

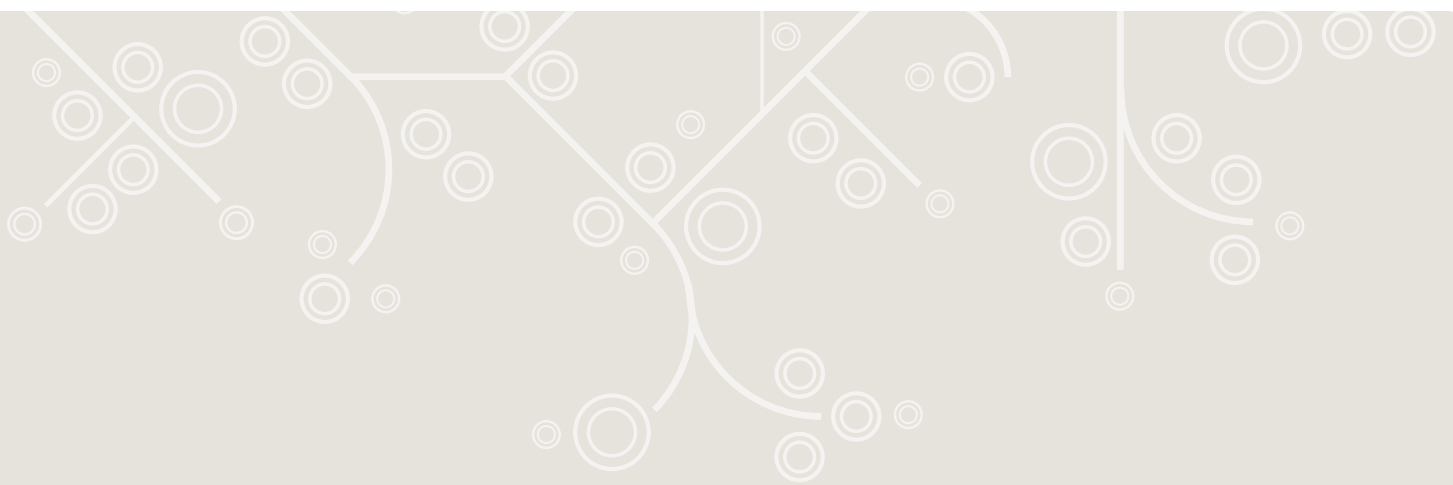
Survey of green legislation and standards in the construction area in the Nordic countries

Background Note



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Project participants

BREEAM - Building Research Establishment's Environmental

Assessment Method

CE - Conformité Européenne (CE-märkning)

CEN - European Committee for Standardization

CENELEC - European Committee for Electro technical Standardization

CPD - Construction Products Directive (89/106/EEG)

CPR - Construction Products Regulation, Byggsproduktförordningen ((EU) nr 305/2011)

C2C - Cradle to Cradle

DGNB - Deutsche Gesellschaft für Nachhaltiges Bauen

EPBD - Energy Performance of Buildings

EPD - Environmental Product Declaration.

GBC - Green Building Councils

LCA - Life Cycle Assessment

LCCA - Life Cost Cycle Analysis

LEED - Leadership in Energy and Environmental Design

NKB - Den nordiske komité for bygningsbestemmelser

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1 Abbreviations

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2 Introduction

The Nordic prime ministers have charged the Nordic relevant ministers with developing a number of specific areas of cooperation to enhance growth and welfare in the Nordic countries. The assessment is that the Nordic countries can and should be a pioneer in dynamic green and sustainable solutions. The areas to which the Nordic countries must pay particular attention is cooperation on the development of test centres for green solutions, training and research into green growth, promotion of flexibility for consumers in the Nordic electricity market, green technical norms and standards, green public procurement, etc. All areas are described in detail in the report "Norden - leadership i grøn tillväxt" ("The Nordic Region - leadership in green growth"). Paragraph 4 of this report is dealing with green building, and a target has been proposed to nominate 4-5 areas that are suitable for Nordic co-ordination. The aim is to support the development of a leading global market for green building in the Nordic countries; especially seeking an overview of the trade barriers and opportunities that currently exist in the form of different requirements in legislation, standards and norms.

The reason is that the Nordic countries are to some extent influenced by nationally defined markets within construction, while increased trade and regionalization could potentially improve the possibilities of developing a larger, innovative and dynamic market for green building. Another aspect is that the Nordic countries will be stronger together in relation to among other things EU and EU legislation, if the Nordic countries will coordinate efforts and the various demands on green building.

2.1 Objective

Thus, the objective of the survey materialised in this report is to identify and describe areas of green building that may be suitable for Nordic co-ordination. Further to this, the goal is to point out approx. 10 areas with associated actions which could ultimately improve the Nordic industries' competitive situation, including eliminating or preventing new barriers to trade in the Nordic countries in these areas.

The task is performed partly by literature studies, information searching on the Internet

and through interviews with 16 Nordic experts in the period from 16 April to 6 June 2012. The result of the survey has been presented at a workshop with relevant Nordic actors, where it was discussed which of the proposed actions are to be pursued further.

The following items are identified in the survey:

- Overview of green building - a concise overview of the major areas within construction that can be characterized as green has been established. In this task, this is defined and limited to energy, water and resource consumption, indoor climate and building materials.
- Survey of technical norms and standards for green buildings in the Nordic countries and the EU. Because of the relatively limited extent of the task, a screening of the area has been carried out, focusing on the essential norms as well as standards; voluntary as well as statutory. But the magnitude of standards and norms in the four areas in the 5 Nordic countries and the EU is huge, and it has therefore not been possible to conduct a complete survey of such national annexes to the European standards.
- Identification of the major national stakeholders as well as already existing Nordic projects and co-operation relations in green building.

The report has been prepared in May 2012 by:

Henrik Sand, Kirstine Hjorth Lorenzen and Christina Burgos Nittegaard,
COWI A/S

3 Overview of green buildings

The following provides a summary of different areas within construction which can naturally be characterized as green. As can be seen from the figure next page these areas are in many ways overlapping and depended upon each other.

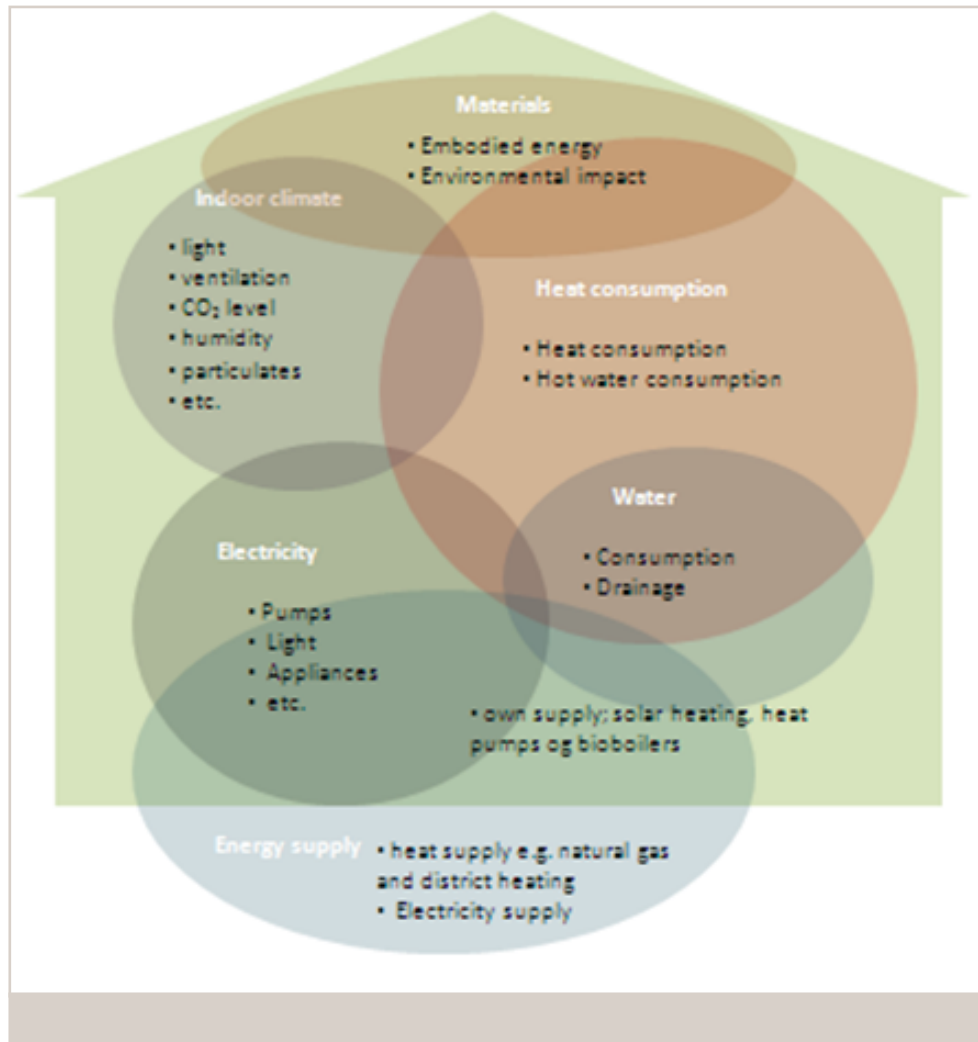
The main areas included in the survey are:

- Energy consumption
- Water and resource consumption
- Indoor climate
- Building materials.

The areas are chosen because they constitute the key elements in relation to green building, and hence make up relevant subjects for the needed delimitation of the survey.

It is important to look at the main areas of green buildings in an overall context. The figure below illustrates how the areas of green building potentially influence each other. A holistic perspective can be seen in most voluntary labelling and certification schemes that are currently gaining ground in the green building sector in Scandinavia. It is recommendable that the prioritization and selection of suitable areas for Nordic coordination also adopt this holistic approach, when dealing with delimited areas. In a unilateral focus on e.g. energy consumption in buildings, one may have overlooked that a low energy consumption in some cases can lead to poor indoor air quality or is based on the use of materials that are produced with high energy consumption.

Figur 3.1 Sustainability elements in buildings and their interconnections



3.1 Energy consumption

Energy demand in buildings is probably the area which in recent years has been most in focus for the regulation of buildings in the Nordic countries. Denmark has been at the forefront in introducing requirements, but both Norway and Sweden have joined, and all the countries now have ambitious requirements for building energy needs. The same applies to Finland, having so far chosen to regulate through demands on the building envelope. Due to the very cheap and renewable energy resources, Iceland has been a

little reluctant to regulate energy consumption in buildings. However, in 2011 energy requirements for buildings there were established new Icelandic building regulations.

A large part of energy consumption in the Nordic countries comes from the use of buildings. This covers energy consumption for heating, hot water, cooling, ventilation and lighting, but also energy consumption for production and recycling of building materials is relevant to consider.

There are several ways of regulating buildings' energy needs, in particular:

- Energy frames - mandatory use in Denmark, Sweden, Norway and to some extent in Iceland.
- Building envelope and U-values - mandatory in Norway, Sweden, Denmark, Finland and Iceland.
- Efficiency requirements for installations - e.g. ventilation systems

Basically, it can be said that laws in Nordic countries sets demands on building construction and expected energy needs, but not on the actual energy consumption in the final building. Only in Sweden is followed up on the actual energy consumption during the consumption phase.

3.1.1 Energy frames

An energy frame contains a calculation of the building's energy needs, typically calculated as kWh/m²/year, and is based on the building design and a series of fixed calculation assumptions. The energy frame requirements are actualized by e.g. the EU Buildings Directive, and the calculation is typically based on monthly averages.

Basically one can not compare the energy regulatory framework across countries, neither in Scandinavia nor in Europe.

This is among other things due to the fact that the energy frame can cover a larger or smaller proportion of the total energy need in the building, and that there are currently large national differences in what is included in the energy frame. Furthermore, climate differences make it difficult to compare energy frames directly, and in Scandinavia it is essential to relate to the climatic differences that exist in the region.

Another discussion in relation to comparing and understanding the energy frames across countries is the calculation methods that underlie the energy calculations. In Denmark, for example, BE10 is used, while Finland and Norway are free to choose between programmes, but there are standard requirements for the energy calculation itself. The project ASIEPI has studied how the different energy frames are influenced by

differences in assumptions, etc.¹

Energy frames in the Nordic countries are closely linked to traditions in relation to building regulations, the climate and discussions in the industry. It is currently a challenge to envisage a harmonization in this area, but many would express a desire for this.

3.1.2 Building envelope

An important step in reducing energy consumption/needs in buildings and thereby living up to an energy frame is by optimizing the building envelope. Buildings lose energy such as heat and cold through poorly insulated roofs, floors, walls, doors and windows. By sealing the building and insulating exterior walls, roofs, and floors and replacing old windows by new energy-efficient windows, a reduced energy bill and a good and healthy indoor environment can be achieved. In addition, buildings are being prepared to withstand future extreme temperature conditions.

The Nordic countries have different demands on U-values, including how they are calculated in relation to a building or building component. The difference is due to traditions, but also the climatic variations have an influence. It should be noted that most countries in Europe today make demands on U-values, and these have typically been further tightened in recent years².

3.1.3 Other subject fields

Other relevant topics related to energy use in buildings include:

- It is important to relate to the **efficiency of energy installations in buildings**, e.g. oil-fired boilers, district heating installations, heat pump, ventilation installations, etc. Inefficient systems may provide a huge energy loss and thus CO₂-emissions. In all the Nordic countries, there are requirements or recommendations for heat recovery of ventilation systems, and in Denmark, there are also demands on the efficiency of some energy-producing plants.
- As buildings by now have become optimized in terms of energy consumption during operation, the **energy consumption for production of building materials** will represent an increasingly larger portion of the building's total energy consumption throughout its life cycle. Energy consumption for materials should be expected to gradually exceed the total energy consumption for operating the building. Better insulated buildings will contain a larger amount of embedded energy, and therefore it is appropriate to pursue an optimum, so that strict demands

¹ <http://www.asiepi.eu/>; Comparison of Energy Performance Requirement Levels: Possibilities and Impossibilities, 2010

² See survey in http://www.ebst.dk/file/146059/energikrav_i_eu_land.pdf "Kortlægning af strategier for lavenergibyggeri i EU lande" COWI 2011

on energy frames goes hand in hand with requirements in relation to materials. In order not to end up transforming a saving in the operation of buildings for energy consumption in the construction industry.

- **Energy supply.** There are many opportunities to supply a building with heat, cold and electricity, and the supply has a decisive influence on how green or sustainable a building can be said to be. We distinguish between individual and public supply, and in connection with the construction it is only possible to influence the extent and how to arrange the individual / building integrated supply. Generally, the Nordic countries - particularly Norway and Iceland - are favoured by large amounts of renewable energy in the public supply, which means that CO₂-emissions from electricity and heat supply are generally low. However, there are large differences between countries and regions.
- **Commissioning.** A number of other countries e.g. United States work on integrating commissioning as a legal part of a construction. Analysis here shows that on average one can achieve energy savings of 16 percent in existing buildings and 13 percent in new buildings with a targeted use of Commissioning. Commissioning is roughly based on the clarification of measurable program requirements, facilitation around the project's compliance with program requirements, review of project documents, dialogue with designers advise on options, development of concepts for balancing and commissioning, testing of commissioning, the interaction of installations and training of operating personnel and documentation
- One of the largest challenges in making demands on energy consumption of buildings is that it is difficult to ensure that the buildings are actually complying with the calculated energy frame or U-value. The building will usually always use more energy due to the parameters that are not contained in the energy frame. The big challenge is hence to ensure that both the energy consumption regulated by the energy frame and the energy that lies beyond do not exceed reasonable limits. It is a general problem that the authorities, etc. do not monitor or consistently follow up on whether buildings after construction meet the energy requirements stipulated in the legislation. Only in Sweden, energy consumption is regulated via a subsequent **monitoring** of the actual energy consumption.
- Another more indirect aspect is the energy used for **transport**, which can be connected to a building. It is essential whether a building is ideally located for public transport, whether you have "plug in" opportunities for electric cars, etc.

3.2 Water and resource consumption

Water shortages, drought, flooding and water quality problems are affecting most European countries, including Scandinavia, where available water resources, however, generally are better than in the rest of the EU. Reducing water consumption also has a seasonal dimension, since water is less available and more used during summer. Water quantity and quality are closely linked, and the more water used in buildings, the more water will be discharged.

