high-quality construction and built environment. Some kind of journeyman training together with mentoring programmes might also play a role in furthering knowledge. In this kind of training, it may be possible to take advantage of the skills of experienced professionals approaching or even past the retirement age. Companies would benefit if the tacit knowledge of those workers could be transferred to younger ones. The art of "hurrying slowly" that experience teaches is necessary for surviving in construction for decades.

3.2 Ensuring sufficient skills

Achieving the EU energy-saving targets requires both effective official controls and increased know-how in different sectors of society. A narrow focus on energy savings could lead to partial optimization, and thus to decreased productivity. Thus, seeing the big picture is important.

With regard to education, the big challenge posed by the 2020 targets is how to motivate already employed workers at all levels to further their education. Even where training is provided, it does not always reach those who need it most. Another challenge to spreading new knowledge is the fact that the building sector consists of a large number of small operators (Ministry of the Environment, 2007). Larger organizations may have, on the average, a better chance to share best practices and train employees in energy matters than do micro enterprises. The cost of education is a whole separate challenge. In addition to the price of education, lost work time results in costs to the company or lost income to the worker.

Two aspects have become evident and need to be considered when ensuring required skills. Educational institutions have demanded that the qualification of workers be proven by diplomas or certificates. Employers, on the other hand, have indicated that it is more important to ensure high-quality construction through internal quality assurance methods because the building sector needs trained and untrained as well as foreign workforce. It has been said that there already are too many different competency cards and we have not seen any support for launching new certificates (which are not already under preparation) during this project. Under this project, we have concluded that there is not so much need for new certifications or competencies at least in the near future. Rather, instead of creating new certificates or cards, existing certification methods should be further developed and get workers motivated to earn such, for example, in the form of skills demonstrations.

Figure 3.9. *The use of access passes is expected to be adopted in Finland. This picture shows a staff entrance in Sweden where entrance gate posts are already used to monitor who is entering a worksite. Access control may also be used to prevent the use of clandestine workers.*

3.2.1 Skills criteria and qualifications

The skills requirements for the mandatory timber framing component of the house building training programme (Finnish National Board of Education, 2009) include a statement that the student or examinee must know how to do exterior and interior wall work and the framing of the roof, including insulation, according to blueprints and documents and taking into account the principles of structural functioning and moisture as well as the impact of climate and seasons on the materials.

The above requirements meet, in principle, our future needs both in new and renovation construction. It is, however, not quite simple to do exterior wall work and insulation while taking into account moisture and climate in any great depth. At least the following learning materials need reviewing:

- instructions for installing heat and moisture insulation,
- instructions for making lead-throughs in heat and moisture insulation,
- materials related to structural functioning, moisture barriers, climate change, construction site climate control (seasonal effects), and quality assurance.

We must also allow enough time for teaching. Especially the apprenticeship training and adult vocational training programmes must make sure that the schools give their students a sufficient theoretical basis and support on-the-job learning. There are many details for which there is not enough know-how at the construction sites, which means that businesses and schools will have to be able to collaborate.

When representatives of construction businesses were interviewed for this roadmap, they expressed the view that they could tell the qualification of a worker from his working methods and quality of his work in two hours and that they did not need any special verification systems for that. They added that businesses tend to get the kind of training that they believe to be useful. The development of energy-efficiency skills was not seen as an issue right now. The training that businesses have organized or ordered has focused more on the office level. Construction companies said that contractors will deliver what has been ordered and planned. Unless a client specifically emphasizes energy issues and is ready to pay for it, minimum requirements will apply.

Nor would construction operators start by training carpenters, but would do it one level at a time from top to bottom starting with developers and designers. Clients will not pay for energy-efficiency or increased energy-efficiency competence. Energy issues do

not receive enough attention in the renovation work of housing companies. In securing sufficient skills, company-internal quality assurance plays a key role, including task plans, kick-off meetings, model installations, and installation method inspections.

3.2.2 Quality assurance

In energy-efficient building, seeing the big picture is more important than ever. Therefore, advance planning and improved skills of the planners must be appreciated more in the practice of energy-efficient building. While planners are not a focus group of this roadmap, it can be stated that their work impacts greatly the operating conditions of construction sites. Especially the contents and presentation of plans and designs leave room for improvement in terms of quality and energy efficiency. Planners should prepare designs and instructions which secure the realization of energy-efficient construction. There seems to be a shortage of competent designers in some places, however.

Open-ended answers given in the Status Quo (2012) survey:

"Energy-efficient building must be made to last."

"A building must be screened as to the risks to comfort, health, and energy efficiency, and the screening recorded for maintenance personnel. Maintenance measures must be self-audited every year."

"Overall, energy efficiency takes the quality aspects of construction to an entirely new level demanding high quality in all parts of construction. The problem with quality control and implementation is that projects and tasks are so fragmented that the so-called ultimate responsibility is hard to determine."

"One factor influencing the level of know-how and information is internal communication and how it reaches all employees. Communication plays a crucial role in a successful outcome."

"Implementation and realization of plans was found to be one of the biggest challenges. In other words, there was not enough communication between designers and installers, which meant that supervisors had to intervene in installation work more often than really would have been necessary. This generates unnecessary work and increases the likelihood of mistakes."

"In terms of worksite practices, the company acting as the main contractor must take a leading role in order to ensure that building technology and construction technology are compatible."

One reason for quality problems has been seen in the fragmentation of construction and long sub-contractor chains. On the other hand, stricter requirements and competitive tendering require specialization which leads to fragmentation. The use of immigrant workforce has also been suspected to cause many problems. Quality problems, however, occur with native workers as well. Skills and development are needed both at individual and company level. The quality assurance methods being applied in companies can be used to produce a high-quality outcome in spite of challenges. International mobility of construction workers can be expected to continue at a high level. All labour resources in Finland should be maintained and developed to produce a good outcome.

BUILD UP Skills Finland Workshop 19.11.2012
In terms of overall management, following themes were mentioned:

- identifying key decision makers in matters of energy saving,
  - including architects, building technology designers, energy co-ordinators or planners,
- steering resources towards further education and training of key operators,
- EU provisions, energy certification, diversity, and regulation create needs for skills,
- ecological premises, aesthetic nature, health, usability, repairability, and maintainability must also be considered,
- both ends of the project process, where the needs are greatest, should be invested in,
- developing management culture, measuring management,
- revolution of work culture, management of sub-contractor chain,
- immigrant workforce recruiting skills,
- presenting the most difficult components of a blueprint in exploded views where cut-away views are not sufficient.

Special issues of quality assurance include the installation of thermal insulation in the envelope, tightness of structures and their thermal imaging and leak testing, which play an increasingly important role in energy-efficient construction in the Nordic conditions. Measuring requires skills both of well-educated professionals and their assistants.