Water consumption and drainage thus become more and more central to the buildings' influence on the environment. Everywhere in the Nordic countries, an increasing pressure on groundwater supplies and sewers is felt. The Nordic countries are still in the unique position that virtually all drinking water can be produced from pumped groundwater, melt water, etc. by means of simple treatment principles. However, it is essential to continue to strive for a sustainable use of groundwater resources as drinking water treatment is expected to become more complicated and costly, while drainage also is a resource problem in itself. In addition, most applications of water are related to energy consumption: in the public supply of water where water is pumped and purified; in the building, where the water is heated and pumped; and finally where the waste water is pumped back and processed.

Unlike energy consumption, water consumption in buildings is by and large unregulated. This is the case in the Nordic countries, as well as in most of the rest of the world. However, in recent years this area has been brought into focus, among other things by voluntary certification schemes and preparatory legal work, including in the EU. In relation to water consumption in buildings, however, requirements exist in the Nordic countries in relation to water quality and drainage.

The following areas are all relevant and potential in relation to future legislation:

- **Reduced water consumption** - demands on water consumption/efficiency in relation to facilities, requirements such as impact per consumer, employee or m², requirements for water efficiency of installations, etc.
- **Use of rainwater, drainage and recycling.** In relation to waste water, studies have shown that there is a large reutilization potential for gray water. For example, reutilization is of special relevance in connection with water consuming plants, especially large communal facilities which for hygienic reasons have difficulties in using their own slightly contaminated gray water themselves, and thus must necessarily be provided with potable water. At present, there is not much legislation in this area. Moreover, it would also be appropriate to work towards limitations for discharge of sewage and rainwater into sewers through for example demands for

more green roofs and facades and fewer paved areas, use of rainwater for flushing toilets, etc.

- **Climate change adaptation in relation to rainfall.** One of the future challenges facing society is adapting to a changed climate with more extreme amounts of rain. This places new demands on the design of buildings and cities - not least in relation to the handling of rainwater and drainage.
- **Surrounding vegetation and water needs.** Another area is protective planting and water needs. Authorities, for example Copenhagen Municipality, have increasingly begun to see the potential water consumption of outdoor planting. Plants have a very different sensitivity to desiccation and a highly variable water need, for which reason well-thought-out plants can save much water.
- **Water footprint** (see under materials).

3.3 Indoor climate

Indoor climate is extremely important for building users' comfort. A good indoor climate has a positive impact on people's health as well as concentration, learning and working abilities. The Nordic countries are generally known for setting relatively high demands on indoor environment, but there are also differences in the traditions, norms and voluntary schemes. The area is particularly important in the Nordic countries, since we spend relatively more time in our buildings, compared with for example Southern Europeans. Historically, buildings in the Nordic countries have had major problems with insufficient ventilation, moisture and mold damages, and this is to some extent still a major problem in existing buildings.

Many areas are controlled by European norms and standards that are to be implemented nationally in the Nordic countries through national annexes.

Indoor climate includes a variety of parameters such as:

- **Air quality, including moisture.** Among the most important indoor climate parameters, air quality can be mentioned. A good air quality implies that the ventilation volume is tailored to the needs of the individual person or room, and that moisture does not create a breeding ground for mold, etc. It is generally important to ensure that the contaminated or humid air is replaced by fresh air from outside, which results in a low health risk to the users. Further, the ventilation should also be designed so that it does not cause draft problems for users. The CO₂-level is commonly used as an indicator, because the air's CO₂-content is crucial for the users' comfort and ability to concentrate, and shows the impact of humans in

relation to the volume of air in the ventilation.

- **Thermal indoor climate.** Demands on the thermal indoor environment include parameters such as the operating temperature, air movements and speeds, drafts, local discomfort due to vertical air temperature gradient, local discomfort due to hot or cold floor, local discomfort due to radiation temperature imbalance and that supply air has a comfortable temperature and helps to support a good indoor climate.
- **Daylight / window conditions.** Light is essential for most activities in a building. Daylight is one of the best forms of workplace lighting and is also beneficial for your wellbeing. Lack of daylight in the room may mean that you feel trapped and isolated from the outside world. Therefore, it is important to organize workspaces with windows, so there is natural light, and so there are views to the surroundings outside. The daylight factor is used to measure the extent of daylight in a room.
- **Environmentally harmful substances.** Finally, there are a variety of indoor climate conditions that are central in relation to environmental contaminants in the building, and which potentially can be found in building materials, appliances, etc.
- **Noise and sound.** Noisy surroundings make it harder to work concentrated, to relax at home, and may at worst cause tinnitus and stress. Noise and poor acoustics must be dimmed to create a good living and working situation.

3.4 Construction materials

In relation to building materials, you have to choose indoor climate-friendly materials and materials that take the utmost account of the environment in the manufacture, use and disposal. In Scandinavia, we have set requirements for the indoor dimensions of materials, i.e. the content of chemicals and degassing, fire protection, etc., while there has not yet been statutory regulation of other dimensions of material consumption.

Significant subjects and parameters in relation to building materials being green include:

- The **life time** of a building is an important element. It has a potentially negative effect in relation to sustainability every time you use a material, build or subsequently demolish the building, as energy is used and resources are lost in this process.
- **Chemicals and environmental impact.** The content of environmentally hazardous or non-renewable substances in materials, components and equipment in a building has a great influence both in relation to indoor climate and also in

relation to resource consumption and opportunities for recycling.

- **Energy embodied in materials or carbon footprint.** The energy and CO₂ content in the production of materials and components varies widely seen in a life-cycle perspective. The concept of “embodied energy” is used to denote the embodied energy as the sum of all the energy required to produce goods or services. It is interesting that with more energy-efficient buildings, we pass the total energy consumption on to the materials. While nearly 100% of energy consumption in existing buildings is located in the operational phase, a relatively large share of energy consumption in the new low-energy/passive buildings will be built into the materials. The following general conditions apply:
 - » Low U-value means less energy consumption for heating, but requires more energy for material production.
 - » Materials such as brick and mineral wool are produced at very high temperatures and therefore contain a lot of embodied energy - but they have a very long lifetime, which partly offsets the energy consumption.
 - » A high heat capacity / heavy constructions reduce energy consumption for heating/cooling, but require more energy for material production.
- **Water footprint,** which is an indication of the quantity of water that has been used to produce the product or building material.
- **Recycling of materials.** The possibility of recycling a material has a great influence on the sustainability of the material or component. Today, most building materials are made from non-renewable resources, where the deposits are limited; recycling may be a prerequisite for future generations also having access to these materials. It is also relevant to come up with targets for recycling content in materials and buildings.

In many contexts, work is done to establish evaluation methods for materials, including life-cycle analyses combined with material databases, labelling schemes, etc.

4 Voluntary certification schemes

Green building today covers a very wide spectrum of buildings and projects claiming to be green or sustainable. One of the biggest challenges concerning green building is the vague definition and thus the broad framework of what can be described as green or sustainable.

Certification schemes for sustainable buildings

A number of voluntary certification schemes have been established globally, aiming to promote the development of more sustainable construction. The norm in sustainability certification of buildings is to draw a distinction between

environmental, social and economic *sustainability*, partly reflected in the new Danish version of the German certification scheme DGNB, currently under development. This means that all schemes are based on overall considerations and existing legislation and construction practices in order to move the market into a more sustainable direction. To the greatest extent possible, existing standards and assessment methods are used in the requirements and assessment of performance in the voluntary schemes.

Figure 4.1 Overview of the most common certification schemes for sustainable construction



Source: Natilie Essig

A number of organizations such as the Nordic Green Building Councils have worked to implement a series of the voluntary international arrangements nationally. This has resulted in a number of nationally tailored or directly implemented certification schemes for sustainable construction, which all have their own areas of focus and character. This makes it difficult to compare and get a clear overview of the overall sustainability or environmental impact.

Certification schemes and their use in the Nordic countries are to a large extent driven by the construction industry / investors using the certification for example in connection with branding and as a selling parameter. Only in Iceland, the state authorities put it as a requirement for new stateowned buildings that they have to be BREEAM certified. However, a number of local authorities/municipalities in the Nordic countries are often making requirements for low-energy housing in local plans and for their own construction.

Below is a schematic overview of the most widely used certification schemes in the Nordic countries, illustrating how the environmental, social and economic *sustainability* is handled since this is the norm for how certification schemes are discussed and applied. In relation to this survey, primarily focusing on green building/environmental aspects, the systems typically have a broader focus.

The table below illustrates the most important voluntary arrangements that exist in the Nordic countries and the EU.

Scheme	Environmental sustainability	Social sustainability	Financial sustainability	Other areas	Utilized
Svanemærket (Nordic countries)	Energy consumption Materials	Good indoor climate Use of harmful materials is very limited		Quality must be high There is an operation and maintenance plan	DK, SE, NO, FI, IS
Minenergi (Sweden)	Energy consumption	Indoor climate requirement are high			SE
BREAM (UK)	Energy Transport Water Materials (LCA) Waste Space consumption & Ecology Pollution	Health & well-being (Transport)	Voluntary Life cycle cost assessment	Management Innovation	Prioritised scheme in NO, SE and IS But also applied in DK and FI

Scheme	Environmental sustainability	Social sustainability	Financial sustainability	Other areas	Utilized
LEED (USA)	Energy & atmosphere Water efficiency Materials & resources Sustainability Site	Indoor quality (Transportation)		Innovation Regional prioritisation	Prioritised scheme in SE, but also applied in DK
DGNB (Germany) Based on European standards	Environmental quality and Life Cycle Cost Assessment (Localization quality)	Social quality	Financial quality and life time (LCC)	Functional quality Technical quality Process quality	Prioritised scheme in DK
Low-energy categories in building regulations	Energy consumption	Indoor climate			Prioritised scheme in DK, NO
Passive house (Germany)	Energy consumption	Indoor climate / temperature			FI, DK, NO and SE
Minergie-ECO (Switzerland)	Energy consumption Demands on energy supply Production Raw materials Reuse	Lighting Noise Indoor climate		Combined with special bank loans	
HQE (France)	Impact on immediate environment Materials & performance Energy Water Waste	Thermal comfort Acoustics Comfort Visual comfort Experienced air quality Healthy rooms Health related air quality Water quality		Maintenance	

See also the report "*Bæredygtigt byggeri - Afprøvning af certificeringsordninger til måling af bæredygtighed i byggeri*" ("Sustainable Energy - Testing of certification schemes for measuring sustainability in construction") (2010), where several different certification schemes are compared in relation to two concrete buildings. (http://www.byggeevaluering.dk/media/5430/baeredygtighed_hr_inkl_uk.pdf).

Product labelling schemes

In addition, there are a number of voluntary **product labelling schemes**, which comprise among other things certain building materials and can be used independently or as a supplement to support buildings using a certification scheme:

- Svanemærket (Swan label) is a voluntary scheme for manufacturers, which was established in 1989 and is used in Denmark, Norway, Sweden, Finland and Iceland. The label places especially strict requirements for the production and disposal. The label applies to a wide range of products and services - including buildings, see the table above. (<http://www.ecolabel.dk>).
- Blomsten (the Flower) is a European label, which was established in 1992 by the European Commission and is used throughout Europe. When the EU Commission established Blomsten, the ambition was to develop a label that could bring together all national and regional eco-labels, including the Nordic Swan. However, there are some practical considerations implying that the two brands continue to live side by side. For example, there are still more product groups that can be labelled with the Swan than with the Flower. (<http://ec.europa.eu/environment/ecolabel>). Currently, attempts are made to develop a label for new and existing buildings, including a number of criteria (see e.g. http://freshproject.eu/data/user/01_public-area/4th_interregional_meeting/Presentations_May_24th/Prof_FRESH_Finland_240511_PP9.pdf).
- The Swedish BASTA system. BASTA sets requirements for the chemical content in construction products. The purpose of BASTA is to contribute to phasing out hazardous chemicals from the building. The system is supported by the largest Swedish players in the construction industry (www.bastaonline.se).
- Environmental Product Declaration, EPD, is an international labelling scheme based on ISO standard ISO 14025, that is gaining more and more ground also in the Nordic countries. (<http://www.environmentalproductdeclarations.com>).

In addition, e.g.:

- Nature Plus is an international label of quality for building and home products. Products bearing this label are characterized by their high degree of quality within health, environment and functionality (<http://www.natureplus.org>).

- Blauer-Angel, a German-based labelling system that covers a range of products related to buildings, including paints, energy installations, water installations, etc. (<http://www.blauer-engel.de>).
- Cradle to Cradle (internationally developed in Germany/USA) contains certified products and materials and concepts for entire buildings. There is not a 100% Cradle to Cradle certified building yet, but it is currently possible to design and construct a building according to the Cradle to Cradle principles which also to some extent includes a broad range of C2C certified products and materials. Cradle to Cradle is established as an organization in Denmark, but not in other Nordic countries (<http://www.vuggetilvugge.dk>).

Generally, there will be increasing focus on voluntary labelling also in the construction industry in the Nordic countries. Many manufacturers of for example insulation, windows, etc. have shown great interest in this area, and certification of complete buildings is increasing markedly in all Nordic countries.

There are also a number of voluntary indoor climate labelling systems that are used in the Nordic region, including:

*Indoor climate
labelling schemes*

- Denmark has recently introduced a voluntary rating system for indoor climate, based on the overall indoor climate in a building - DS 3033:2011 "Frivillig klassificering af indeklimaets kvalitet i boliger, skoler, daginstitutioner og kontorer" ("Voluntary classification of indoor air quality in homes, schools, day-care centres and offices") (www.indeklimaklassificering.dk).
- Danish indoor climate label makes demands on products. The label sets an upper limit on degassing, just as there are requirements for the substances that may degas. The label is used in both Denmark and Norway (<http://www.teknologisk.dk/ydelser/253>)
- The Finnish M1 system: "Emissions klassificering af byggematerialer" (Emission classification of building materials) has been established as one of the very first in the world. The scheme classifies building materials in relation to the three emission classes: M1, M2 and M3.

5 Special Nordic projects and collaboration relations

This section contains a brief listing of the Nordic collaborative relations and analyses which we have encountered in the survey. A number of Nordic projects and initiatives has been initiated under the heading “sustainable construction and low-energy buildings”, including:

- Nordic and European calls for tender (ERACOBUILD) within the theme “Sustainable Renovation”, two Nordic projects have been financed within this framework:
 - » *One Stop Shop in Sustainable renovation, Aiming to facilitate market penetration of housing renovations for family houses of high energy standard while providing comfort and sustainability to occupants* (2010-2012). <http://www.nordicinnovation.org/projects/one-stop-shop-in-sustainable-renovation>.
 - » *Sustainable construction products and materials for renovation. Developing and supporting the use of safe and sustainable construction products and materials in renovation* (2010-2012). <http://www.nordicinnovation.org/projects/sustainable-construction-products-and-materials-for-renovation/>
- *Nordic Built: Accelerate Nordic competitive concepts for a sustainable built environment.* Large Nordic initiative that will contribute to the development of competitive solutions for sustainable building based on Nordic positions of strength, tradition and expertise. The program seeks to contribute to the location of the Nordic building and construction sector. A four-year programme (2011-2014) funded by the Nordic Council of Ministers and Nordic Innovation.
- *HANDBOOK - Environmental Assessment of Construction Products - An introduction to test methods and other procedures related to CE-marking (NT TR 618).* This handbook presents an overview of the technical, regulatory and administrative framework within which CE marking of construction products takes place and offers guidance on the selection of test methods for assessment of release of regulated dangerous substances from construction products to soil, surface water and groundwater. This document is the final report for the project: “Generella riktlinjer för miljöbedömning och CE-märkning av nordiska byggprodukter i ett europeiskt sammanhang” financed by Nordic Innovation Centre. The project

was initiated in August 2006 and finalised in December 2008. The project has been carried out by VTT from Finland in cooperation with its Danish partner DHI, Swedish partners SGI and SP, Norwegian partner SINTEF and Icelandic partner EFLA

- *Nordisk myndighedsnetværk byggeri* (Nordic authority network buildings), headed by the Swedish Social Department.
- *Nordisk Analyse af klimavenlige bygninger* (Nordic analysis of climate-friendly buildings). The main objective of the project was to establish a knowledge and decision basis for a Nordic innovation program that will promote the development and demonstration of low-energy and climate-friendly buildings. Completed in 2010. Nordic innovation centre, <http://www.norden.org/da/publikationer/2010-40>
- *Increased exchange in the Building Sector*. Comparison of Building Legislation in the Northern Dimension region. A project which is also supported by the Nordic Council of Ministers and completed in 2009. http://www.norden.org/da/publikationer/publikationer/2009-506/at_download/publicationfil
- *NorthPass*. The project aims at promoting low-energy concepts in the Northern European construction sector, focusing on new homes. The goal is to define criteria for low-energy houses and concepts adapted to the Northern European countries, to find solutions to remove market barriers, to bridge the gap between demonstration and market penetration as well as support the implementation of EU strategy for low-energy buildings. There are a number of interesting reports and news on the website: <http://northpass.ivl.se>. The project is supported by Intelligent Energy Europe and runs until May 2012.
- The Nordic *Green Building Councils* have had a cooperation project including a series of conferences.
- *Harmonisation of Building Regulations in the Nordic Countries*, 2007-2008, having completed a study on harmonization of regulations for wooden buildings. http://www.ltu.se/cms_fs/1.15491!/sp%20rapport%202008_45%20harmoniser
- For the Danish Business Authority, COWI completed the analysis: *Kortlægning af strategier for lavenergibyggeri i EU lande*, (Identification of strategies for low-energy housing in the EU countries) in 2011. It compares and analyzes legislation and voluntary initiatives in low-energy buildings in 12 EU countries. http://www.ebst.dk/file/146059/energikrav_i_eu_lande.pdf
- *Nordiskt samarbetsprojekt i syfte att undanröja gränshinder inom byggområdet*. The project also aims to create an enhanced Nordic cooperation in the negotiation and implementation of EU building directive. Financed by the Nordic Council of

Ministers. 2011-2012.