3.3 Spreading of know-how

3.3.1 Collaboration and co-ordination of development

Building is a collaborative result of many different parties. In addition to numerous external parties, a construction site itself may at the same time see representatives of many different businesses. Building means aligning knowledge, plans, components, and materials with implementation. The standards for many construction tasks have risen and continue to rise. Meeting these standards has forced many operators to specialize in narrow fields of expertise. To ensure efficient (including energy-efficient) and high-quality (including material-efficient) construction, its prerequisites must be in order. Employers and employees must collaborate smoothly. Different stakeholders take an important place in creating the prerequisites needed for successful building. According to the Lean principle (Koskela & Koskenvesa 2003), the conditions for performance must be in order. The role of workers is to accomplish the physical work once the preconditions, such as plans, materials, equipment, site, previous stages of operations, and working conditions are as needed for the work.

Lately, construction quality and work culture have been discussed widely in the Finnish media. Improving work culture is a central issue in construction. The building industry has noted it as one of the main targets for development. The change in work culture begins with the developer and the building company management. Many schools teach how things are done. At actual construction sites, however, practices may differ from those taught in schools, and worksite practices (good and bad) are adopted by the new professionals. The work culture of the building sector cannot, therefore, be changed only through schools. Collaboration is needed in the entire construction sector with all pulling together for common goals.

Work culture discussion:

> *"We have become used to acting without sufficient preparation. 'It's none of my business' kind of thinking is wide-spread. The current culture is marked by sayings such as 'you can't make an omelette without breaking an egg' or 'something is better than nothing'. How do we mitigate or eliminate the impact of weak points? The key is constant improvement. Development and correcting of failures must be a continuing process. Where defects are detected, the causing processes must be addressed and changes made instead of simply correcting one particular mistake. In construction, no two projects are identical, but even so we must learn from every project.*
>
> *Action is possible when one knows what to do, why, and how to do it, and is also willing to do it. When there is an operation system describing the what, why, and how, creating willingness will be the task of the management. If the goals and meters of the management system are not synchronized, the outcome may be lacking. The traditional meters of construction projects are time and money. Some may add quality and safety. In practice, however, these seem to have very little meaning. The central issue in productivity, i.e. smooth operation, seems to have no significance whatsoever. Could managers be committed to the principles of constant improvement? Could this commitment be measured in some way?" (Teriö & Koskenvesa 2012)*

When it comes to expanding and ensuring professional skills for energy-efficient building, the teachers of vocational institutions together with company-internal trainers take the centre stage. In the technical field, a large number of vocational teachers are approaching their retirement age in the near future: 69.4% in 2010-2025, being the highest percentage in all vocational fields in Finland (Nissinen & Välijärvi 2011, 91). Polytechnics owned by municipalities and federations of municipalities together with private continuing education institutions provide further training for vocational teachers. Vocational teachers receive pedagogical education at polytechnics.

The key questions in organizing training and its development are: what, for whom, and how is it financed. Tasks need to be divided clearly between different parties to promote competence in a watertight manner. Educational organizations need to collaborate as do various divisions of business organizations. With increasing worker mobility, we need to increase our collaboration with international educational organizations. It should also be clarified what exactly belongs to basic vocational education and further training while employed, what is needed for qualification, and how long qualifications are valid and how often they need to be renewed. Current vocational requirements are written and described in a fairly general manner, probably intentionally so. It should also be defined how skills should be demonstrated and what criteria will be applied, as is stated in the vocational qualification requirements.

Ideas expressed in the BUILD UP Skills Finland Workshop 19.11.2012

- Federations of associations and organizations must participate in the development and implementation of education. Educational organizations need to collaborate as do various divisions of business organizations.
- Schools should provide more support to company-internal training.
- Motivation of builders, mandatory qualifications, use of carrots (for example, energy-efficient building should entitle to additional building rights).
- Role of supervisors?
- Pulling together, looking in the mirror.

3.3.2 Communication

Energy-efficient building has been the subject of official regulations and a great deal of research. It seems, however, that those responsible for building projects have not always received the message. The information exists, but it does not always reach the receiver or make an impact.

If the public sector is to adopt nearly-zero-energy building by 2019, it is necessary to first define the best practices for energy-efficient building and start piloting them across the country. The skills of designers and other parties to building projects must be substantially increased before nearly-zero-energy building can be safely implemented on a larger scale. Skills must be accumulated widely, which is connected to the next idea.

Communication and campaigning are needed to spread information on energy efficiency and to motivate people. Media usually prefers to report on failed projects at the cost of successful ones. Finland has many schools plagued by mould problems. One suggestion to help develop and spread know-how is that government aid for their renovation would be made subject to the building work being conducted according to nearly-zero-energy principles. It has been proposed that we could, for example, demolish 100 schools with mould problems in different parts of Finland and replace them with nearly-zero-energy buildings. Construction sites could be used as a teaching environment for energy-efficient building while documenting practices so that also other people could use them. This kind of piloting might be economically justified for schools which are approaching the end of their life cycles. At the same time, we could offer many students (in other words, future builders) good conditions for training while perhaps also convincing their parents of the benefits of energy-efficient building. Schools as the cradle of civilization are suitable for spreading know-how more widely. A decision to replace 100 schools plagued by mould could be expected to attract media attention after which it should be easier to get different forms of the media, such as the TV, radio, and press, to spread more information on the subject.

4. Roadmap

The proposed measures cover three main themes:

1) development of teaching and knowledge,
2) dissemination and verification of knowledge, and
3) supporting measures.

The implementation of the measures requires collaboration between and commitment by the many stakeholders. For every proposed measure, the key stakeholders have been listed who are expected to participate in the implementation, control, or financing of the measure. The views of the various stakeholders are also needed to ensure the success of the undertaking and the finding of high-leverage development inputs. Advisory groups selected among the stakeholders should be nominated to direct the measures.

Table 4.1. *Proposals for measures and actions for the roadmap together with key objectives*

	Themes and actions	Objective, impact
1	Development of learning and knowledge	Raising the level of teaching and learning
1.1	Identifying, documenting and further developing best practices in energy-efficient construction.	Forming a basis for future work. Preparing learning materials. Motivating parties for energy-efficient construction and its overall management.
1.2	Updating curricula, supplementing teaching materials, further education of teachers.	Integrating best practices and results of latest research in teaching materials and vocational training. Motivating teachers to address energy issues.
1.3	Developing new teaching methods to support on-the-job learning. Utilizing information technology in teaching.	Improving quality of teaching, making learning more effective. Making participation more attractive for employers and employees. Developing teaching on learners' terms. Developing precision training.
2	Dissemination of know-how, verification	Raising the level of workers' skills
2.1	Dissemination of best practices in energy-efficient building	Implementing best teaching methods, increasing awareness of energy-efficient construction. Employing mentors and attitude builders to promote knowledge.
2.2	Developing competences and skills demonstrations, encouraging workers to complete qualifications.	Increasing and securing the know-how of untrained workers and immigrant workers. Increasing the number of those completing qualifications.
2.3	Including criteria of energy-efficient building in quality assurance of construction sites.	Improving the quality of energy-efficient building. Guidance of the workers. Ensuring the quality of their work regardless of qualifications.
3	Supporting measures	Steering and encouraging development
3.1	Assessing the effectiveness of measures, co-ordinating with other development programmes in the industry.	Steering development activities and resources towards high-leverage projects. Securing, sharing and implementing outcomes.
3.2	Communicating outcomes to stakeholders and media.	Transfer of energy-efficient building know-how to builders, clients, designers, and authorities. Increasing the support of stakeholder groups in energy-efficient construction.
3.3	Increasing incentives, motivating to developing knowledge and doing quality work.	Improving attitudes and reducing resistance to change, influencing attitudes, removing barriers to development.

4.1. Development of learning and knowledge

The theme of development of learning and knowledge focuses on raising the level of teaching especially in vocational adult training and on-the-job learning. This is done by identifying best practices for energy-efficient construction, updating curricula to include the needs of energy-efficient construction, producing teaching material and supporting materials as well as providing vocational teachers with further education in energy-related issues.

Table 4.2. *Indicators for the progress in development of learning and knowledge, key stakeholders, timetable, and budget. Stakeholder symbols are described in Annex 2*

	Themes and actions	Progress indicator	Key stakeholders	Time-table	Estimate (€ 1,000)
1	Development of learning and knowledge		A, B, C, D, I, J	2013–2016	800–1,100
1.1	Identifying, documenting and further developing best practices in energy-efficient construction.	Contents and volume of published material.	Associations of house building and building technology (C, D), universities and research institutes (I), educational organizations (J)	2013–2014	100–150
1.2	Updating curricula, supplementing teaching materials, further education of teachers.	Integrating best practices and results of latest research in teaching materials and vocational training. Motivating teachers to address energy issues.	Ministry of Education and Culture (A), National Board of Education (A), associations of house building (C) and building technology (D), labour market organizations (B), educational organizations (J), teachers, students	2013–2016	400–600
1.3	Developing new teaching methods to support on-the-job learning. Utilizing information technology in teaching.	Number of worker training days.	Educational organizations (J), National Board of Education (A), universities and research institutes (I), teachers, students	2015–2017	300–400

4.1.1 Documentation of best practices in energy-efficient construction

The purpose of the documentation and further development of best practices for energy-efficient construction is to spread know-how and to support further measures. By gathering good examples, we aim to demonstrate the possibilities of energy-efficient construction and motivate different operators to implement them in their construction work.

Implementation includes:

» Best practices in energy-efficient building at construction sites and other places will be documented using photographic records (possibly with examples of poor (in terms of energy efficiency) practices).

» Interviews with industry experts, project teams of energy-efficient construction projects as well as supervisors and workers, documenting their views on good and bad practices.

» An online data bank for best practices in energy-efficient building is created for public use.

Possible additional measures: Recommendations for implementation at the construction site, structural solutions, and building technology solutions, made from the point of view of practical energy-efficient construction.

The main objective for the collection of best practices is to generate information and make it available to the public in order to avoid the lack of information becoming an issue in energy-efficient construction. At the same time, we strive to increase the understanding of the overall management of energy-efficient construction and how energy issues relate to other construction goals. The requirements for best practices include safety, quality, and cost effectiveness and energy efficiency.

4.1.2 Curricula, teaching materials, further education of teachers

While a great deal of research and development has focused on energy-efficient construction lately, related information has not been sufficiently shared with all parties who need such information. Information is available, but it has not been processed or simplified enough to meet the needs of various target groups. The goal of this measure is to supplement teaching materials with knowledge gained from latest research and the best practices identified for energy-efficient construction under proposed measure 1.1. The issues of energy efficiency should be explained in detail to teachers and students so everybody can understand how he/she can contribute to improving energy efficiency and reducing emissions.

New materials should be directed primarily to teachers to support their work as much of the learning of students takes place in practical work. The further education of teachers should focus on familiarizing them with the teaching materials and ensuring that the key issues of energy-efficient construction are included in teaching. In addition, teachers should be motivated and encouraged to address energy efficiency more actively than before.

Implementation includes:

- Curricula will be updated to include energy issues (both energy efficiency and renewable energy forms) throughout the training and with stronger emphasis than before.
- Current teaching materials should be reviewed from the viewpoint of energy efficiency, renewable energy forms, and structural physics.
- Current useful teaching material will be gathered and updated and new material prepared to support vocational teachers in their work.
- More than before, teaching material will be published online where it is available to teachers, professionals, and other interested parties. In addition to information packages, online teaching materials should include questions to identify correct solutions.
- New education packages for further training of teachers will be planned with regard to energy issues, including material for work practice programmes and support material for on-the-job learning.
- Piloting of different forms of training, development of training material for those who educate teachers.

Possible additional measure: Videos and/or other multimedia information packages in different languages could be prepared for break rooms. Possible topics include: installation of thermal insulation and plastic vapour barriers, lead-throughs in the envelope, insulation of protruding support elements, sealing of windows, insulation of metal windows.

4.1.3 On-the-job learning, learning environments

The goal of the development of teaching methods for on-the-job learning and learning environments is to take training to the worksites and encourage learning. The purpose of this measure is to identify opportunities to develop teaching methods especially in adult education. Teaching methods should be developed on learners' terms. It has become clear that it is difficult to entice already employed workers to enrol in schools. For this reason, learning and training at worksites should receive more attention. Today, the principal target of construction enterprises' internal training is office staff. Our goal is to organize more precision training for workers on relevant issues, such as energy-efficient construction.

Implementation includes:

- Increased offering of energy-efficient construction training for construction sites.
- Identifying and developing precision training methods for construction sites.
- Studying the use of training containers as learning environment and the use of multimedia presentations to support learning at worksites.
- Implementing new methods at pilot sites.
- Development of cross-auditing methods to ensure energy-efficiency contents and teaching in adult education centres.

Where possible, means for training and improving attitudes and understanding of cultural differences in building should be identified.

New teaching materials should be piloted in practice and other results of development disseminated as broadly as possible for the use of target groups. The ultimate goal is the implementation of best practices at construction sites. At the building stage, management and workers are made familiar with the know-how.

The development of energy-efficient construction skills consists of many small components. Annex 1 describes the components of teaching development by occupation. Once teaching materials have been developed, precision training can be organized for different target groups. Annex 2 presents the stakeholder and target groups related to the development and implementation of teaching.

4.2. Dissemination of know-how and verification

The theme of dissemination and verification of know-how aims to spread know-how at worksites, develop competences, and increase the number of qualifications completed.