- In 2010, SINTEF Byggforsk carried out an analysis: *Analyse og sammenlikning av krav til energieffektivitet i bygg i Norden og Europa*. <http://www.buildup.eu/publications/10043>
- Cooperation on *CEN / TC 166 Chimneys*, where the Nordic and Baltic countries and Poland have formed the Network "Baltic Sea cooperation".
- FLEC stands for Field and Laboratory Emission Cell, which is used for product development of indoor climate-friendly building materials. FLEC is designed to deliver reliable results, and it is also easy and quick to use. FLEC was developed by Arbejdsmiljøinstituttet (the Institute of Occupational Health), Danish Building Research Institute and Statens prøvningsanstalt in Sweden in 1991. Since then, a Nordic standard (NORDTEST-1177-94) and a European standard (ENV 13419-2) have been developed in parallel with an ISO standard (DIS 16000-10).

6 Areas relevant for Nordic coordination

The following section describes recommended areas and initiatives for green buildings, which are suitable for Nordic co-ordination. The recommendations are based on COWI's survey and interviews with Nordic experts. This is described in:

- Overview of green building (see Chapter 2)
- Overview of voluntary standards and certification schemes (see Chapter 3)
- Overview of special Nordic projects and collaborations (see Chapter 4)
- Overview of technical norms and standards in the EU and the Nordic countries (see country reports in Annex to this report)

The survey and interviews with experts have shown that there are a number of trends that are central in relation to green buildings:

- New laws and standardisation actions from the EU will have great impact on green buildings in the Nordic countries. The impacts are especially relevant in relation to initiatives concerning legislative requirements of the Construction Product Regulation (CPR)/CE marking and the voluntary standards under TC350, which sets the framework for voluntary environmental labels of both products and buildings. These actions will have a major impact on the development of voluntary as well as statutory schemes in the north.
- Labeling and standardization within the building and building products areas is very complex, since there are a huge amount of different national, international and European mandatory and voluntary schemes, which continually evolves. This makes it particularly difficult for smaller companies to keep up and it appears as a trade barrier.
- There is a strong focus on building energy / consumption and the Nordic countries and generally setting more strict requirements than the other countries in the EU. The Nordic countries have very different tradition in relation to building regulations and there are currently no indications of future harmonization.

- The voluntary schemes include an increased focus on sustainability in buildings. Voluntary schemes usually put up requirements for water and resource consumption, indoor climate and building materials. These areas are not very well integrated into the Nordic building regulations at present time.
- Energy efficiency in the existing building stock is high on the political agenda in the Nordic countries, because there is a big potential for energy savings. At present time, this is no specific regulation or direct actions in the regulation in the Nordic countries.
- There are many and strong public institutions, private organizations and companies in the Nordic countries, which have traditionally worked closely together on joint projects and activities. Since EU regulation within the building area has increased the Nordic partnerships have generally been scaled down.
- There is a strong and innovative Nordic construction industry, which has developed strongly in line with tighter regulation and more public investment in green buildings. The Nordic construction industry has been further strengthened by an increased private demand for certified green buildings.
- Legislation and implementation of building with very low energy and related markets are relatively limited in some of the Nordic countries. This is particularly true when comparing with countries like Austria, Germany and Switzerland, where various voluntary schemes and regulatory measures really have affected the industry in a positive direction. At present time, the market for buildings with very low energy consumption is still in its infancy when looking in a worldwide perspective and hence there is good potential for innovation in the field. This is confirmed in the analysis "Nordic Analysis of Climate Friendly Buildings"

Generally it is estimated, that there is a great potential for developing a stronger Nordic platform for green solutions within the building area. This can be done by further development of existing skills, which the Nordic countries already possess. The interviewed experts find that the Nordic countries already possess the products and the skills needed to develop a major export in relation to green building.

The problem at the present time is that the Nordic market is not optimal in relation to creating the framework for innovative manufacturers. The experts especially point out that it is a major problem, that the construction sector in the Nordic countries are characterized by legal, traditional and cultural differences and barriers between the countries. The interviewed experts ask for initiatives that can support the creation of a more integrated Nordic market for green solutions.

The trends and assessments above form the basis for the recommendations of the report for priority areas and actions that are suitable for Nordic co-ordination. The

recommendations are supported by input from 16 expert interviews. Recommendations for areas and associated actions are listed in an unprioritized order:

2. Demand for green building solutions. A good way to stimulate the development of new solution is to create a demand through regulation and public investments. During the past years, the Nordic countries have introduced strict requirements in the building regulations, which have initiated a development of new sustainable products and concepts with a great potential for export. Several stakeholders have emphasized the positive influence of regulation and public investments. In the following there will be drawn up some recommendation which could increase the demand for green solutions in buildings:

- Development of common or coordinated requirements for green buildings through a wider adoption of the sustainability aspect, which are poorly integrated into the Nordic building regulations. This broader sustainability aspects includes more specific demands for materials, water efficiency, efficiency demands for installation and energy producing units, indoor climate, etc. This has for instance happened in the UK, where the BREEAM system has been partly integrated into the building code. A joint Nordic efforts on sustainability issues will provide the opportunity to influence the next recast of the EBCPD.
- Development of a common concept for green public tenders, including for example the incorporation of Swan requirements. State and municipal actors are large investors when it comes to construction of new buildings or renovation of existing buildings. The issue is also high on the EC agenda, where several initiatives on Green Procurement have been launched, just as the EC already in 2008 set an indicative target that, by 2010, 50% of all public tendering procedures should be green. A possibility could be to link this cooperation to the effort in relation to the renovation of buildings / energy renovation. In Denmark there is the Partnership for green procurement, where 6 large municipalities cooperate on green procurement in particular in the area of building and plants. This experience would be perfect to share with colleagues from other Nordic municipalities.
- Improved coordination at expert/legislative level. Several experts have expressed a wish for a more continuous coordination/exchange of information of initiatives regarding building/green building regulation/legislation within the Nordic countries on the level of experts from building institutes, standardisation organisations and authorities. This could be done in a similar way to previous Nordic Committee for building regulations.

2. Indoor climate. The Nordic countries have a tradition for requiring a high level of indoor climate and there is a number of voluntary labeling schemes. All countries have implemented the main European standards, and moreover several voluntary indoor

climate labelling schemes exist across the Nordic countries. Just recently, Denmark as the first country in the world has implemented a voluntary scheme which assesses indoor climate in buildings from an overall approach, whereas all other regulations or schemes focus on partial elements of indoor climate (e.g. ventilation rates, chemical substances, etc.).

The revised building directive requires that all EU member states implement “Nearly Zero” energy demand for new buildings in 2020. This will put pressure on the need for regulation concerning indoor climate in buildings. With the long tradition for indoor climate focus and moreover the high demand for good indoor climate in the Nordic countries, it is obvious that the countries could work together by requesting strict indoor climate requirements to be a more integrated part of the EBPD in the future. Relevant areas of Nordic coordination include:

- Coordination of indoor climate labelling schemes; transfer of experience and streamlining of different voluntary schemes including the indoor climate aspects in the building directive and standards which supports it.

3. A better coordination in the elaboration of the future EU Construction Products Regulation, including the product and building declarations. On the basis of the new construction product regulation in 2013 which replaces the CPD, a number of standardisation activities have started in the EU. This is important for all countries, particularly those countries which, as Sweden and Finland, have not previously implemented the directive requiring the CE mark.

At the moment, EC is working on development of new environmental declarations on materials. EC has already released TC350, which sets the framework for voluntary product and building declarations. In addition there is TC351 standards, which deals with horizontal standardised assessment methods for harmonised approaches relating to CE marking of dangerous substances under the Construction Products Directive (CPD), which has to be implemented nationally. Moreover, the EC intends to launch an eco-label for new and existing buildings. A common Nordic voice on ambitious input to the building and product declarations with regard to LCA requirements etc. would be very strong and relevant, as the Nordic countries have many sustainable products and competences in this area.

Standardization and the new initiatives in relation to CPR is a large and very complex area for authorities and particularly for companies to navigate in. Many of the companies that produce products for the construction sector are SMEs and they experience very high costs and barriers in relation to standardization in the construction product areas. With the new voluntary environmental standards for buildings and building products under TC350 the area is getting even more complicated. Product which should be approved in

all the Nordic countries requires a lot of work, because there has to be communicated to all the approval institutions in all countries.

- The authorities should initiate a review work where it is analyzed how Nordic authorities/organization can cooperate and prepare the implementation of the new standards in relation to CPR, including the TC350 and TC351. Herunder a common harmonization of national tests and procedures for approval should be made, as this could set the framework for the development of the whole industry in the EU.

4. Water and buildings. The Nordic countries have a strong profile/industry in the area of water solutions in general, and still there has not been implemented statutory requirements for water efficiency and - recycling. At the moment the EU Commission is preparing legislation in this area. Furthermore, the market is expected to be growing very fast due to high pressure on the water resources in many countries and the market for efficient products and solutions can become an even more important export area for innovative Nordic companies.

Relevant areas include:

- Water efficiency requirements for appliances and building installations, where EU and Sweden has already started up work with methods for determination of energy efficiency of mixing valves, etc. It would be relevant to include manufacturers, standards organizations and authorities in a joint Nordic initiative, initially to present successful ideas / different actions that are initiated in the Nordic countries. The experts / representatives should then be involved in the prioritization of specific areas within which it would be appropriate to develop Nordic solutions in the form of voluntary standards or legislation. This work could also be used to influence the further development of EBPD.
- There has always been a relatively good cooperation between the Nordic countries within the plumbing field. This cooperation has been rooted in the common NKB (Nordic Committee on Building Regulations) rules which has gradually phased out. Because these rules have phased out there is a need to coordinate requirements among the various countries. It will take a huge effort to get an overview of the rules. The small and medium businesses rely on being able to buy counseling, testing and certification for the new requirements and it is currently very costly. This is necessary in order to compete on the Nordic market, where major international manufacturers are selling their products.
- Use of rainwater and grey wastewater in buildings - coordination of information regarding the potentials for use of rainwater, grey wastewater, green roofs, etc. in order to speed up implementation at the Nordic markets. There are many

opportunities for cooperation on both research and authority level. It is an area where sharing of development and research could be very beneficial.

5. Sustainable renovation of existing buildings. All the Nordic countries face an enormous challenge with regard to the quality and energy efficiency of their existing building stock, which was also stressed by several Nordic experts. This is a very wide field that can be approached in several ways. The goal is to find the right tools - political, legislative as well as technical - to relaunch energy renovation of buildings, which is a highly relevant area in all Nordic countries. Furthermore it appears that the EU Commission and the Danish presidency might not be successful in introducing enforced targets for energy renovation in relation to publicly owned buildings.

Relevant issues for coordination could be:

- › Development of certification standards/standard translation and supporting tools for green/sustainable renovation of buildings e.g. feasibility/cost estimations i.e. in relation to voluntary certifications under the Green Building Councils.
- › Development and implementation of energy/green legislative requirements for renovated buildings. This could be done by developing a regulatory framework on special loans for public housing, mandatory requirements for public authorities on energy renovations, etc.
- › Preparation of guidelines on how to deal with mould - due to great problems with mould, many Nordic countries have specialized knowledge in this area. An area which has been mentioned by several of the interviewed experts.

6. LCA and LCCA tools. Concerning sustainable materials, the development of lifecycle approaches where the impact from the materials is looked at during the whole lifetime of the materials are getting more and more important. There is a large potential for coordination of methods and concepts for LCA tool and material databases. This will also be actualised through the further development of the EU initiative under TC350. Relevant organisations in the Nordic countries have been working with LCA methodologies for a long time and have experience to offer in order to develop LCA tools of a high quality. Moreover, all Nordic building industries would benefit from LCA tools incl. databases being developed at a high quality, as it would demonstrate the high environmental performance of most Nordic building materials: low content of chemicals, high efficiency in production, use of RE in the energy supply, etc.

Similarly to LCA, the life cycle approach on cost (LCCA) is becoming more and more important also in the context of EC initiatives. The various national building regulations and the EPBD require different kinds of LCCA assessments or estimates, just as the

many certification schemes have different levels of LCCA demands. Currently, there is no common methodology. As the welfare system and economic approach in the Nordic countries are quite similar, coordination on economic sustainability (LCCA tools) could be very relevant. However, it should be mentioned that the outcome of LCCA calculations in a Nordic context would be very different within the Nordic countries, reflecting the fact that energy prices differ significantly.

- › Development of LCA databases on products and materials. because the need for access to qualified data will greatly increase due to the use of voluntary building certification schemes EPDer and the introduction of standards under the TC350. This is particularly highlighted by the Green Building Councils.
- › Further development of LCCA tools and application in the national legislation herunder following - up work on the EU Buildings Directive and volunteers sustainability standards and standards under the Working Group 4 of TC350 (CEN / TC 350 WG 4 Economic performance assessment of buildings).

7. Energy concepts for green buildings. The Nordic countries have very strong competences in the areal of district energy solutions and heat pumps where there is a strong Nordic industry in the global market. Furthermore, this area is central in regard to the phasing out of fossil fuels in Denmark, Sweden, Norway and Finland. Potential areas for cooperation could include:

- › Exchange of information on development of low-temperature district heating solutions for low energy buildings. The district heating industry is heavily dependent on finding solutions to match future requirements for low energy buildings. This is an area which is high on the agenda, particularly in Sweden, Denmark and Norway, but where research and experiences from the demonstration projects and product development is only coordinated to a limited extent. The aim is to ensure a competitive Nordic industry and maintain district heating as a major sustainable Nordic technology.
- › Coordination of data, calculation methodologies and development of schemes for high-quality solar and heat pump installations. All Nordic countries have a challenge in phasing out fossil fuels in connection with individual heating - especially in Norway and Denmark the oil burner has been on the political agenda (Energy Agreement in Denmark and The Climate Announcement of NO). It is a challenge to find alternatives and ensure that these are installed and operated effectively. Sweden has extensive experience with individual pumps and the operation of these. The Nordic cooperation within small heating technologies including testing, test, and etc. has generally has been declining. Collaboration

could establish in the regime of the authorities, GTS institutes or others. The aim is to ensure that the Nordic manufacturers and suppliers continue to deliver innovative and effective solutions to homeowners, etc., which should be challenged by the authorities in requirements for testing, efficiency, and metrics.

8. Voluntary certification schemes and tools. Even though the Nordic countries have chosen different certification schemes most of the content and objectives are the same. There is therefore a great potential for coordination and common efforts, as all Nordic countries experience that most of the certification schemes need an adaptation/transformation in order to make sense in the national context. This field of cooperation has especially been highlighted by the Green Building Councils. Moreover, a coordinated effort would facilitate the use of certification schemes among the high number of developers, consultants, etc. working across the Nordic borders. In this context, it should be mentioned that the elaborated green building markets in the countries that we usually compare with: Germany, Switzerland and Austria to a large extent have been driven by voluntary certification schemes (coupled with funding schemes).

- › General coordination on implementation of voluntary schemes and translation of criteria in a national/Nordic context.
- › Defining of requirements for social sustainability. As the Nordic countries are quite alike when it comes to climate, habits for building use and traditions, there could be a potential for common development/coordination on this area.

9. Nordic design is known for its simple and elegant expression, both in terms of applied arts and architecture. A huge challenge in the coming years is to make sustainable buildings “sustainable” in their appearance - they must fit into the landscape and the existing architecture. This challenge is in many ways overlooked when the focus is mainly on compliance with regulations. A Nordic initiative that focuses on this problem could contribute to develop a Nordic platform for green building design. One area of focus in this context could be Nordic materials like wood (including to the great expertise in humidity also be used). Experts recommend that different groups of designers, architects, artists and engineers are brought together to develop the next generation of green building.

7 APPENDICES. Overview of technical codes and standards in the EU and the Nordic countries

7.1 Introduction

In recent years, the EU has published many reports, adopted directives and regulations to achieve greener and more sustainable construction which to a high extent set the framework for what the Nordic countries implement nationally. Consequently, the following overview starts with a description of the legislation and the main technical standards in EU in light of the four main areas of this mapping: energy consumption, water and resource consumption, indoor climate and building materials. Then, the Nordic countries are outlined in similar fashion.

7.2 EU

In 2008, the EU chose the construction sector as one of six market areas that are most important to ensure a better and faster development towards a more sustainable future³. The arguments behind this prioritisation included, among other things:

- The seven billion living on the earth must be given sustainable housing in order to significantly develop sustainable world societies. By 2050, there will be nine billion people in the world.
- Between 10 to 15 per cent of the EU population is directly or indirectly employed by or depend on the construction sector.
- Around 20 per cent (in tonnes) of Europe's industrial production is building materials.
- Homes and other buildings account for around 40 per cent of Europe's energy consumption.

3 Source: Industrial innovation - A Lead Market Initiative For Europe

- 30 per cent of the waste produced in the EU comes from the construction and housing sectors.
- 20 per cent of the water consumed in the EU is related to the construction and housing sectors.

Source: Industrial innovation - A Lead Market Initiative For Europe

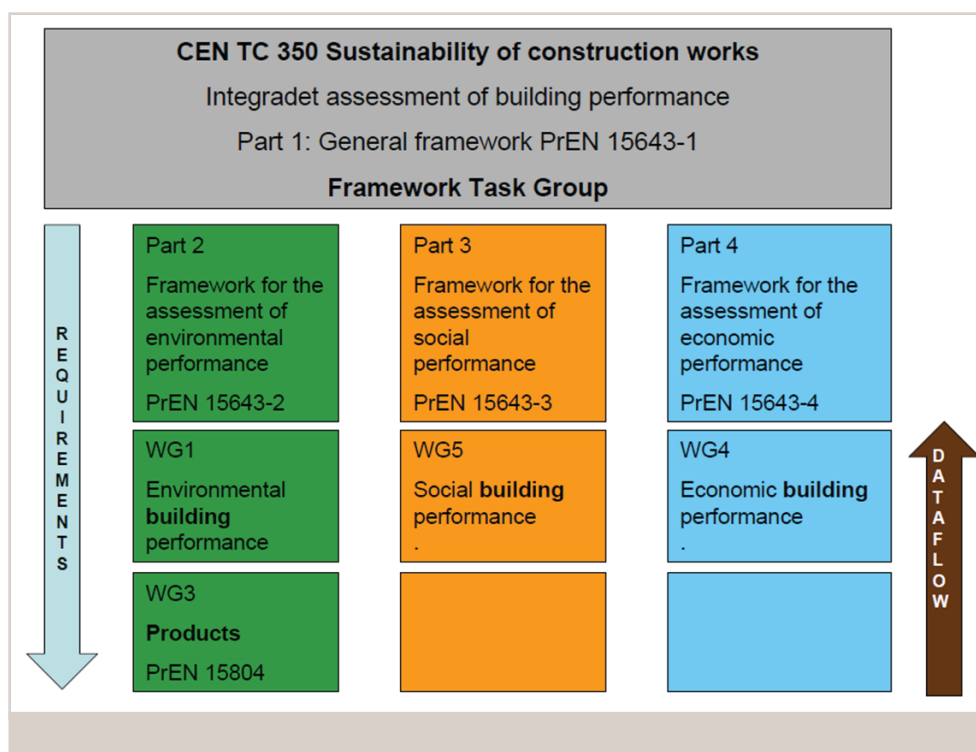
7.2.1 Sustainability and buildings

The EU has really launched initiatives that point towards a regulation of buildings and products for construction in relation to the concept of sustainability. Several mainly voluntary/non-binding initiatives are on the way:

- *Eco labelling in sustainable construction.* In 2007, it was decided to develop a voluntary eco-label (the flower) for new and existing buildings.
- COM (2008) 400 - *Public Procurement For A Better Environment*⁴. EU communication that puts green public procurement (GPP) on the agenda. A preliminary list of criteria has been established within the framework of Training Toolkit on green public procurement. The criteria were developed for products and service groups within ten sectors.
- *Construction Building Regulation* (No 305/2011 (CPR)), where sustainability is now integrated as a requirement for the 2013 implementation.
- *CEN/TC350 - Sustainability of Construction Works* was launched in 2005 to create methods for voluntary declaration of environmental information that supports the construction of sustainable structures, including new and existing buildings. This framework contains four overall segments:
 - » Part 1: Overall
 - » Part 2: Environment, including environmental product declaration - EPD, **EN 15804** and environmental building performance - EBP, **EN 15978**
 - » Part 3: Social (**prEN16309, on the way - to be published**)
 - » Part 4: Economy (**to be published**)

The standards from CEN/TC 350 will be an important basis for developing future product standards where a sustainability assessment of buildings and building materials is to be carried out. Below is an overview of TC350:

⁴ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0400:FIN:EN:PDF>



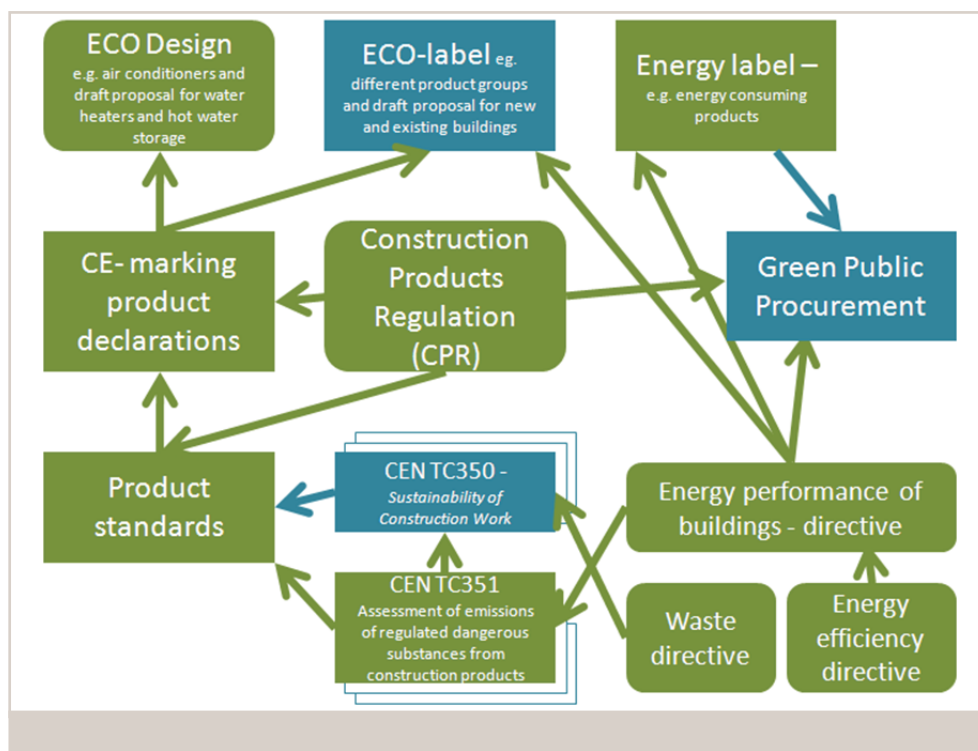
The technical committees carrying out the CEN TC 350 activities were set up in 2005 and are currently divided into six task groups:

- CEN/TC 350/ : TG Framework
- CEN/TC/WG1: Environmental performance of buildings
- CEN/TC WG2: Building life cycle description
- CEN/TC WG3: Product Level (EPDs), communication formats etc.
- CEN/TC WG4: Economic performance assessment of buildings
- CEN/TC WG5: Social performance assessment of buildings.

The activities will be carried out pursuant to ISO standards ISO/TC59/SC17 (Building Construction - Sustainability in Building Construction).

A lot of EU initiatives in labelling, standards etc. concern construction and it is difficult to grasp it all, especially the many activities in standardisation. The below figure illustrates the overall links:

Figure 7.1 Network of EU policies related to green buildings (inspired by Prof. Antonio Scipioni, 2011). - green boxes represent mandatory regulation, while blue boxes covers more areas where there are no binding obligations for the timing being.



7.2.2 Energy consumption

In May 2010, the EU passed a revised **building directive** (EPBD) (2010/31/EU) as framework legislation for both new and existing buildings based on the original principles of the 2002 building directive, the objective being to come up with as yet untapped potential for saving in the building sector.

The main elements of EPBD are:

- A common general framework for a methodology to calculate the integrated performance of buildings
- Minimum energy demand for new buildings and building units
- Minimum energy demand for buildings undergoing major renovations
- Minimum energy demand for all building elements and technical building systems when installed, retrofitted or replaced
- Energy labelling of buildings

- National plans for nearly zero-energy buildings
- Independent oversight systems for energy performance certificates and reports.

Some of the initiatives caused by the building directive are mentioned below:

- CEN continuously works to harmonize calculations methods for EPBD. The result is a number of standards which comprise harmonized methods for calculating buildings' energy performance as well as energy-related standards for cooling, ventilation, heating, electricity etc. Member states are free to adapt these European standards to national standards.
- Finally, in connection with EBCD guidelines were issued to accompany Commission delegated regulation (EU) no. 244/2012 of 16 January 2012 supplementing directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:081:0018:0036:EN:PDF>

Futhermore, a directive on energy end-use efficiency and energy services exists (2006/32/EF), and is currently being renegotiated. Among other things, the directive sets the overall framework for how member countries work with building energy efficiency, including ambitions for national EPBD implementation. It is commonly expected that the current version of the directive will no longer be able to ensure that the EU's 20-20-20 target will be met, which is why it is currently being revised. The trilogue negotiation between the Council of the European Union, the European Commission and the European Parliament on a revised version has been underway since 11 April. The current plan is to reach agreement by 1 July, when the Danish EU-presidency ends. General information on EU legislation on building energy efficiency: http://ec.europa.eu/energy/efficiency/buildings/legislation_en.html

Below are presented the most relevant EU initiatives in terms of buildings' energy consumption:

Table 7.1 Overview of relevant EU initiatives relevant to buildings' energy consumption.

Measure	Description	Status
Directive (2010/31/EU) on the energy performance of buildings	Under this directive, Member States must establish and apply minimum energy performance requirements for new and existing buildings, ensure the certification of building energy performance and require the regular inspection of boilers and air conditioning systems in buildings. Moreover, the directive requires Member States to ensure that by 2021 all new buildings are so-called 'nearly zero-energy buildings'.	Directive
EPBD - CEN standards	Standards that support the national translation of requirements in the EPBD/buildings directive. http://www.cen.eu/cen/Sectors/Sectors/Construction/SustainableConstruction/Pages/EPBD.aspx	Voluntary standards
Directive (2006/32/EC) on the energy end-use efficiency and energy services	The directive requires Member States to improve energy efficiency at the end use and exploit potential cost savings in an economically sustainable way. Member States shall determine the energy savings target of 9% to be achieved in nine years, and report on their progress in national action plans for energy efficiency. Furthermore, they must promote a market for energy services and implement energy efficiency measures on end-users.	Directive under renegotiations
Directive (2010/30/EU) on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products	Energy labeling and disclosure requirements for a range of energy-using product groups, including a number of relevant devices used in buildings. The directive is implemented in the EU countries' legislation by law and a series of announcements for the various product groups.	Directive
Directive (2009/125/EC) on establishing a framework for the setting of ecodesign requirements for energy-related products	The directive is a framework that sets requirements for energy related products. It aims to improve the environmental performance of products throughout their life-cycle by integrating environmental aspects at a very early stage in the product design.	Directive

7.2.3 Water and resource consumption

There is very little EU-level regulation of water consumption in buildings. The EU water framework directive requires member countries to introduce incentives for efficient use of water, but the directive does not stipulate standards for consumer goods as well as their water efficiency. Various analyses and studies treat this area and it is expected that the EU will implement regulation at some point.

The EU Commission is undertaking several initiatives and studies aiming to prepare and recommend water efficiency initiatives. An example is "*Water Performance of Buildings - Background paper - stakeholder consultation*" from November 2011 (http://ec.europa.eu/environment/consultations/pdf/background_water_efficiency.pdf)

For more information, go to

http://ec.europa.eu/environment/water/quantity/water_efficiency.htm

Table 7.2 Overview of relevant EU initiatives relevant to buildings' water consumption.

Measure	Description	Status
Directive (2000/60/EC) on establishing a framework for Community action in the field of water policy	<p>Member States must identify and analyse European waters, on the basis of individual river basin and district. They shall then adopt management plans and programmes of measures adapted to each body of water.</p> <p>This Framework has a number of objectives, such as preventing and reducing pollution, promoting sustainable water usage, environmental protection, improving aquatic ecosystems and mitigating the effects of floods and droughts.</p> <p>Its ultimate objective is to achieve "good ecological and chemical status" for all Community waters by 2015.</p>	Directive
Water efficiency in buildings - policy consultation	Research on potential area of politics.	Preparing work
CEN/TC 351- Construction Products -Assessment of Release of Dangerous Substances	<p>CEN/TC 351 includes two overall areas:</p> <ol style="list-style-type: none"> 1. Generic horizontal dynamic surface leaching test (DSLTL) for determination of surface dependent release of substances from monolithic or plate-like or sheet-like construction products 2. Generic horizontal up-flow percolation test for determination of the release of substances from granular construction products <p>The TC work has been followed up by a number of standards; http://www.cen.eu/CEN/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/WP.aspx?param=510793&title=CEN%2F TC+351</p>	Standard under development related to the implementation of the CPR - The Construction Products Regulation

7.2.4 Indoor climate

Based on the building directive, CEN has been authorised to develop a set of standards. Standard EN 15251 specifies indoor climate factors, input parameters for design and assessment of building energy performance, and it touches upon indoor air quality, thermal environment, lighting and acoustics. EN 13779 sets standards for the design and installation of ventilation and air conditioning in non-residential buildings.

Measure	Description	Status
CEN/TC 351	CEN/TC 351 includes two overall areas: <ol style="list-style-type: none"> 1. Generic horizontal dynamic surface leaching test (DSLTL) for determination of surface dependent release of substances from monolithic or plate-like or sheet-like construction products 2. Generic horizontal up-flow percolation test for determination of the release of substances from granular construction products 	Standard under development related to the implementation of the CPR - The Construction Products Regulation
ISO/EN 7730	Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria.	Standard
Standard EN 15251: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics	Criteria for the indoor environment including thermal, indoor air quality, light and noise includes minimum ventilation rates, lighting levels, minimum and maximum temperature, lighting and acoustics etc. to be used as input or default value for the energy calculations in connection with national implementation of the Energy Performance of Buildings Directive.	Standard
DS/EN ISO 16000	Indoor air - Part 10: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test cell method	Standard
CEN/CR 1752 "Ventilation for Buildings: Design Criteria for the Indoor Environment" [CR1752-1998].	This standard specifies the requirements for, and methods of expressing the quality of the indoor environment for the design, commissioning, operation and control of ventilation and air-conditioning systems. The standard covers indoor environments where the major concern is the human occupation, but excludes dwelling. The standard does not cover buildings where industrial processes or similar operations requiring special conditions are undertaken. The practical procedures, including selection of parameters to be measured during commissioning, control and operation, are not covered.	Standard

7.2.5 Building materials

The future EU standards for sustainable building materials are primarily derived from the construction product regulation (Construction Products Regulation (305/2011/ EU - CPR) is supported by the standardisation work os CEN/TC350 - *Sustainability of construction works* and CEN/TC351 Construction Products -Assessment of Release of Dangerous Substances, which will contain voluntary, horizontal standards for sustainability aspects of major renovations of existing buildings as well as new building. The regulation divides sustainable construction materials into two levels that take their

starting point in the life-cycle process: product level and building level. The construction product regulation has already taken effect, so we are now in a transition period between the construction product directive (Direktive 89/106/EC of 21. December 1988) and the construction product regulation. However, the main elements of the construction product regulation do not take effect until 1 July 2013.