Table 4.3. *Indicators for the dissemination and verification of know-how, key stakeholders, timetable, and budget. Stakeholder symbols are described in Annex 2.*

	Themes and actions	Progress indicator	Key stakeholders	Time-table	Estimate (€ 1,000)
2	Dissemination of know-how, verification		A, B, C, D, G, H, I, J	2013–2020	900–1,300
2.1	Developing competences and skills demonstrations, encouraging workers to complete qualifications.	Number of worker training days. Number of training days for mentors and attitude builders.	Ministry of the Environment (A), labour market organizations (B), developers (H), research institutes (I), schools (J), construction enterprises	2013–2020	500–700
2.2	Developing competences and skills demonstrations, encouraging workers to complete qualifications.	Number of graduates.	National Board of Education (A), Ministry of Education and Culture (A), labour market organizations (B), educational organizations (J)	2015–2020	300–500
2.3	Including criteria of energy-efficient building in quality assurance of construction sites.	Declining number of quality defects and complaints.	Certification organizations (G), associations (C, D), construction enterprises	2016–2018	100–150

4.2.1 Dissemination of best practices in energy-efficient building

The goal is to spread the best practices of energy-efficient building widely among the operators in the industry. Often we know how we are supposed to work, yet we still follow old practices. Our goal is to initiate a change in attitudes to integrate best practices in practical decision-making and implementation. For foreign workers, a different culture or language may hinder the adoption of best practices. For this reason, it has been found necessary to produce different materials in other main languages spoken at the worksite.

Implementation includes

- More mentors and attitude builders are sought and trained for worksites.
- Tools will be developed to present information packages in video or multimedia format at worksites.
- Teaching materials will be translated in the most common foreign languages.
- Joint training events for management, workers and designers are tested.
- Prerequisites for information sessions held by building supervision authorities will be determined.
- The environmental meter of housebuilding will be complemented by the criteria of energy-efficient construction and tested as a tool in training of professional workers.

Energy-efficient construction requires higher quality than ever before at construction sites. One way to improve quality is to find pace-setters, mentors, or attitude builders to work at construction sites. The example and encouragement of experienced professionals will help build professional pride and appreciation of quality in the new generation of builders. In addition, we also need new teaching and learning methods based on collaboration together with easy-to-use online materials to support them.

4.2.2 Development of skills demonstrations and qualifications

The building sector employs a large number of domestic and foreign workers who do not have qualifications that are recognized in the European education system or known in Finland. The goal of this measure is to increase and ensure the know-how of untrained workers and immigrant workers and to raise the number of graduates.

Implementation includes:

» We should identify the reasons for the relative low appreciation for skills demonstrations and their use, and try to make them more attractive.

» For foreign workers, new methods could be developed to verify and secure knowledge, such as skills demonstrations on the worksite, model installations, and inspections.

» The idea of implementing and using professional skills cards and competence and knowledge registers should be explored.

Skills demonstrations are the basic way to demonstrate one's knowledge, and they should be used more widely and efficiently. If clients required professional qualifications of their builders, there would be more interest in obtaining such qualifications. Builders do not see any need for new qualification certificates, but would rather increase the use of the existing ones and encourage workers to acquire them. Today, there are numerous qualifications and related certificates or cards. It would therefore be useful to create a comprehensive data bank of construction qualifications, including the contents and requirements of each and the qualification requirements for each construction job. This measure will also explore other ways of demonstrating one's competence.

4.2.3 Criteria and quality assurance of energy-efficient building

Skills are highly appreciated at construction sites, but the same cannot be said of qualifications. To develop qualifications and competences will not be enough. In addition to individual skills, we also need to improve the quality assurance at worksites in order to ensure high-quality energy-efficient construction. This measure aims to develop the methods of quality assurance in energy-efficient construction. Quality assurance determines the energy-efficiency criteria of different jobs and the practices for their inspection and other methods of verification.

Implementation includes:

» Criteria for energy-efficient building will be determined for structures and building technology systems.

» Check lists for assuring the quality of energy-efficient building will be prepared.

» Means and practices of inspection of energy-efficient construction will be developed and made more efficient.

Skills are highly appreciated at construction sites, but the same cannot be said of qualifications. To develop qualifications and competences will not be enough. In addition to individual skills, we also need to improve the quality assurance at worksites in order to ensure the high quality of energy-efficient construction.

4.3. Supporting measures

The purpose of supporting measures is to help carry out other actions. By assessing the effectiveness of the actions and co-ordinating them, we can help to prioritize and steer these measures to have the desired impact. Good communication and information will help to commit all parties to support energy-efficient construction. Incentives can be used to motivate parties to promote energy-efficient building and to remove barriers.

Table 4.4. *Indicators for supporting measures, key stakeholders, timetable, and budget. Stakeholder symbols are described in Annex 2.*

	Themes and actions	Progress indicator	Key stakeholders	Time-table	Estimate (€ 1000)
3	Supporting measures		A, B, C, D, E, F	2013–2020	850–1000
3.1	Assessing the effectiveness of measures, co-ordinating with other development programmes in the industry.	Indicators of sections 1-2. Measuring stakeholder satisfaction.	Ministry of Education and Culture(A), Ministry of the Environment (A), labour market organizations (B)	2013–2020	120–180
3.2	Communicating outcomes to stakeholders and media.	Number of media hits, newspaper articles, TV minutes. Quality of public discussion. Visibility in stakeholder actions.	Ministries, Motiva (A), labour market organizations (B), associations (C, D, E, F)	2014–2020	400–500
3.3	Increasing incentives, motivating to developing knowledge and doing quality work.	Improving attitudes and reducing resistance to change, influencing attitudes, removing barriers to development.	Ministry of Education and Culture, Ministry of Employment and the Economy (A), labour market organizations (B)	2014–2017	300–400

4.3.1 Assessment of the effectiveness of measures, co-ordination

By co-ordinating and assessing the effectiveness of the actions, we can steer the development and make sure the measures have the desired impact. Co-ordination will help direct scarce resources towards high-leverage projects. We also have to make sure that the results of the development measures are shared and used.

Implementation includes:

» Implementation of measures should be managed and collaboration and information exchange secured during implementation.
» Outcomes should be recorded and progress reports prepared.
» The impact of measures on target groups needs to be determined.

There are numerous projects related to energy-efficient construction and teaching. We should make sure that their work does not overlap and existing resources are used effectively.

4.3.2 Communication and information

Energy-efficient building requires that the level of knowledge be raised broadly. In addition to schools, also developers, designers, and authorities need to be made aware of energy-efficient know-how if we want to succeed in our goal of energy-efficient building. We must keep the big picture in mind and have the various parties collaborate. Our goal is to integrate energy issues in the everyday work of construction design, execution, and maintenance.

Implementation includes:

» Results should be processed to be presented to different target groups and for different purposes.
» Organizational communication on energy issues should be supported.

Possible additional measure: “TV clinics” for energy-efficient building could be organized, call-in programmes for the radio, and also better opportunities to ask questions online. Energy-related communication of organizations and businesses should also be supported.

4.3.3 Incentives and motivation

Energy-efficient, high-quality construction requires continuing and comprehensive development of knowledge. Many barriers have to be taken down to achieve this. One notable barrier is the lacking interest of businesses in educating their employees. The building sector does not generally appreciate or encourage education very much. The goal of this measure is to identify and increase effective incentives for increasing knowledge, further training, on-the-job learning, and completing qualifications.