One of the new features of the new construction product regulation is the fact that sustainability now is the seventh basic requirements. The six other requirements transferred from the construction product directive are:

- Mechanical resistance and stability
- Safety in case of fire
- Hygiene, health and the environment
- Safety in use
- Protection against noise
- Energy economy and heat retention.

From a long-term perspective, the standards from CEN/TC 350 will be an important basis for the development of the future, obligatory product standards for environmental declarations (EPD) of contents which covers a life-cycle assessment of the construction product. Joint efforts are being made to develop standards for LCA and LCCA methods applicable in this context.

For more information on EU legislation on building materials, go to:

- http://ec.europa.eu/enterprise/sectors/construction/legislation/index_en.htm
- EU criteria for construction materials: http://ec.europa.eu/environment/gpp/pdf/toolkit/construction_GPP_product_sheet.pdf
- EU's green guideline on procurement of sustainable materials for buildings: http://ec.europa.eu/environment/gpp/pdf/toolkit/construction_GPP_background_report.pdf
- The homepage of the Danish Energy Agency: <http://www.byggevaereinfo.dk/standarder>

Below table contains an overview of the most important legal initiatives as regards building materials.

Measure	Description	Status
Directive (89/106/EC) on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products	The existing directive regarding construction products, also known as CDP 89/106/EEC will be repealed by Directive (305/2011/EC) on laying down harmonised conditions for the marketing of construction products (CPR) on 1 July 2013.	Directive
Regulation (305/2011/EC) on laying down harmonised conditions for the marketing of construction products (CPR).	As part of the Better Regulation initiative, the CPR provides more clarification of the concepts and the use of CE marking; introduces simplified procedures, which will reduce the costs incurred by enterprises, in particular small and medium enterprises (SMEs). Construction Products Regulation (the CPR) is to ensure reliable information on construction products in relation to their performances. This is achieved by providing a “common technical language”, offering uniform assessment methods of the performance of construction products. These methods have been compiled in harmonised European standards (hEN) and European Assessment Documents (EAD)	Regulation
CEN/TC350 - Sustainability of construction works	CEN/TC 350 is responsible for the development of voluntary horizontal standardized methods for the assessment of the sustainability aspects of new and existing construction works and for standards for the environmental product declaration of construction products. The standards will be generally applicable (horizontal) and relevant for the assessment of integrated performance of buildings over its life cycle. The standards will describe a harmonized methodology for assessment of environmental performance of buildings and life cycle cost performance of buildings as well as the quantifiable performance aspects of health and comfort of buildings.	Future requirements - regulation with relevance to all CE labelled products
Directive (98/8/EC) concerning the placing of biocidal products on the market	The Biocidal Product Directive aims to harmonise the European market for biocidal products and their active substances. At the same time it aims to provide a high level of protection for humans, animals and the environment.	Directive
Directive (2008/98/EC) on waste	The new Framework Directive requires more stringent waste reduction and waste prevention efforts. Member States must ensure that waste is recovered or disposed of without endangering human health and the environment and that the waste amount disposed of is reduced to a minimum by kind of measures and effective tools to minimise waste generation. Further principles of the revised Directive are re-use, recycling and recovery, which shall be promoted and adopted whenever suitable in order to save resources and to reduce the amount of waste.	Directive

Measure	Description	Status
Regulation (1907/2006/EC) concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)	<p>REACH is the Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals. It entered into force on 1st June 2007. It streamlines and improves the former legislative framework on chemicals of the European Union (EU).</p> <p>The main aims of REACH are to ensure a high level of protection of human health and the environment from the risks that can be posed by chemicals, the promotion of alternative test methods, the free circulation of substances on the internal market and enhancing competitiveness and innovation.</p>	Regulation
Directive (2004/42/EC) on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products.	Regulates the contents of harmful additives in paint etc. (A part of REACH)	Directive
Green Public procurement product scope	Toolkit	Voluntary initiative

7.3 Denmark

7.3.1 Introduction

For a long time, Denmark has focused on low-energy building. To exemplify this, for years the Danish building regulations have stipulated requirements for low-energy buildings. The first official low-energy house requirement was introduced already in 1985. This was one of the reasons why Denmark really got started on low-energy construction projects in the 80s. Today, stricter requirements for energy consumption exist, focusing especially on indoor climate.

There are different Danish initiatives regarding voluntary certification schemes for indoor climate, products, sustainable building and low-energy classes/passive house standards. For instance:

- Danish Building Regulations: Low-energy classes 2015 and 2020 are official parts of the building regulations and are specified in the following section.
- The swan label for houses.
- Danish indoor climate labelling included requirements for products in the usage

phase and provides documentation of release of chemical substances into the air. In other words, focus is on the product's impact on the indoor climate.

- Environmental description of contents, which states a product's environmental properties in words and figures. Brief and verified environmental information. Such declaration is LCA-based as it builds on international standards.
- Passive house.
- Cradle to Cradle
- LEED
- BREEAM
- DGNB-DK. Denmark concentrates on the German DGNB scheme. The reason for this is that, in the Danish authorities' opinion, DGNB best weighs all dimensions (environmental, social and economic sustainability) and integrates the EU standardization initiatives carried out in relation to CEN TC350.

7.3.2 Legislation and initiatives

Energy consumption and energy efficiency

Denmark has introduced official low-energy classes directly in the building regulations: low-energy building classes 2015 and 2020. The plan is to make these classes minimum requirements by, respectively, 2015 and 2020. The Danish building regulations are relatively ambitious when it comes to energy consumption. The current framework for homes is 52.5 kWh/m² per year, plus 1650 kWh per year.

Low-energy building class 2015 sets even stricter requirements to reduce energy consumption for heating, hot water, cooling, ventilation and lighting. The requirement for low-energy building class 2015 is 41 kWh/m² per year, plus 1000/A kWh per year, whereas the voluntary low-energy class 2020 framework is 20 kWh/m² per year.

Among other things, low-energy classes 2015 and 2020 features stricter requirements for U value/heat insulation of building elements to achieve a building envelope that is as tight and well-insulated as possible. Furthermore, they include requirements for installations and ventilation systems to ensure optimum functioning. In summary, low-energy building classes 2015/2020 include requirements for the following:

- Building envelope: insulation, heat capacity, passive heating, thermal bridges
- Building design, orientation and location (including outdoor climate)

- Passive solar energy and solar screening
- Heating system including hot-water system
- Air conditioning
- Ventilation (natural or mechanical)
- Installations
- Indoor climate
- Internal loads.

A number of additional factors may be included such as local production of heat and power as well as district heating, which are considered positively in the calculation method regarding sustainable energy and district heating.

The input described is gathered in a calculation method (Be10), which is based on the Danish calculation core defined in SBI-instruction 213 by the Danish Building Research Institute.

U value minimum requirements, cf. the 2010 building regulations: U value minimum requirements, cf. the 2010 building regulations:

Outerwalls (W/m ² K)	Roofs (W/m ² K)	Floor (W/m ² K)	Windows (W/m ² K)	Average of building envelope (W/m ² K)
0.3	0.3	0.2	1.8 (moreover the energy balance for the whole window must be at least -33 kWh/m ²)	5 W/m ² (please note the unit - temperature difference is included)

It should be noted that the required U-values in itself is not enough to reach the energy frame. The requirements for building envelope included in the low-energy building class 2015 contain requirements for both U values and tightness:

National classifications	U-value walls (W/m ² K)	U-value roof (W/m ² K)	U-value floor (W/m ² K)	U-value window (W/m ² K)	Tightness requirement
Low energy class 2015	0.3	0.2	0.2	1.8	≤1.0 l/sm ² (gross area)

Relevant standards in relation to 2010 building regulations (BR10) (implementation of EBPD):

- DS 469 Heating systems with water as the heating medium - Conditions for the dimensioning and energy performance
- DS 447 Code of Practice for mechanical ventilation installations.

Indoor climate

In Denmark, there are different codes and standards for indoor climate, some of the most important being DS474, DS/CR/CEN 1752, DS/EN 15251, DS 418 and SBI instruction 196. The standards feature the different indoor climate classes A, B and C, which are defined by means of design criteria. Indoor climate class A represents a high level of indoor climate, class B is medium level, and class C represents a moderate level of expectations.

Below are the requirements mapped, cf. 2010 building regulations, for ventilation and other indoor climate requirements.

Requirements for ventilation	Specific indoor climate requirements
Minimum 0.3 l/s pr. m ² Kitchen: 20 l/s Bathroom incl. toilet: 15 l/s Toilet: 10 l/s If the requirement for exhaustion results in an air change rate above 0.3 l/sm ² , demand controlled ventilation can be used. In general the requirement of 0.3 l/sm ² must be complied with.	Overheating included the calculation method i.e. calculated cooling demand is included as a part of the calculated energy demand

National classifications	Specific requirements or other characteristics etc.
Low energy class 2015	More stringent demands to the transmission loss of the building envelope (5 W/m ² compared to 6 W/m ²) than the minimum requirements in the building regulations More stringent demands to the air tightness (1.0 l/sm ² compared to 1.5 l/sm ²) than the minimum requirements in the building regulations

Requirements to renewable energy supply

In new building constructions or in renovated buildings outside areas with district heating, where the expected domestic hot water consumption will exceed 2000 litre per day, a solar heat plant must be established which is able to comply with an energy demand corresponding to a hot water consumption under normal conditions.

Inclusion of common renewable energy supply outside areas with district heating for low energy buildings.

As the first country in the world, Denmark has introduced a voluntary indoor climate standard, by which buildings can be rated on a scale from A++ to C. The standard was published in 2011 and developed based on Danish law, the building regulation, European CEN standards and international ISO standards. The indoor climate standard measures and assesses using nine parameters: Ventilation rate

- CO₂
- Thermal conditions
- Radon
- Formaldehyde
- Particles
- Humidity and mould
- Daylight and artificial lighting
- Acoustics.

Unlike other initiatives in indoor climate, this standard applies to the entire building and indoor climate as one overall parameter, whereas other existing initiatives in indoor climate - legislation, standards, voluntary labelling schemes - are based on individual components (materials etc.) or conditions (ventilation, humidity etc.).

Materials

Denmark has guidelines for low-polluting materials. DS/CEN/CR 1751 Annex G offers the following guidelines for, respectively, categories M1, M2 and M3. Furthermore, there is the environmental description of contents (MVD-DK scheme). MVD-DK features requirements for declaration, including LCA calculations that follow the ISO 14040 and ISO 14044 standards.

The sustainability schemes BREEAM, Cradle to Cradle and DGNB Denmark also contain requirements for materials in relation to building certification. In addition, the Danish

Working Environment Authority and the Danish Building Research Institute (SBI) have prepared guidelines on low-polluting materials.

Within the Danish Building Research Institute, a number of tools have been developed for life-cycle assessments of materials. Years ago, SBI was one of the leaders in LCA and developed the BEAT model, which is, however, considered outdated today. In connection with the new certification schemes (DGNB), SBI had developed a simpler LCA spreadsheet that can be used for preparing environmental assessments of materials. The tool is still being developed.

Denmark closely follows the standardisation activities under CEN-TC350. An overview of standards for products and materials can be seen on the homepage of the Danish Energy Agency: <http://www.byggevaereinfo.dk/standarder>

In general, Danish construction product manufacturers are cautious when it comes to having their products LCA assessed, but it is expected that the new CEN-TC350 initiatives will spark a trend.

Water resources

Denmark has a number of recommendations and legal requirements for water-consuming installations in the 2010 building regulations, but no requirement for the total water consumption. Furthermore, guidelines exist for, e.g., grey water⁵ and rainwater⁶. Danish municipalities are obligated to preparing climate adaptation plans.

The mandatory approval of water and drain systems (VA approval) covers products included in drinking water systems and stipulates that water and drain systems must be designed to offer satisfactory reliability in terms of fire protection, safety, function and hygiene (DS 432, Code of Practice for Sanitary Drainage - Wastewater Installations, DS 439, Code of Practice for domestic water supply installations) (read more at <http://www.etadanmark.dk/danish/va/frameset.htm>).

At first glance, Denmark - like the other Nordic countries - has relatively good and high-quality water resources via the groundwater. However, efforts are made to reduce water consumption due to diminishing and more polluted groundwater resources.

7.3.3 National players

A number of interesting players are involved in green building, including:

- The Danish Construction Association

⁵ Danish Environmental Protection Agency: <http://www.statensnet.dk/pligtarkiv/fremvis.pl?vaerkid=14440&repid=0&filid=20&iarkiv=1>

⁶ Sustainable drainage systems: <http://www.ciria.com/suds/>

- Bygningstilsynet
- The Danish Energy Agency
- Danish Building Research Institute
- Technical university of Denmark
- Aalborg University
- Danish Technological institute
- Dansk ventilation
- Confederation of Danish Industries
- The Danish Architects Association
- Danske Ark, Danish association of architectural firms
- Danish Association of Consulting Engineers (FRI)
- Green Building Council
- InnoBYG
- The Danish Energy Saving Trust (Go' Energi)
- Vugge til Vugge
- Realdania.
- Danish Standard

7.3.4 Selected projects

A number of exciting projects have been carried out in Denmark:

- Green Lighthouse: Denmark's first public CO₂ neutral building. It has achieved LEED Gold certification and is being DGNB certified. The office building was constructed as low-energy class 1, cf. the 2008 building regulations. The following sustainability initiatives were implemented in the building: high-insulating building component with high tightness, PCM walls, thermo active structural floors, natural ventilation, solar cells, solar panels and LED lighting.
- Warehouse on Langelinie: New 14,000 m² office building to be constructed as low-energy building 2015. It will feature natural ventilation, thermo active structural

floors and optimised daylight conditions to reduce energy consumption. To be built. (<http://www.dk-gbc.dk/profilbyggeri/det-klimavenlige-pakhus.aspx>)

- Widex building in Allerød: New Widex headquarters in Allerød is to house 600 employees. Renewable energy is combined with maximum energy recovery. Technologies in groundwater cooling and heating systems are applied. Solar cells are included and rainwater from the roof is reused for flushing toilets.
- Company House is a 6,000 m² office building in Aarhus that has achieved DGNB certificate.
- In Køge, a complex was built, consisting of swan labelled buildings, and quite a few standard houses have achieved the swan label. <http://www.fp.fremtidensparcelhuse.dk/>

7.3.5 Market perspectives

The Danish market

In general, building elements for energy-efficient buildings are available on the Danish market. For instance, you can acquire a number of different insulation materials and products based on natural raw materials or recycled products. There is a large range of energy-efficient components for installations, pumps, energy-supply, windows etc.

The general interest to invest in energy-efficiency remains low, nevertheless, albeit on the rise, supported by the strict energy requirements in Danish law. For instance, homeowners' and companies' interest in especially solar cells, heat pumps, insulation etc. is growing.

Municipalities have really discovered energy renovation - and ESCO (energy service company). This is possible because municipalities are able to borrow money for energy savings proposed in the energy label. Therefore, the municipalities' energy renovations do not affect their general budget - and jobs for local builders are created.

Generally, most attention is paid to energy consumption and relatively little to sustainability as an overall concept. However, in recent years, voluntary certification schemes have taken off, even though only few buildings have been certified. The Danish authorities are working on translating and implementing the German DGNB scheme - both for construction and urban areas.

The Danish Knowledge Centre for Energy Savings in Buildings was established to disseminate interdisciplinary knowledge on energy-saving measured. Furthermore, several regulations have been established to promote energy efficiency in buildings, and network and distribution companies within electricity, natural gas, district heating and oil must deliver a significant part of the fixed total energy savings. The Danish strengths

are considered to be:

- Focus on low consumption of primary energy
- Environmentally friendly district heating and supply solutions
- Great joint wastewater treatment as well as a tradition of efficient water installations
- A high degree of recycling of construction waste
- Great dialogue on local planning
- Voluntary indoor climate schemes and high-quality indoor climate
- Focus on thermal, acoustic and visual quality
- Experience with DGNB
- Great dialogue in the construction process.