Implementation includes:

» We should identify current barriers to developing knowledge and completing qualifications.
» New kinds of incentives should be created to develop knowledge for both workers and their employers.
» We should try to change attitudes in the building sector to make them more favourable towards developing knowledge.

The direct and especially the indirect costs of training weaken the interest in developing workers’ know-how by training. Workers, on the other hand, expect to benefit from their increased skills themselves, whether in the form of a rise or a better job description.

5. Conclusions

The goal of this roadmap is to define the development needs for professional skills and their securing with regard to energy know-how needed at construction sites. This roadmap stresses the importance of overall management and keeping the big picture in mind. A central question is who make the concrete decisions impacting energy efficiency or are otherwise in a key position. What roles do architects, building technology designers or supervisors play? What roles do authorities, developers, and clients play? Measures directed at the construction process would be most effective when focused on the quality of work and the energy consumption during the construction phase. The construction site is not where the most important choices concerning energy-efficiency are made, but rather a place where designs created elsewhere are realized as faithfully as possible. On the other hand, it is quite possible that good decisions made elsewhere can be ruined at the site.

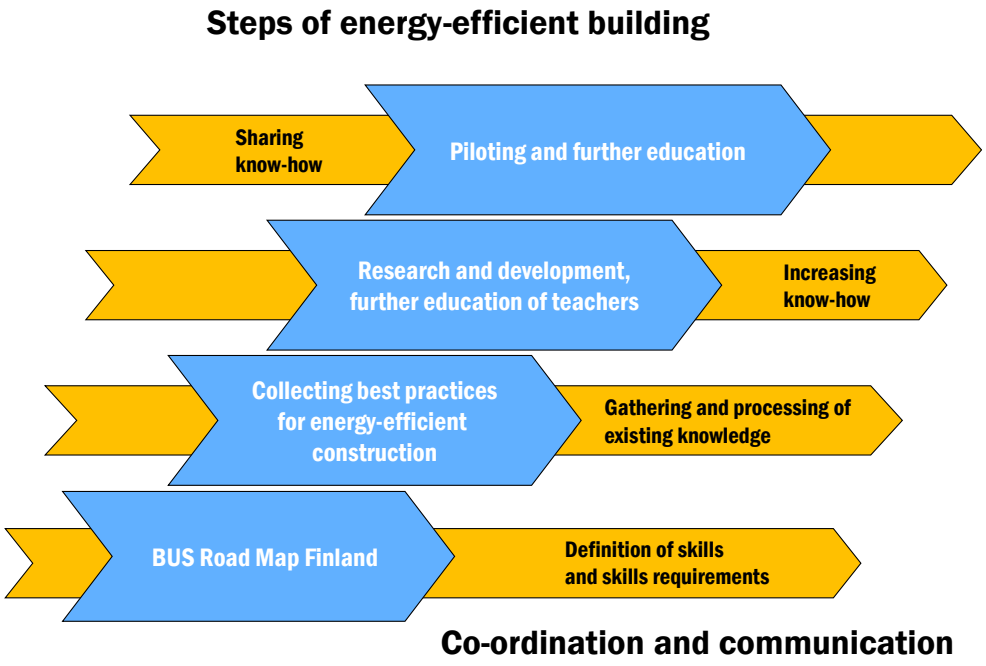
A skill related to overall management is also important in terms of risk management. New practices entail new risks for the quality of construction. In order to avoid major risks, resources should be steered towards further education and training of key operators. Ecological premises are important, but we also have to keep in mind other worthy goals, such as aesthetics, health, as well as the ease of use, repairs, and maintenance.

Special knowledge is needed to solve the special problems brought about by foreign work force, and the management of sub-contractor chains. Quality assurance practices of enterprises play an important role in addressing the above issues. International obligations, national legislation and regulations, stricter energy-saving targets, new energy forms and hybrid solutions together with a more complex construction process create new needs for skills, requiring new attitudes of workers and their supervisors. In order to succeed in energy-efficient building, we need improved attitudes, renewed professional pride, and assertive management.

The parties involved in the creation of the roadmap have largely agreed that different forms of short-term precision training, which pay sufficient attention to the starting skills and knowledge level of the trainees, are needed. Improving work culture and changing attitudes should be considered as part of teaching as well. More mentors and attitude builders are needed in the industry. The tacit knowledge and good practices of experienced professionals approaching retirement age should be transferred to the new generation of builders.

Educational organizations need to collaborate as do different divisions of business organizations. Federations of associations and organizations must participate in the development and implementation of education. All interested parties should be informed on all pilot projects. Best practices need to be identified and information shared openly by all operators concerned. Schools should lend more support to company-internal further training.

Figure 5.1. *Steps of energy-efficient building. Energy-efficient construction is based on the knowledge of best practices as well as on research, development, and further education of teachers. If certain knowledge is useful in pilot projects, it should be disseminated more broadly.*



Society can support energy-efficient and innovative construction by providing financial inputs and flexibility. Both public and private sector investments are needed to fund these measures.

The measures presented in the roadmap are mutually dependent and may overlap in time and frequency. Many organizations participate in the implementation of the measures, and the number of target groups is high. This roadmap has attempted to outline the division of labour and collaboration between the parties.

6. Testimonials

We, the undersigned consider the BUILD UP Skills Finland project to be necessary and relevant to meeting our energy-efficiency goals and improving the quality of construction. We have participated in an advisory role in the preparation of the roadmap for the BUILD UP Skills Finland project and given our input to this document. We will continue to do our best to help realize the proposed measures.

We would like to continue our collaboration with the different parties in order to promote and implement the roadmap.

Helsinki, 29 April 2013

BUILD UP Skills Finland Strategic Advisory Group:

Maarit Haakana
Ministry of the Environment

Varpu Weijola
Ministry of Employment and the Economy

Arto Pekkala
National Board of Education

Juha Mäntynen
Confederation of Construction Industries

Markus Ainasoja
The Finnish Construction Trade Union

Päivi Laitila
Motiva Oy

BUILD UP Skills Finland Consortium:

Irmeli Mikkonen
Motiva Services Oy

Minna Kuusela
Work Efficiency Institute TTS

Matti Vesalainen
Ami Foundation, Amiedu

Pertti Kokki
RATEKO, Training Centre of Finnish Construction Industries

7. Authors and other participants in the process

Commissioned by RATEKO, this roadmap has been prepared by two experts working at the Tampere University of Technology, Mr Olli Teriö and Mr Jaakko Sorri. To support the preparation, various stakeholders have been interviewed and workshops organized. Partners to the BUILD UP Skills Finland project, Motiva, Amiedu, Työtehoseura, and RATEKO, have also provided content to the roadmap. The members of the Strategic Advisory Group, various government agencies, business enterprises, and industry associations together with private citizens have commented on the roadmap as well.

8. Sources

ERA17. 2010. Energiaviisaan rakennetun ympäristön aika 2017. Ympäristöministeriö, Sitra ja Tekes.