Denmark has a vast building industry and is known across the world for its architecture. In 2011, the construction product industry exported for a total of DKK 41.5 billion, amounting to almost seven per cent of the total Danish export of DKK 604.6 billion. Around half of Denmark's construction product export traditionally goes to the neighbouring markets of Germany, Great Britain, Sweden, Norway and Finland.

Export

Last but not least, Danish architects, consulting engineers and contractors have in recent years become important players on the international markets, and after a small setback in 2009 the sector as a whole once again experienced growth in the international turnover of 1.5 per cent and a turnover of around DKK 16.6 billion in 2010. Currently, trends mostly benefits consulting engineers and architects, who have seen a growth in international turnover of 15 and 12 per cent, respectively. Contractors, however, have seen a decline of 11 per cent compared to 2009. For the total sector, international activities make up 41 per cent of the total turnover in 2010, which is the highest percentage ever.

7.3.6 Sources

Interviews with;

- Green Building Council; Senior Researcher Harpa Birgisdottir, 8 May 2012
- COWI, Senior Consultant Linda Højby, 3 May 2012

- The Danish Energy Agency, Principal Marie Kring, 8 May 2012
- Danish Standards, Head of Department John Adelhøj, 16 May 2012
- Per Thomas Dahl, Industry Sector Executive at Danish Construction Association, 15 May 2012.
- Dansk Standard, Projekt manager Erling Trudsø, 23 maj 2012

7.4 Finland

7.4.1 Intro

In 2010 the Finnish Minister of Housing defined the ERA17 action plan⁷. The objective of the ERA17 was that Finland should achieve its emission-reduction goal for the built environment already in 2017, before its deadline (the EU deadline is in 2020). The outcome of the ERA17 was 31 proposed actions concerning energy-efficient land use, decentralised energy production, construction guidance, building use and ownership, and competence development. Since the definition was made in 2010 the process has been rather slow. Different organizations have been trying to speed up the process, and at the moment there seems to be a huge progress in green building area - and the general level in the area is expected to be very high in the next couple years.

In contrast to other Nordic countries, Finland is regulating the energy performance in building by minimum requirements on components only (e.g. u-values), and there is no calculation of primary energy consumption or CO₂-emission. The renewed building code, which came into effect in 2010, requires new buildings to be more energy efficient in terms of U-values. At the moment Finland is working on making the building certification scheme much more ambitions (for a building with an “A” label the requirement for the heating demand must be half the level it is today).

7.4.2 Initiatives and voluntary certification schemes

Since January 2010, the chapters C3, D2 and D3 of the Finnish building regulation have been renewed. Low-energy buildings are mentioned, but not specifically defined by limit values, only by a recommended guideline value for maximum heat loss (Regulation D3, 2010)⁸. Because the only criterion is a guideline value, the Finnish Association of Civil Engineers, RIL has developed a regulation for low-energy and passive houses, the guidebook RIL 249-2009⁹. In the regulation, RIL has defined low-energy buildings, classified into different type. Parallel to low-energy buildings, passive houses are defined

⁷ http://era17.fi/en/files/2010/11/ERA17_brochure.pdf

⁸ Ministry of Environment, The National Building Code of Finland: <http://www.ymparisto.fi/default.asp?contentid=271665&lan=FI&clan=en>

⁹ RIL 249-2009, [only in Finnish], http://www.ril.fi/web/shop_files/249_alkusivut_taittovedos.pdf

in the RIL 249-2009 subdivided into different classes: relating to their annual delivered energy.

Table 7.1 Requirements for passive houses in Finland (VTT)¹⁰

Zone	Heating and cooling demand kWh/m ² /year	Primary energy demand kWh/m ² /year	Air tightness n ₅₀
South Finland	20	< 130	< 0.6
Middle Finland	25	< 135	< 0.6
Lapland	30	< 140	< 0.6

Finland has a voluntary emission classification of building materials called M1. The aim of the classification is to enhance the development and use of low-emitting building materials¹¹.

A “Rating tools group” in the Finnish GBC has discussed the use of different certification scheme (LEED, BREEAM, DGNB etc) in Finland - however they are decided to use the new Finnish scheme with 5 key indicators. . The Finnish GBC is working on a scheme containing five key indicators for green buildings. The calculations in this scheme will be based on CE350, LCA and ambitious projects in the EU. So far the indicators are: indoor climate, LCA and energy consumption (in energy certificate). The scheme is expected to be ready in 2013.

There are some buildings in Finland with LEED and BREEAM certifications

7.4.3 Legislation and regulations - sustainable buildings

Energy consumption and efficiency

In Finland the minimum requirements is set in the National Building Code for thermal insulation and ventilation of new buildings since 1976. The requirements have been changed several times in order to improve energy efficiency in buildings, see Table 7.2. The latest changes were made in 2010, when the level of the requirements was tightened by 25-50%.

Finland has not yet defined how they intent to interpretate the EU demand on “nearly zero” consumption in 2020 yet.

¹⁰ NorthPass – Promotion of the Very low-energy house Concept to the North European Building Market; <http://northpass.vtt.fi/>

¹¹ <http://www.rakennustieto.fi/index/english/emissionclassificationofbuildingmaterials.html>

Table 7.2 Minimum requirements of building components in Finland

Reference value for maximum heat loss	1976	1978	1985	2003	2007	2010
Wall, U-value	0.4	0.29	0.28	0.25	0.24	0.17
Ceiling, U-value	0.35	0.23	0.22	0.16	0.15	0.09
Floor, U-value	0.4	0.4	0.36	0.25	0.24	0.16
Window, U-value	2.1	2.1	2.1	1.4	1.4	1.0
Door, U-value	0.7	0.7	0.7	1.4	1.4	1.0
Air tightness, n50	6	6	6	4	4	2
Efficiency of the heat recovery (yearly) from the exhaust air	0	0	0	30 %	30 %	45 %

The existing building regulations are given in the National Building Code of Finland under the Land Use and Building Act administrated by the Ministry of the Environment. The building regulations deal with the calculation methodology and the minimum energy performance requirements and consist of following decrees:

- Thermal insulation in a building (C3), Regulations 2008 (Amended in 2010)¹².
- Energy performance of buildings (D3), Regulations and guidelines 2008 (Amended in 2010)¹³. Finland has developed calculations methods for calculating heating and electricity consumption during a year (but this is only guidelines).
- Calculation of energy consumption and heating power demand of buildings (D5), Guidelines 2007¹⁴.

Through the implementation of EPBD it has been mandatory to present an energy certificate (label A-F) when applying for a building permit for all new buildings from 2008. From 1st January 2009 it has also been mandatory to have an energy performance certificate in other buildings, when rented or sold.

In 2012 the demands for an "A" label building will be strengthen by nearly 100% and in public buildings the label should be visible to the public.

In 2011 new Government buildings shall be have a high energy-efficiency standard (rated A and renovated buildings rated C according to the energy-labelling scheme)¹⁵.

¹² C3 Byggnaders värmeisolering, Finlands Byggbestämmelsesamling, 2010 http://www.finlex.fi/data/normit/34163-C3_2010_svenska_221208.pdf

¹³ D3 Byggnaders energiprestanda, Finlands Byggbestämmelsesamling, 2010, http://www.finlex.fi/data/normit/34165-D3-2010_ruotsi_22-12-2008.pdf

¹⁴ D5 Beräkning av byggnaders energiförbrukning och uppvärmningseffekt, Finlands Byggbestämmelsesamling, 2010, <http://www.finlex.fi/data/normit/29520-D5-190607FINAL-svenska.pdf>

¹⁵ Mail correspondence with Seppo Silvonen, Motiva.

The foreseen changes in building requirements in the coming years are¹⁶:

- 2012–2014: Requirements for refurbishment.
- 2015: All public buildings should fulfil the requirements for very low-energy houses corresponding roughly to the definition of a Finnish passive house.

The building code changes should also be followed by other legislative actions, e.g. feed in tariffs for distributed renewable energy production.

Indoor climate

The indoor climate in Finland is regulated according to; *Indoor climate and ventilation of buildings (D2), ventilation of buildings regulations and guidelines 2008 (Amended in 2010)*¹⁷. These are based on the EU legislation prEN 15217 <http://www.ymparisto.fi/download.asp?contentid=33667&lan=en>

Table 7.3 Overview of requirements of the indoor climate

Area	Requirements
Ventilation	<p>Instruments for measuring the most important functions of the ventilation system must be installed.</p> <p>Air flow is determined by number of persons in the room. In general, the air flow must be minimum 0.35 l/sm² corresponding to 0.5 h⁻¹</p> <p>The ventilation must be demand controlled.</p> <p>SFP must be maximum 2.5 kW/m³s</p>
Temperature	The building should be designed so that a limit temperature of 26°C should not be exceeded for more than 50 hours per year.
CO ₂	Maximum level of 1200 ppm in operational time.
Other air pollution	There are maximum values of ammoniac, asbestos, formaldehyde, ultrafine particles, radon etc. in the Building Code.

Materials

Construction products are attested by the national type approval system, by certified product declarations, and by CE marking within the European Economic Area. VTT Technical Research Centre of Finland is responsible for all type approval activities from the 1st of January 2009. However the CPD has not been implemented fully and Finland

¹⁶ Northpass [2010]; Suggestions for the reachable minimum performance requirement to be utilized in the update process of the Energy Performance of Buildings Directive, SINTEF Building and Infrastructure <http://northpass.vtt.fi/>,

¹⁷ D2 Byggnaders inomhusklimat och ventilation, Finlands Byggbestämmelsesamling, 2010, http://www.finlex.fi/data/normit/34164-D2-2010_ruotsi_22-12-2008.pdf

is about to implement a new structure for CE marking as part of the CPR.

In Finland the government is trying to push forward the new EU legislation in order to make the Finnish industry ready before the new regulation comes. Furthermore it is expected that Finland will implement demands on energy efficiency for building materials in 2016.

Water resources

Water resources are regulated according to the national building code of Finland: regulations and guidelines 2007, part D1 and SNIP 2.01.04-85(2000): Inner water supply and drainage¹⁸.

7.4.4 National actors

The list of important stakeholders includes;

- SFS Finsk Standard
- Confederation of Finnish Construction Industries RT
- GBC- Finland
- Motiva
- VTT
- Ministry of the Environment
- Finnish Environment Institute - SYKE
- Sitra
- TEKES
- Academy of Finland, <http://www.aka.fi/en-gb/A/>
- Finish science and technology information service, <http://www.research.fi/en>

7.4.5 Selected projects

Many ambitious sustainable city development projects has been implemented in Finland: http://www.tekes.fi/u/sustainable_solutions.pdf

¹⁸ http://webcache.googleusercontent.com/search?rlz=1T4RNRN_enDK440DK440&q=cache:3Hfdlk2fgM4J:https://publications.theseus.fi/bitstream/handle/10024/34085/Belobratova_Maria.pdf%3Fsequence%3D1%2BD1%2BWATER%2BSupply%2BAnd%2Bdrainage%2BInstallations%2Bfor%2Bbuildings%2BRegulations%2BAnd%2Bguidelines%2B2007&gs_upl=0101014691111111110&hl=da&ct=clnk#10

Among these are:

- Eko-Viikki has been a pioneer in ecological building and sustainable urban planning in Finland
- Rebuilding of Jätkäsaari and Kalasatama, two former harbour sites in Helsinki to sustainable urban areas.
- Eco-block in Kempele, a municipality in northern Finland near the Arctic Circle, where all of the energy needs of buildings in the block are met by a small-scale CHP (combined Heat and Power) plant and wind generator
- Skaftkärr - an energy efficient residential area. The Skaftkärr project has already produced completely new information about how municipalities, through spatial planning, can influence the energy efficiency of their areas
- Low 2 no, the project is designed to help transition cities to a low carbon future. The aim is to balance economy, ecology and society through strategic investments and interventions in the built environment.

7.4.6 Market perspectives

In Finland, wood accounts for about 40% of all building materials. Nearly 90% of detached houses and almost 100% of leisure homes have a wood frame, and usually wood cladding, too. Building with wood has been promoted since the 1990s through a variety of policy programmes and action plans, however the full potential for growth in the wood industry has not come yet.

The popularity of prefabricated housing has risen remarkably and this might offer important opportunities for implementing low-energy technologies. Another channel for marketing low energy houses are the Housing Fairs organized annually in a different city in Finland. Several companies are manufacturing products suitable for low energy houses, and also companies manufacturing prefabricated houses are offering low energy and passive house products.

A major barrier for more extensive implementation of energy efficiency in buildings is the scattered field of expertise and information. For example, for an individual constructor it is difficult to obtain information about the building materials and techniques related to passive house construction. (Source: NorthPass)

The Finnish concrete, wood and steel industry are very competitive. International growth is mostly in nearby markets: Scandinavia, the Baltic States, and Russia. These are countries where the industry traditionally had the strongest bonds and where it made most sense to concentrate according to The Finnish Confederation for Construction

Industries (RT). The expansion of the EU internal market also contributed.

There are two main areas where the construction industry is earning money abroad: the export of raw materials, and the export of knowledge in the form of project management. The Finnish Confederation for Construction Industries, RT, sees an especially bright future for knowledge export, where Finnish construction companies have competitive advantages over those from other countries. Finnish construction companies have developed expertise in using information and communication technologies for project management and data storing and sharing, which improve efficiency. Thus, Finnish construction companies working abroad can use the methods for cost-efficient production and collaborative work learned in the home market¹⁹.

Some input/expertises in Finland:

- An area where Finland seems quite ambitious is within sustainable urban development, where there have been many projects in the recent years.
- In Finland there has been big problems with humidity in the indoor climate (due to bad construction from the 1960´s), and this has let to strong competences on the area.
- From the interview with Finnish GBC “The social aspect within sustainability” was suggested as a good subject for Nordic coordination - i.e. there are any similar demands/traditions on this area in the Nordic countries.

7.4.7 Sources

- Interview with Green Building Council, Antti Lippo, 6. May 2012

7.5 Island

7.5.1 Intro

Iceland is characterised with abundant resources of renewable energy (and water), which is perhaps why there has been relatively limited attention to regulation of the energy consumptions in buildings compared to the other Nordic or European countries. The situation with low consumer prices is a general issue in Iceland, where efficiency measures regarding water, heat and electricity often suffers from lack of feasibility due to very low prices.

¹⁹ http://webcache.googleusercontent.com/search?rlz=1T4RNRN_enDK440DK440&q=cache:S0BISZM9YRoJ:http://www.eurofound.europa.eu/emcc/publications/2005/ef0566enC2.pdf%2Bexport+building+industry+finland&hl=da&ct=clnk

However, recently a new building regulations has been adopted; <http://www.reglugerd.is/interpro/dkm/WebGuard.nsf/2d8cdab9a540c73600256a0d0055eeb1/558cc9b22a7075cc002579a400073076?OpenDocument>. It contains requirements concerning U-values for building components and also an overall energy frame requirement. The energy frame is quite different from the one applied in e.g. Denmark and Norway and is based on transmission heat losses/max. U-values for the components of the building.

7.5.2 Initiatives and voluntary certification schemes

There are some activities concerning the introduction of voluntary certification schemes in Iceland. The Icelandic Green Building Council (IGBC) has been set up and works with companies, municipalities and public entities with the common goal of increasing the use of sustainable construction methods and land-use planning in Iceland. The council is working with different certification schemes and has not decided to support a particular one. At this stage only BREEAM has been used in the building sector and around 10 building has been certified / or is currently in the certification process. The government requires that all new buildings owned by the state should be certified by BREEAM or other similar certification schemes. The municipalities have currently not introduced the same requirement.

However, it is found that BREEAM in certain areas do not match the specific Iceland conditions. Recently, the council has work with DGNB and intend to investigate the possibilities of introducing DGNB in Iceland.

http://www.vbr.is/efni/icelandic_green_building_council

7.5.3 Legislation and regulations - sustainable buildings

A resolution of the Committee on greener economy was adopted by the Parliament on 20 March 2012 this year, which included proposals on various aspects relating to Icelandic consumers and their possibilities to adjust to a more environmentally friendly lifestyle. The resolution also suggests that there is a need for an evaluation of energy consumption in public buildings and to set up a system for measurement of energy consumption of buildings in accordance with the systems used in Europe and the Nordic Region.

Iceland does not have a formal national energy saving target. Nevertheless, a number of measures are currently in place to promote energy efficiency.

Energy consumption and efficiency

The U-values introduced in Iceland are quite strict compared to earlier standards and many stakeholders of the sector states that the feasibility of the new U-values are quite poor, primarily because the heat cost in Iceland is very low.