Euroopan komissio. 2012. Komission tiedonanto Euroopan parlamentille ja neuvostolle. Rakennusalan ja rakennusalan yritysten kestävää kilpailukykyä koskeva strategia. 31.7.2012. Luettavissa: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0433:FIN:FI:PDF

Euroopan parlamentin ja neuvoston direktiivi 2012/27/EU. Energiatehokkuudesta, direktiivien 2009/125/EY ja 2010/30/EU muuttamisesta sekä direktiivien 2004/8/EY ja 2006/32/EY kumoamisesta.

Heljo, J.; Nippala, E. & Nuuttila, H. 2005. Rakennusten energiankulutus ja C02-ekv päästöt Suomessa. Rakentamistalouden laitos. Raportti 2005:4. Luettavissa: http://webhotel2.tut.fi/ee/Materiaali/Ekorem/EKOREM_Loppuraportti_051214.pdf

Hämäläinen, J. 2012. Rakennustyömaan energiatutkimus. Diplomityö. Tampereen teknillinen yliopisto. Luettavissa: http://www.tut.fi/idcprod/groups/public/@I102/@web/@p/documents/liit/p033746.pdf

Jylhä, K.; Kalamees, T.; Tietäväinen, H.; Ruosteenoja, K.; Jokisalo, J.; Hyvönen, R.; Ilomets, S.; Saku, S. & Hutila, A. 2011. Rakennusten energialaskennan testivuosi 2012 ja arviot ilmastonmuutoksen vaikutuksista. Ilmatieteen laitos. Raportteja 2011:6. Sitran selvityksiä 53. Luettavissa: https://helda.helsinki.fi/bitstream/handle/10138/33069/2011nro6.pdf?sequence=1

Koskela, L. & Koskenvesa, A. 2003. Last Planner -tuotannonohjaus rakennustyömaalla. VTT Tiedotteita / VTT Research Notes 2197. 82+20 s.

Koulutusnetti. 2012. Oppilaitoshaku. Sivuston taustalla on Opetushallitus. Luettavissa: http://haku.koulutusnetti.fi/koulutusnetti/schoolSearchPage.do.

Lahdensivu, J.; Suonketo, J.; Vinha, J.; Lindberg, R.; Manelius, E.; Kuhno, V.; Saastamoinen, K; Salminen, K. & Lähdesmäki, K. 2012. Matalaenergia- ja passiivitalojen rakenteiden ja liitosten suunnittelu- ja toteutusohjeita. Tampereen teknillinen yliopisto. Rakennustekniikan laitos. Rakennustekniikka. Tutkimusraportti 160. 121 s.

Luoma, P.; Vehviläinen, I. & Oja, L. Energiatehokkuuden liiketoimintamahdollisuudet Suomelle. Muistio työ- ja elinkeinoministeriölle. Gaia Consulting Oy. 28.11.2012. Luettavissa: https://www.tem.fi/files/35282/TEM_EE_Cleantech_Loppuraportti_2012_11_%28ID_5388%29.pdf

Nissinen, K. & Välijärvi, J. 2011. Opettaja- ja opettajankoulutustarpeiden ennakoinnin tuloksia. Jyväskylän yliopisto. Koulutuksen tutkimuslaitos. Luettavissa: https://jyx.jyu.fi/dspace/bitstream/handle/123456789/37587/978-951-39-4622-7.pdf?sequence=1

Opetus- ja kulttuuriministeriö. 2012a. Koulutus ja tutkimus vuosina 2011-2016. Kehittämissuunnitelma. Opetus- ja kulttuuriministeriön julkaisuja 2012:1. Luettavissa: www.minedu.fi/export/sites/default/OPM/Julkaisut/2012/liitteet/okm01.pdf?lang=fi

Opetus- ja kulttuuriministeriö. 2012b. Nuorten yhteiskuntatakuu: koulutusta, työtä ja täsmäpalvelua. Tiedote 15.3.2012. Luettavissa: http://www.minedu.fi/OPM/Tiedotteet/2012/03/yhteiskuntatakuu.html

Rakennusalan suhdanneryhmä. 2012. Rakentaminen 2012-2013. 28.8.2012. Luettavissa: http://www.vm.fi/vm/fi/04_julkaisut_ja_asiakirjat/01_julkaisut/02_taloudelliset_katsaukset/20120828RAKENT/RAKSUraportti_elokuu_%282%29.pdf

RIL 249-2009. 2009. Matalaenergiarakentaminen: Asuinrakennukset. Suomen Rakennusinsinöörien Liitto RIL ry.

ROTI. 2013.Rakennetun ympäristön tila 2013. Suomen Rakennusinsinöörien Liitto RIL. Luettavissa: http://www.roti.fi

Suomen lämpöpumppuyhdistys. 2013. Lämpöpumppujen myyntimäärät vuosittain 1996-2012 kappaleina. Luettavissa: http://www.sulpu.fi/documents/184029/208772/L%C3%A4mp%C3%B6pumppujen%20vuosittaiset%20myyntim%C3%A4%C3%A4r%C3%A4t%201996-2012%20kappaleina.pdf

Suomen rakentamismääräyskokoelma. D2. Ympäristöministeriö. Rakennetun ympäristön osasto. Rakennusten sisäilmasto ja ilmanvaihto. Määräykset ja ohjeet 2012. Luettavissa: http://www.finlex.fi/data/normit/37187-D2-2012_Suomi.pdf

Suomen rakentamismääräyskokoelma. D3. Ympäristöministeriö. Rakennetun ympäristön osasto. Rakennusten energiatehokkuus. Määräykset ja ohjeet 2012. Luettavissa: http://www.finlex.fi/data/normit/37188-

D3-2012_Suomi.pdf

Säteri, H. Kansallisia ilmasto- ja energiapoliittisia ajankohtaisia asioita. 5.2.2013. Ympäristöministeriö. PP-esitys. Luettavissa: http://www.korjausrakentaminen2013.fi/File/312/helena-sateri.pdf

Status Quo Report. 2012. BUILD UP Skills – Finland. Nykytilanteen analyysi. Status Quo. Elokuu 2012. Luettavissa: http://www.motiva.fi/files/6526/BUILD_UP_Skills_Finland_Nykytilan_analyysi_-raportti.pdf

Talonrakennusteollisuus. 2011. Työvoimatiedustelu marraskuussa 2011. Talonrakennusteollisuus RT ry Talonrakennustoimiala.

Tilastokeskus. 2012a. Energiatilasto. Vuosikirja 2011. Luettavissa: http://www.stat.fi/tup/julkaisut/tiedostot/julkaisuluettelo/yene_enev_201100_2012_6164_net.pdf

Tilastokeskus. 2012b. Oppilaitostilastot 2011. Luettavissa: http://www.stat.fi/tup/julkaisut/tiedostot/julkaisuluettelo/ykou_opla_201100_2012_7735_net.pdf

Tilastokeskus. 2012c. Rakennukset ja kesämökit -tilasto. Luettavissa: http://tilastokeskus.fi/til/rakke/index.html

Tilastokeskus 2013. Energian hankinta ja kulutus. 2012, 4. neljännes. suomen virallinen tilasto. Luettavissa: http://tilastokeskus.fi/til/ehk/2012/04/ehk_2012_04_2013-03-22_fi.pdf

Toivari, O.-P. 2011. Kosteudenhallinnan ja sääsuojauksen taloudellinen tarkastelu. Diplomityö. Tampereen teknillinen yliopisto. Luettavissa: http://www.tut.fi/idcprod/groups/public/@l102/@web/@p/documents/liit/p018275.pdf

TTY Rakennustekniikan laitos. 2008. Matalaenergiarakenteiden toimivuus. Tutkimustuloksia ja suosituksia uusiin lämmöneristys- ja energiankulutusmääräyksiin ja –ohjeisiin. Loppuraportti. Talonrakennustekniikka. Tutkimusselostus Nro TRT/1706/2008. 88s.

Työ- ja elinkeinoministeriö. 2010. Suomen kansallinen toimintasuunnitelma uusiutuvista lähteistä peräisin olevan energian edistämisestä direktiivin 2009/28/EY mukaisesti. Energiaosasto. Luettavissa: http://www.tem.fi/files/29773/Suomen_kansallinen_toimintasuunnitelma.pdf

Työ- ja elinkeinoministeriö. 2012a. Työelämän kehittämisstrategia. Luettavissa: http://www.tem.fi/files/33484/TEMtyoelaman_kehittamisstrategia2020_A4_fi.pdf

Työ- ja elinkeinoministeriö. 2012b. Työvoimapoliittisen aikuiskoulutuksen vuositilastot vuonna 2011. TEM Tilastotiedote 2012: 3. Luettavissa: http://www.tem.fi/files/33173/3_Tilastotiedote_2012.pdf

Työ- ja elinkeinoministeriö. 2013. Kansallinen energia- ja ilmastostrategia. Valtioneuvoston selonteko eduskunnalle 20. päivänä maaliskuuta 2013. VNS 2/2013 vp. Luettavissa: http://www.tem.fi/files/36266/Energia_ja_ilmastostrategia_nettijulkaisu_SUOMENKIELINEN.pdf

Työ- ja elinkeinoministeriö. 2013. Nuorten yhteiskuntatakuu 2013. TEM raportteja 8/2012. Luettavissa: http://www.tem.fi/files/32352/Nuorten_yhteiskuntatakuu_-tyoryhman_raportti_%282%29.pdf

Vainio, T. Rakentamisen yhteiskunnalliset vaikutukset. Asiakasraportti VTT-CR-05932-12. 8.10.2012. Luettavissa: http://www.infrary.fi/files/4359_SselitystekstitLOKAKUU2012.pdf

Valtioneuvosto. 2008. Pitkän aikavälin ilmasto- ja energiastrategia. Valtioneuvoston selonteko eduskunnalle 6. päivänä marraskuuta 2008.

Valtioneuvosto. 2010. Valtioneuvoston periaatepäätös energiatehokkuustoimenpiteistä. 4.2.2010. Luettavissa: http://www.tem.fi/files/26023/ETT-periaatepaatos_-_040210.pdf

Valtioneuvosto 2011. Hallitusohjelman strateginen toimeenpanosuunnitelma – kärkihankkeet ja vastuut. Valtioneuvoston periaatepäätös 5.10.2011. Luettavissa: http://valtioneuvosto.fi/tiedostot/julkinen/vn/hse-2011/fi.pdf

Valtioneuvoston kanslia. 2012. Ilmasto- ja energiapolitiikan EU-vaikuttamisstrategia. Valtioneuvoston kanslian julkaisusarja 2/2012. Luettavissa: http://vnk.fi/julkaisukansio/2012/j02-ilmasto/PDF/fi.pdf

Valtiovarainministeriö. 2012. Eurooppa 2020 -strategia. Suomen kansallinen ohjelma. Kevät 2012. Taloudelliset ja talouspoliittiset katsaukset. 162/2012. Luettavissa: http://ec.europa.eu/europe2020/pdf/nd/nrp2012_finland_fi.pdf

Vihola, J. & Heljo, J. 2011. Toteutettavissa olevat energiansäästöpotentiaalit Tampereen kaupungin asuinrakennuskannassa. Tampereen teknillinen yliopisto. Rakennustekniikan laitos. Tampere 2011

Vihola, J. & Heljo, J. 2012. Lämmitystapavalintojen kehitys 2000–2012. Tampere, Tampereen teknillinen yliopisto. Rakennustekniikan laitos, Rakennustuotanto ja -talous. Raportti 10. 64 s.

Ympäristöministeriö. 2007. Korjausrakentamisen strategia 2007-2017. Linjauksia olemassa olevan raken-

nuskannan ylläpitoon ja korjaamiseen. Ympäristöministeriön raportteja 28/2007.

Ympäristöministeriö. 2010. Ympäristöministeriön asetus kiinteistöjen vesi- ja viemärilaitteistoista annetun ympäristöministeriön asetuksen muuttamisesta. 9.1.2010. Luettavissa: http://www.finlex.fi/data/normit/36380-D1_2010.pdf

Ympäristöministeriö. 2012. Rakennusten energiavaatimusten Road Map – moottoritie kohti 2020. Helena Säteri. Esitys. 7.6.2012. Luettavissa: http://web.finnexpo.fi/Sites1/FinnBuild/MaterialBank/RoadMap%202012-2020.pdf

Ympäristöministeriö 2013. Ilmastolaki valmistellaan vielä tämän hallituskauden aikana. Tiedote. Luettavissa: http://www.ymparisto.fi/default.asp?contentid=428736&lan=fi