The new building regulation

Total energy demand of a building shall be defined by use of total transmission losses, ventilation losses and air temperature on inside and outside of the building and shall be calculated for all buildings.

The total transmission losses, considering thermal bridges and design U-values, shall not be higher than the total sum determined by use of maximum U-values (table 13.01) and the areal size of each component.

Generally, in determining total transmission losses for a new building, the U-value of building components shall not be higher than values shown in table below. It is though allowed to increase the U-value of single component(s) by 20% but then insulation of other parts must be increased so that the total transmission loss of the building is not increased.

Table 7.4 Max values of U-values (W/m²K) for new building components, depending on indoor temperature θ_i (°C);

	Unit	$\theta_i \geq 15^\circ\text{C}$	$15^\circ\text{C} > \theta_i \geq 5^\circ\text{C}$
Building components	(W/m²K)		
Roof		0.15	0.25
Wall		0.25	0.30
Windows (weighed average for different components of window)		1.7	2.0
Doors		1.7	2.0
Skylights		1.7	2.0
Floor (lowest floor)		0.20	0.25
Walls; weighted average of insulated wall, windows and doors		0.80	1.10
Thermal bridges	(W/mK)		
Foundation wall		0.12	0.12
Intersection wall-window		0.03	0.03
Intersection skylight-roof		0.10	0.10

In locations with high energy prices (compared to average Icelandic situation) it is recommended that minimum values are at least 10% lower than tabulated values above.

Other directives

The main EU directives; Directive 2010/31/EC on Energy Performance of Buildings (EPBD), and Directive 2006/32/EC on energy end-use and energy services have not been implemented in Iceland.

As mentioned a new Building Act (2011) has just been adopted and is currently under introduction, but it does not represent an implementation of the EPBD. In relation to

energy it includes some U-value requirements which are differentiated for the different climatic zones in Iceland.

Despite from these two directives, Iceland has implemented quite a few of the other directives related to energy efficiency of relevance for energy consumption in buildings, including;

- Directive 2010/30/EU on labelling and standard product information of the consumption of energy and other resources by energy-related products (recast), Iceland has completely implemented the predecessor Directive 92/75/EEC and Directive 2010/30 will be implemented into Icelandic legislation in the first half of 2012 through amendments to the 1994 act that implement Directive 92/75/EEC.
- As regards Directive 2009/125/EU on establishing a framework for the setting of ecodesign requirements for energy-related products, Iceland already implements the predecessor Directive 2005/32/EC. Iceland foresees to implement Directive 2009/125 in the first half of 2012 through amendments to Act 42/2009 which transposes Directive 2005/32/EC.
- Regulation (EC) No 106/2008 (Energy Star) on an energy efficiency labelling programme for office equipment has been implemented into Icelandic law with Regulation n° 819/2010.

In general all European standards (EN) become Icelandic standards. In December 2010, new building standards from CEN, with their National Annexes were implemented including standards regarding security issues, stress, different construction materials and foundation structures.

Indoor climate

There are only a few requirements concerning ventilation and CO₂ levels in the new building regulation and only for office buildings. The building regulation put forward demands on minimum ventilation of rooms, depending on type of use and level of activity. Almost all dwellings and also some (most even) other types of buildings in Iceland are not designed with ventilation systems (except for kitchens, sanitary rooms etc.).

Currently, there are a number of relevant areas, where a more focused effort with regard to ventilation of buildings would be beneficial according to experts.

With no regulations or traditions for installation of ventilation systems and very low heat prices, many people tend just to open windows for longer period without any concerns on the potential heat loss/waste of energy. Consequently, some houses and apartments have extremely high energy consumption. Another and somehow opposite

problem is that a group of people is not aware of the need for ventilation and tend to forget to ventilate. This has resulted in problems with mold in many buildings in Iceland causing a very bad indoor environment. It is estimated that around 30% of the buildings suffers from a mold problem at national level.

Materials

Most regulations concerning chemicals in products, etc. has been implemented or is under implementation in Iceland. This includes the law framework of REACH/CLP and biocides.

In the survey only a few regulatory initiatives with relevance for sustainable building materials has been found. There is a general phrase in the building regulations stating that LCA of building should be carried out. Moreover there is a quite ambitious objective for disposable of construction material; 60% of the waste has to be reused by 2015 increasing to 75% in 2020.

The Green Building Council has decided to focus part of their effort to investigate the availability of sustainable construction materials in Iceland, where the issue also will be dealt in relation to certification systems that are being used in Iceland and in the other Nordic countries. The objective being to encourage designers, users and sellers to increase the range of supplies and purchases of sustainable construction materials, and to prepare a check list or criteria on what assessment aspects and/or systems are generally used when referring to sustainable construction materials. Currently the general findings of the architects using the BREEAM Green guide are that the materials in the list are rather "British" and materials commonly used in Iceland are lacking.

Water resources

There are no regulations/laws concerning water consumptions in buildings. There is a very rich accessibility of cold water in Iceland and hence traditionally there has not been much focus on water savings. Also in the case of voluntary certification schemes the suitability of some criteria, such as recycling of water and using a lot of equipment to reduce water usage in toilets is not as relevant in an Icelandic context compared to other countries. However, there is a growing concern that the ground water level is decreasing and way to re-infiltrate water and rainwater should be applied.

Water resources are regulated through the Water Act No. 20 of 31 March 2006. Moreover Iceland foresees implementation of the Water Framework Directive 2000/60/EC during 2011-20²⁰.

There are no regulations in the field of buildings and climate adaption, but also Iceland experience heavy rainfalls which might actualise an effort in this field.

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Screening Report Iceland, Chapter 27 - Environment, Oct. 2011, EU Commission

7.5.4 National actors

- Staðlaráð Íslands (standardisation Iceland)
- Ministry of Environment: <http://eng.umhverfisraduneyti.is/agencies/>
- Building institute: <http://www.skipulagsstofnun.is/skipulagsstofnun/log-og-reglugerdir>
- Ministry for Industry, Energy and Tourism: <http://eng.idnarraduneyti.is/institutions/Undertheauspices/>
- National Energy Agency: <http://www.nea.is/the-national-energy-authority/publications/nr/81>
- Green Building Council Iceland (<http://www.vbr.is/efni/fyrirtaekid>)
- <http://www.byggingar.is/html/storf/default.asp>
- Iceland Academy of Arts; Design and Architecture <http://honnunardeild.lhi.is/namsbrautir/>
- Reykjavik municipality

7.5.5 Selected projects

- Institute of Natural History designed by the Icelandic architects of ARKÍS
- A university building for Icelandic sciences and culture is under planning and appear to become an interesting project.

7.5.6 Market perspectives

Some 95% of all buildings in Iceland are constructed in reinforced concrete. Cement is locally produced, whilst gravel and sand is found in abundance in Iceland. Laminated trusses and steel frames for industrial buildings are produced locally or imported. Insulation is locally produced, as are concrete and plastic water- and drainpipes. Other building materials are imported mainly from different European countries, including lumber, reinforcing steel, metal claddings, structural steel, and electrical and plumbing materials.

On one hand it can be claimed that there has not been a large political or legislative focus on issues which are traditionally related to sustainable buildings. On the other hand it can also be argued that Iceland have some of the most sustainable buildings,

as the operation of the buildings (heat, electricity and water) is based on almost 100% renewable resources. This means that there is a relatively low level of knowledge among sector regarding sustainable buildings materials and installations.

There seem to be a move toward a more broad focus on sustainability aspects of buildings in Iceland. Hence it has been decided that new public buildings should be certified using BREEAM or similar schemes and moreover political attention on sustainable buildings has been increasing lately.

7.5.7 Sources

Interviews;

- Icelandic Green Building Council, Sigridur Bjork Jonsdottir, 1. May 2012
- Innovation Centre Island, Björn Marteinsson, 3. May 2012
- EFLA consulting, Helga Johanna Bjarnadottir, EFLA consulting, 2. May 2012

7.6 Norway

7.6.1 Intro

Norway has an energy system with a very high percentage of renewable energy; 99% RES in the electricity production and more than 50% RES in the overall energy supply (incl. transportation, heating etc.). At the same time Norway has ambitious objectives set up for the energy sector. These include an objective to become carbon neutral by 2030. There are no official objectives for energy efficiency and savings in buildings, but these are being prepared.

Norway is currently preparing the introduction of a nearly zero energy building requirement and preparations have been carried out by a working group established by the Government. There are indications that passive-house standard will be introduced for new buildings in 2015 (public buildings in 2014) and a nearly-zero energy performance requirement will be launched from 2020. Currently, two low-energy and passive-house levels are officially defined in a standard for dwellings, and work is underway for establishing a standard for other types of buildings.

Norway has chosen BREEAM as the official certification standard.

The Norwegian government has announced that it will publish an overall building policy during the summer of 2012. It is expected that it will cooperate more broad aspects of sustainability.

7.6.2 Initiatives and voluntary certification schemes

There is a considerable amount of support schemes in Norway dealing with energy efficiency in buildings:

- EcoBuild programme
- ENOVA
- Support for passive and low-energy buildings. The program offers support to investment in demonstration elements implemented to achieve passive or low-energy buildings in all building types.
- Support for the project development of passive houses.
- Incentives for low-energy housing, The Norwegian State Housing Bank promotes low-energy houses and requires low-energy qualities for the projects that they are financing.

Norway has implemented BREEAM NOR, which is the first sustainable building certification scheme in Norway, which goes beyond the energy focus.

The Norwegian standardization agency has elaborated a standard for low-energy and passive house dwelling, where definitions and specific criteria are included. The national standard for low energy and passive house dwellings; NS 3700 was adopted as a standard after nearly 3 years of development/work. NS 3700 can be used for planning, construction and evaluation of homes with low energy.

The Norwegian standardization agency is currently in the final review process for an equivalent standard for low-energy and passive houses for commercial buildings - NS 3701: Criteria for passive houses and low energy buildings - Non-residential buildings. The work has taken a considerable amount of time, but a final version is expected during 2012.

7.6.3 Legislation and regulations - sustainable buildings

Energy consumption and efficiency

The national building regulation is TEK with the recent issue being TEK10. TEK10 refer to the Norwegian standard NS 3031; Calculation of the energy performance of buildings. TEK 10 represented approx. a 5% tightening of the previous TEK07 and more strict requirements for heat recovery, annual average temperature efficiency, use of glass area and a ban on installing oil-fired boilers. According to the TEK 10 there are two models that can be used when calculating the energy performance requirements: *single-measure model* and *energy-frame model*.

Norway is currently working with implementation of the article 9 of the EBPD - requirements for implementation of nearly Zero-Energy buildings. The Working Group for energy efficiency in buildings has submitted a report in August 2010 providing input for a coming action plan.

The official climate statement, which was published in April 2011 confirms that Norway has ambitious objectives concerning the building sector; *The Government presented an action plan for energy efficiency, with the goal of reducing overall energy consumption significantly in the building sector by 2020. The energy requirements of building regulations should be tightened to the passive level in 2015 and almost zero energy level in 2020. The use of oil-fired boilers in households will be phased out.*

<http://www.regjeringen.no/nb/dep/smk/pressemeldinger/2012/offensiv-klimamelding.html?id=679419>

The group has come up with a proposal for a coming structure of an action plan and the following objectives for new houses:

- Introduction of a passive-house standard for new buildings in 2015 (public buildings in 2014) (70-80 kWh/m²) in 2015.
- Introduction of a nearly-zero energy performance building standard from 2020.

Figures on energy performance/net energy demand in Norway - status and requirements;

Level	Commercial buildings kWh/m ² /yr	Dwellings kWh/m ² /yr	Factor
Existing buildings	238	201	Net energy demand
Estimated energy consumption after tradition rehabilitation	215	160	Net energy demand
Energy performance requirements - new buildings (TEK10)	150	120	Net energy demand
Low-energy buildings (prNS3701/NS3700)	80	70	Net energy demand
Passive-house buildings (prNS3701/NS3700)	60	55	Net energy demand

Indoor climate

Generally Norway has a high standard, when it comes to indoor climate, supported by sector traditions and legislation. The main requirements are harmonized with EC regulation. One of them is EN 15251 Class II and minimum requirements for indoor

climate and air quality have remained largely unchanged since 1997. The demand for ventilation is $1.2 \text{ m}^3 / \text{m}^2$ of surface area, when in use, and 0.7, when not in use. This corresponds to 0.5 ac / h or 0.3 AC / h. Bedrooms must have 26 cubic meters of fresh air per hour per hour/bed. The minimum extract flow rates from wet rooms & hoods must be upheld. The minimum requirement of one-family to SFP-value of 2.5 kJ/m^3 while the requirement for heat recovery is 70%. Equivalent requirements are 1.5 kJ/m^3 and 80% in multi-family housing.

There are also requirements for air quality, emissions, radon, noise, daylight moisture damage protection. Not directly linked to energy consumption

There has been a tradition with over-ventilation of the buildings with too much energy consumption being used as a consequence.

More information: <http://www.standard.no/no/Fagomrader/Bygg-og-anlegg/Ventilasjon-og-inneklimal/Ventilasjon-og-inneklimal/>

Materials

Norway has introduced the so-called substitution principle related to the Working Environment Act and the regulation of chemicals. It ensures that all companies must work with replacement of less toxic and environmental critical substances in all products. This means that requirements imposed by the substitution principle must be incorporated in the company's internal control and documented in writing.

Currently, Norway has implemented the EU standards of TC-350; through among other things; NS-EN 15643-1:2010, NS-EN 15643-2:2010 and NS-EN 15942:2011. More information to be found on; <http://www.standard.no/no/Fagomrader/Bygg-og-anlegg/Miljoriktige-byggverk1/Om-miljoriktige-byggverk/Oversikt-over-standarder-fra-CENTC-350/>

Norway has implemented REACH and the biocide directive.

Moreover there is a focus on waste products from the building sector. A "National Action Plan for Construction Waste Management" has been issued and better waste management in the building and construction sector has been a priority from the start. The National Plan provides solutions for reduction of waste and recycling of construction waste.

Water resources

There are no legislation in relation to water consumption in buildings and generally there has been little focus on this area, mainly due to the fact that water is cheap and water resources are boundless.

However, there are requirements related to water drainage.

In relation to BREEAM, the sector has experienced a very positive attitude towards water efficiency in buildings.

7.6.4 National actors

There are a number of interesting stakeholders in Norway including;

- Standard Norge
- Ministry of Local Government and Regional development
- Ministry of Petroleum and Energy
- Ministry of the Environment
- National office of Building Technology and Administration under Ministry of Government and Regional development, which is responsible for development of building regulations, etc.
- National energy agency ENOVA under the Ministry of Petroleum and Energy, which is responsible for dissemination of information about energy policies and administration of support schemes for building energy renovation and low energy building demonstration
- National Climate and Pollution agency KLIF
- 430 municipalities responsible for enforcement of building regulations.
- SINTEF Byggforsk
- The Research Centre for Zero Emission Buildings (ZEB)
- The Building and Construction Association
- National Association of Norwegian Architects, NAL
- Norwegian Green Building Council
- Lavenergiprogrammet
- Future Built
- Framtidens Byer
- Framtidens Bygder

7.6.5 Selected projects and initiatives

The 13 largest municipalities are all members of Framtidens Byer, and they have taken large steps towards low energy construction and can serve as examples. Moreover, there are several good examples of very low-energy houses. Below some examples are listed.

- Loevaashagen, Norway
- Løvåshagen (low-energy and passivhouse dwellings), Bergen
- Miljøbyen Granåsen (passivhouse dwellings), Trondheim
- Powerhouse Brattøra (zero-energy commercial building), Trondheim
- Belona huset (passivhouse commercial), Oslo
- Nardo skole (low energy school - well documented), Trondheim
- Kvamskogen barnehage (passivhouse kindergarden), Tromsø
- New harbour building at Longyearbyen, Svalbard being planned as Passivhouse: http://www.vvsaktuelt.no/xp/pub/hovedmeny/varme_og_energi/593683 (I have this report if not available on net)
- A very large number of documented examples can be found in NAL ECOBOX - a project database: <http://www.arkitektur.no/?nid=5683&lcid=1044>
- There are a number of examples of both commercial and residential passivehouses. Some residential activehouses, some commercial nearly-zero energy and net-zero buildings under way
- Skagen Å~Kontor: The Greenest Office Building in Norway
- Villa Stoknes, Norway
- EKSBO project, Norway
- Passivhus bygget med massivtre. R Bofellesskap for Trondheim kommune, Norway
- Barents House in Kirkenes will hopefully set an example of green building for all of Scandinavia. This is to be **the world's tallest wooden building**. This is still only being planned. <http://inhabitat.com/worlds-tallest-wooden-building-planned-for-norway/>
- Norway is also home to a low-security **eco prison**, where inmates develop a sense of responsibility by maintaining the building and grounds. Solar power has reduced

the energy use by 70%. They grow most of their own food, selling surplus to other prisons, and they recycle just about everything. http://www.msnbc.msn.com/id/20483351/ns/world_news-world_environment/t/eco-prison-aims-change-hard-core-criminals/

7.6.6 Market perspectives

Environmental awareness among Norwegian people is considerably high and more than half of the population consider global warming as a very serious threat. According to a study conducted by the Norwegian association of housing suppliers, 30% of the house buyers chose energy-efficiency measures exceeding the conventional standard.