Annex 1

Action areas of raising the level of teaching and learning by occupation

Worksite teaching material to be developed	Occupations	Focus	Stakeholders for content implementation
Construction site climate control heating, special nature of winter construction, moisture control, drying, worksite energy inspection	711, 7111, 7112, 7114, 7115, 7121, 7124, 7125, 7126, 7127, 741, 7411, 7421, 74212	TTL, TP	A7, C1, C3, D2, F6, F7, G1, I1-I4, J1-J6
Building energy-efficient structures thermal insulation, sealing, sandwich structures, other elements, wood structures, brick walls, windows	711, 7111, 7112, 7114, 7115, 7121, 7124, 7125,	TP, A, LV	A7, C1-C4, F7, F8, F10, H5, I1-I4, J1-J6
Improved collaboration, overall management development of attitude building, worksite energy co-ordinator	711, 7111, 7112, 7114, 7115, 7121, 7124, 7125, 7126, 7127, 741, 7411, 7421, 74212	TTL, TP	A7, C1, C3, D2, D8, E6, F1 ,F6, F7, F10, G1, H3, I1-I4, J1-J6
Quality assurance at worksite quality criteria for energy efficiency, inspections	711, 7111, 7112, 7114, 7115, 7121, 7124, 7125, 7126, 7127, 741, 7411, 7421, 74212	TTL, TP	A7, C1-C4, D2, D4, D8, F5, F6, F7, F10, G1, H1, H3, H4, I1-I4, J1-J6
Energy-efficient plumbing boilers, conveyors, pipe materials, pipe routes, pumps, pump equipment, valves, accumulators, pipe insulation	7124, 7126, 741, 74212	TP, A, LV	A7, D1-D7, F1, F2, F9, F10, H2, I1-I3, J1, J2, J4, J5
Energy-efficient ventilation installations installation of ventilation channels, modifications and channel outs, channel equipment, dampers, ventilation machines, air intake and removal cases, grills, roof exhaust fans, cooling beams, fan coil units	7124, 7127, 741, 74212	TP, A, LV	A7, D2, E6, F1, F2, F9, F10, H2, I1-I3, J1-J2, J4, J5
Energy-efficient electrical installations lighting, engines, cabling, switching centres, transformers, frequency transformers, lifts, information systems, signalling systems	741, 7411, 7421, 74212	TP, A, LV	A7, D8, E1, E5, E6, F3, F4, F5, G3, H4, I1-I3, J1-J2, J4
Energy-efficient automation installations control systems, sensors, measurements, frequency converters, sub-distribution boards	741, 7411, 7421, 74212	TP, A, LV	A7, E5, E6, H2, H4, I1-I3, J1-J2,
Renewable energy systems heat pumps, solar heat and energy systems	7126, 7127, 741, 7411, 7421, 74212	TP, A, LV	A7, D1-D8, E1-E7, F1, F10, H2, I1-I3, J1-J2, J4, J6
Insulation of building technology systems	7124, 7126, 7127	TP, A, LV	A7, D2, D6, F1, F9, H2, I1-I3, J1-J2, J4, J5

OCCUPATIONS (according to the classification of Statistics Finland)

711	Construction workers
7111	House builders
7112	Bricklayers
7114	Concrete workers and steel fixers
7115	Carpenters and joiners
7121	Roofers and roof repairers
7124	Insulation workers
7125	Glaziers
7126	Plumbers
7127	HVAC installers
741	Electricians, electrical appliances
7411	Building electricians
7421	Electronic and automation installers
74212	Automation installers and repairers

AREA OF FOCUS

WAL =	Worksite activities and logistics
BI =	Basic information
IT =	Installation technique
QA =	Quality assurance

Annex 2

STAKEHOLDERS (This classification made for this present purpose only)

A MINISTRIES, GOVERNMENT AGENCIES, NATIONAL PROGRAMMES

A1	Ministry of the Environment
A1.1	Motiva
A2	Ministry of Employment and the Economy
A3	Centre for Economic Development, Transport and the Environment
A4	National Board of Education
A4.1	Education and Training Committee
A4.2	Qualification Committee
A5	Ministry of Education and Culture
A6	Safety and Chemicals Agency, TUKES
A7	City Building Control
A8	Real Estate and Construction Forum, KIRA
A9	ERA17 Programme

B LABOUR MARKET ORGANIZATIONS

B1	Confederation of Finnish Construction Industries, RT
B2	Finnish Construction Trade Union
B3	Akava, Confederation of Unions for Professional and Managerial Staff
B4	Trade Union of Education OAJ, Trade Union of Vocational Educators OAO, Adult Educators' Union AKO, Vocational Teachers' Union AO
B5	Electrical Workers' Union
B6	Finnish Energy Industries, ET
B7	Electrical Employers, STTA

C HOUSE BUILDING ASSOCIATIONS

C1	Confederation of Finnish Construction Industries
C2	Association of Finnish Construction Product Industries, RTT
C3	Association of Mechanical Building Services Industries
C4	Concrete Association of Finland, BY
C4	Pientaloteollisuus PTT (Association of House Suppliers)

D BUILDING TECHNOLOGY ASSOCIATIONS

D1	Finnish Heat Pump Association, SULPU
D2	HVAC Technical Contractors, LVI-TU
D3	Heating Energy Association, LEY
D4	Finnish Refrigeration Enterprises Association, SKLL
D5	Oil and Gas Heating Association, ÖKY
D6	HVAC Technical Trade Association
D7	Oil Industry Service Centre
D8	Electrical Contractors' Association, STUL

E PROMOTION OF INDUSTRY AND BUSINESS

E1	Association for Promotion of Electrical Safety, STEK
E2	Bio Energy Society
E3	Solar Energy Society
E4	Finnish Association of HVAC Societies FINVAC
E5	Finnish Society of Automation, Building Autoation Division, BAFF

E6 Electrical Building Services Centre, STOK

E7 Finnish Energy Industries, ET
E8 Finnish Real Estate Federation
E9 Association of Finnish Local and Regional Authorities
E10 Real Estate Services Federation
E11 Finnish Real Estate Management Federation

F PERSONNEL ASSOCIATIONS AND COMPETENCES

F1 Finnish Association of HVAC Societies, SULVI
F2 VVS Föreningen i Finland
F3 Henkilö- ja yritysarviointi Seti Oy (Personnel and Enterprise Qualification Institution)F4 Electrical Installation Safety Inspection, SÄTY
F5 Finnish Society of Senior and Master Electricians, SAMSY
F6 Finnish Construction Managers and Engineers, AMK RKL
F7 Society of Building Inspectors, RTY
F8 Finnish Association of Civil Engineers, RIL
F9 Finnish Society of HVAC Engineers, LIVI
F10 FISE Oy, Qualifications for professionals in building, HVAC, and real estate industries

G ENTERPRISE QUALIFICATIONS, STANDARDS

G1 Construction Quality Association, RALA
G2 Henkilö- ja yritysarviointi Seti Oy (Personnel and Enterprise Qualification Institution)
G3 Electrotechnical Standardization Association, SESKO

H BUILDING DEVELOPMENT AND DESIGN

H1 Building Developers Association, RTL
H2 Finnish Association of Consulting Firms, SKOL
H3 Building Development Association, RAKLI
H4 NSS Association of Finnish Electrical Designers
H5 Association of Finnish Construction Engineers and Architects, RIA
H6 Association of Finnish Architects' Offices, ATL
H7 Finnish Association of Architects, SAFA

I RESEARCH, INFORMATION SERVICES

I1 Technical Research Centre of Finland, VTT
I2 Universities of Technology
I3 Building Information Foundation / Building Information Ltd.
I4 Sähkötieto ry / Sähköinfo Oy (Electricity Information)

J EDUCATIONAL ORGANIZATIONS

J1 Vocational colleges
J2 Polytechnics
J3 RATEKO (Construction Industry Education Centre)
J4 Amiedu (Vocational Adult Education Centre)
J5 Real Estate Education Centre KIINKO
J6 TTS – Työtehoseura (a research, development and training institute