Currently several hundred projects are being planned and already, several hundred low-energy buildings and also some passive houses have been built. There is no national register of low-energy and passive buildings. Hence, estimations of the market share of new buildings LEB is estimated to be about 10 % for residential buildings - both single-family houses and apartment blocks - about 8 % for office buildings and less than 1 % for other types of buildings, including educational buildings (source: NorthPass)

During the past 5-10 years new products, solutions and processes in relation to energy-efficiency have been developed and the construction industry's competence has been increased with the implementation of several successful pilot projects, but there is still a lack of customised and integrated solutions for sustainable and energy efficient solutions and general awareness among construction professionals.

Main strengths of the Norwegian green building sector are;

- Wooden buildings
- New energy efficient buildings
- Indoor climate aspects
- Sustainable materials

(<http://www.nordicinnovation.org/news/results-from-workshops-on-nordic-sustainable-building-concepts/>)

Norway has some export of building product and construction mainly related to steel, concrete and wood. However, there are also export within construction products; windows and design.

7.6.7 Main sources

- <http://www.standard.no/no/Fagomrader/Bygg-og-anlegg/Miljoriktige-byggverk1/Om-miljoriktige-byggverk/Oversikt-over-standarder-fra-CENTC-350/>
- <http://northpass.ivl.se/publicationsfromnorthpass/reports/reports.5.50a499dd132037d524e80008573.html>
- NAL ECOBOX: <http://www.arkitektur.no/?nid=5683&lcid=1044>
- SINTEF Byggforsk: <http://www.sintef.no/Byggforsk/Bygninger/>
- www.ngbc.no
- Miljø og bærekraftig utvikling; Bruk av standarder og standardisering, Standard Norge, 2008

Interview;

- Green Building Council, Sverre Tiltnes, interview 11. May 2012
- COWI Norway, Dagfinn Bell interview 1. May 2012

7.7 Sweden

7.7.1 Intro

Sweden has a long history of energy-efficient building construction and has rather high mandatory building-performance standards. In contrast to other countries the energy requirements regulate the **actual energy consumption** and not the energy demand. The verification of the energy consumption must be calculated during the planning of the house and afterwards throughout measuring of the actual consumption. The major step towards EBPD was taken in 2006 when a limit for maximum energy use of buildings was defined and major steps towards Nearly Zero Energy Buildings were taken in 2009 and 2011.

The legislation on indoor climate follows the EU legislation. In general the industry and universities has a high know-how on the area - especially when it comes to interaction between the systems (controlling the indoor climate) and the user.

Sweden has experienced a building boom during the past ten years and part of the activities has concerned green/sustainable buildings. Hence the sector has gained a lot of expertise and knowledge with green buildings, just as producers, contractors etc.

have experienced a booming market.

7.7.2 Voluntary certification schemes

There are currently no official low-energy standards in Sweden, but several voluntary schemes. An organisation called Sveriges Centrum för Nollenergihus has made a specification of requirements for low-energy houses in Sweden. Sweden has four semi-official low-energy building types:

- Low energy "Minienergi"
- Passive house
- Zero-energy house
- NNE-buildings (Nearly zero-energy house) (Target for 2021).

In October 2010, the Swedish Energy Agency published a new national strategy for implementation of nearly-zero-energy buildings (NNE-buildings) in Sweden. NNE will be mandatory in 2021 and the sub - target is that 25% of all new buildings and 40% of renovated buildings in 2015 must fulfil the requirements for NNE-buildings. Moreover, the public sector must fulfil the requirements already in 2019, and already in 2015 at least 50% of all new and renovated public buildings must fulfil the requirements.

Some of the interviewed experts have emphasized passive house as a very recognized scheme in Sweden.

Several incentives for low-energy buildings and in particular RES in buildings in Sweden exist, including tax reduction for small-scale building work, investment grants for solar cells and grants for conversion of heating systems.

Apart from these building types the Swedish GBC has defined four voluntary green building certification:

- Green Bulding
- Miljøbyggnad
- BREEAM
- LEED

The Swedish building industry (developers and large building owners) has developed a certification for sustainable building materials (Byggvarubedömningen). This organisation has made a database where building materials are evaluated on

different sustainability parameters: <http://www.byggvarubedomningen.se/sa/node.asp?node=496>.

Furthermore there is a volunteer scheme called BASTA, <http://www.bastaonline.se/>. The scheme contributes to the minimization of harming chemicals in building materials. The scheme is supported by the large actors in the Swedish building industry, and it contains two registers:

- BETA-registret, which contains the products that full fill the minimum demands of the system
- BASTA-registret, which contains the products that full fill the higher demands of the system

7.7.3 Regulation and actions

Energy consumption and efficiency

The proof of energy performance compliance must be made within 24 months after completion of the building. Control of this regulation is the responsibility of the municipality where the building is located. In January 2012 Boverkets published the new building legislation, BBR 19 (BFS 2011:26).

Sweden is divided into three climate zones with different energy requirements to the buildings. Zone I is in the north, zone II in mid-Sweden, and zone III is the southern Sweden.

Table 7.5 Figures on energy performance in Sweden - status and requirements

Level	Commercial buildings kWh/m ² /yr (zone 1/2/3)	Dwellings kWh/m ² /yr (zone 1/2/3)
Energy performance requirements - new buildings	120/100/80	90/110/130

For buildings under 100 m² alternative demands for the energy consumption can be met (demands for the U-values for the building envelop are set).

Indoor climate

In section 6 in BBR 19 (Avsnitt 6 Hygien, hälsa och miljö) the overall requirement for the indoor climate can be found. The requirements are not very specific: http://www.boverket.se/Global/Bygga_o_forvalta/Dokument/Bygg-och-konstruktionsregler/BBR_avsnitt_6/avsnitt_6.pdf

For requirement on indoor climate at work places the legislation can be found on: <http://www.av.se/lagochratt/>

General norm and standards:

Air

- R1 Riktlinjer för specifikation av inneklimat. VVS Tekniska Föreningen (2006). ISBN 91-976277100.
- Regelverk för hushållning, planering och byggande. Boverket (2007). ISBN 978-91-85751-02-0. This includes the regulation and rules for performance testing of ventilation systems.
- Världshälsoorganisationen (www.euro.who.int/air) has produced recommended limits for air quality for indoor and outdoor air.

Light

- Att se, höra och andas i skolan: en handbok om skolans innemiljö. Arbetskyddsstyrelsen och Boverket (1996). ISBN 91-7464-963-9.
- Ljus och belysning - Belysning av arbetsplatser - Del 1: Arbetsplatser inomhus. SIS (2003). SS-EN 12464-1. Ljuskultur, belysningsbranschens informationsorgan, www.ljuskultur.se

Thermal indoor climate

- Fukt och värmetekniska egenskaper hos byggnader - Klimatdata - Del 5: Data för att bestämma byggnaders effektbehov för uppvärmning. (ISO 15927-5:2004). SS-EN ISO 15927-5. The standard specifies the basis for calculating DVUT be developed.
- R1 Riktlinjer för specifikation av inneklimatkrav. VVS Tekniska. Föreningen (2006). ISBN 91-976277100.

Humidity

- Guidance on critical moisture condition is presented for signature Moisture Effects on materials - critical moisture levels. Forskningsrådet Formas. ISBN 91-540-5951-8.
- In the series Moisture safety in buildings treated a variety of building components from moisture standpoint. The series is published by Formas and there along with

some other reports on www.formas.se.

- Kritiskt fukttillstånd för mikrobiell tillväxt på byggnadsmaterial – kunskapssammanfattning. SP Energiteknik, SP Rapport 2005:11. ISBN 91-85303-442-9. SP Sveriges Provnings-och Forskningsinstitut, www.sp.se.
- SS 02 01 06 In the series Moisture safety in buildings treated a variety of building components from containing information on measurement uncertainty and other concepts related to measurement uncertainty. To EN 12 865 contains a laboratory method for testing the facades against driving rain.

Materials

On Boverket homepage the requirement for building materials can be found: <http://www.boverket.se/Bygga--forvalta/Byggprodukter/Bygg--och-anlaggningsprodukter/Regler-for-byggprodukter/>. The Swedish requirements follows the EUs legislation (EU) nr 305/2011 on CE labelling.

There are a few Swedish voluntary schemes for materials, which is listed in chapter 4. The CPD has not been implemented fully and Sweden is about to implement a new structure for CE marking as part of the CPR²¹.

Water

The EC Directive has been partly transposed into Swedish legislation, primarily through the Environmental Code. Since the Directive sometimes states in fairly broad terms the SGU (The Geological Survey of Sweden), together with the Environmental Protection Agency, have drawn up more detailed regulations.

The quality of the drinking water is set by Livsmedelsverket (water plants) and Socialstyrelsen (individual water wells). More information can be found in section 6.6 Vaten och avlopp, BBR19.

In the following norms the quality of the installation can be found

- Avsnitt 6:62 i BBR19 sets demands for drinking water.
- VVS-Företagens Teknikhandbok 2008. VVS-Företagen (2007). ISBN 978-91-976619-1.

With support from the Swedish Energy Agency, a technical committee under supervision by the Standards Institute of Sweden developed two test standards:

²¹ <http://www.boverket.se/Global/Webbokhandel/Dokument/2012/Anpassning%20av%20svensk%20r%C3%A4tt%20till%20EU-f%C3%B6rordningen%20om%20harmoniserade%20villkor%20f%C3%B6r%20saluf%C3%B6ring%20av%20byggprodukter.pdf>

- Sanitary tapware - Method for determination of energy efficiency of mechanical basin and sink mixing valves, SS 820 000
- Sanitary tapware - Method for determination of energy efficiency of thermostatic mixing valves with shower, SS 820 001

The purpose of these two test standards is to establish a method for determining the energy efficiency of sanitary tapware and shower heads.

In Sweden water isn't an issue because there is plenty. Regulation on the area has therefore not been a focus. Consequently, the piping system was in the 1960's dimensioned for a bigger consumption than has turned out to be necessary.

7.7.4 National players

- SIS (svensk standardiseringsorg.)
- Socialdepartementet
- The Swedish Construction Federation
- The Ministry of the Environment works to ensure sustainable development and is responsible for building policies, etc.
- Energimyntigheten manages the renewable/efficiency subsidy schemes, make statistics etc. They have also made requirements for low energy buildings.
- "Boverket" is the administrative body on the building regulation.
- There are 290 municipalities, which are responsible for controlling the energy performance of buildings.
- SP - Sveriges Tekniska Forskningsinstitut
- Sveriges Centrum för Nollenergihus
- IVL - Svenska Miljöinstitutet
- Passivhuscentrum
- GBC- Sverige - herunder mange certificeringer
- Sveriges Centrum för Nollenergihus
- Universities (Stockholm, Lund)

- Kretsloppsradet, <http://www.kretsloppsradet.com/web/page.aspx?refid=5>; Arbejder ambitiøse mål inden for med energy, materialer, begrænsning af skadelige stoffer og indeklima
- SGBC
- FEBY/ SCN <http://www.energieffektivbyggnader.se/>
- BASTA <http://www.bastaonline.se/>

7.7.5 Projects

- Understenshöjden 1995 <http://www.understenshojden.se/joomla/>
- Lindås 2001 <http://www.egnahemsbolaget.se/sv/Forsaljning-pagar31/Energieffektiva-hus/Lindas-Park/>
- Brogården 2009 http://www.alingsashem.se/index.php?page=brogardens_ombyggnad
- Portvakten 2009 <http://www.vaxjo.se/-/Stadsutvecklingsprojekt--startside/Om-Valle-Broar/Grundide/Portvakten/>
- One tonne life <http://www.a-hus.se/one-tonne-life>
- Urban development in Malmö (Bo01, Västra hamnen)
- Områdena som ska BREEAM Community certifieras i Malmö (Masthusen + varvstaden) - men det är inte bara Grönt byggande.
- ÅF-skrapan i gbg? <http://www.afconsult.com/sv/om-af/press2/nyheter/det-forsta-officiella-spadtaget-for-det-nya-af-huset-i-goteborg/>
- Djurgårdstaden
- Kvillebäcken och eller Krokslätt fabriker (Områden - Göteborg) <http://www.businessregion.se/huvudmeny/affarsomraden/affarsdrivenmiljoutveckling/demoutvecklingsprojekt/3k.4196.html>
- Hammarby sjöstad, http://www.hammarbysjostad.se/inenglish/pdf/HS_miljo_bok_eng_ny.pdf
- Järva, located in the west of Stockholm, comprises the Rinkeby and Tensta townships south of Järvafältet, one of Stockholm´s green corridors, and the

townships Kista, Husby and Akalla to the north of it, and has roughly 60,000 residents

- The SymbioCity Platform gathers Swedish urban planning expertise and a network of more than 700 environmental technology firms, and serves to facilitate the international activities of the Swedish environmental technology industry

7.7.6 Market perspectives

The majority of the very low-energy houses are owned by the municipalities but also private owners hold an increasing interest in energy-efficient solutions. The passive house concept was introduced in the South-West Sweden and a large part of all low-energy buildings are located in this part of the country. Also in the Stockholm area and in Northern Sweden there have been low-energy building projects. Around 400 passive houses have been constructed in Sweden, but it is still difficult to find components in the Swedish market²². The Stockholm area have many building which have a LEED or BREEAM certificate while the south of Sweden primarily are using their own sustainable certificate (Miljöprogram Syd).

There seems to be a large interest from the universities on the developing of certification for sustainable buildings; however there are not enough supporting schemes at the moment. In Sweden the big entrepreneurs (NCC, Skanska) are huge drivers on the market for green building. They have large project which are very ambitious and use certification of buildings as a marketing tool (foreign developers are more willing to invest in buildings with a green certificate like BREEAM and LEED).

In general there seems to be high focus on the building process - making this as efficient and as flawless as possible, also when it comes to green building. The technical university of Denmark has made a Dialogue based tender procedure (BYGGBYG), where the objective is to make a tool which helps the building planner make an effective building process (based on Danish and Swedish knowledge).

Apart from working on green buildings the Swedish Green building council is planning to make an adapted BREEAM certification for urban development in Sweden.

7.7.7 Important sources

The Swedish building code BBR19 regulated the legislation in buildings: <http://www.boverket.se/Bygga--forvalta/Bygg--och-konstruktionsregler-ESK/Boverkets-byggregler-BBR-19/>

²² Conclusion from North pass project

Interviews;

- Green Building Council, Bengt Wångren , April 2012
- IVL, Jacob Lindblom, 6, May 2012
- Socialdepartementet, Camilla Adolfsen, 16. May 2012

Table of abstract

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Abstract: <p>The Nordic prime ministers have charged the Nordic relevant ministers with developing a number of specific areas of cooperation to enhance growth and welfare in the Nordic countries. The assessment is that the Nordic countries can and should be a pioneer in dynamic green and sustainable solutions.</p> <p>This report deals with green building. The aim is to support the development of a leading global market for green building in the Nordic countries; especially seeking an overview of the trade barriers and opportunities that currently exist in the form of different requirements in legislation, standards and norms.</p> <p>The reason is that the Nordic countries are to some extent influenced by nationally defined markets within construction, while increased trade and regionalization could potentially improve the possibilities of developing a larger, innovative and dynamic market for green building. Another aspect is that the Nordic countries will be stronger together in relation to among other things EU and EU legislation, if the Nordic countries will coordinate efforts and the various demands on green building.</p> <p>Thus, the objective of the survey materialised in this report is to identify and describe areas of green building that may be suitable for Nordic co-ordination. Further to this, the goal is to point out approx. 10 areas with associated actions which could ultimately improve the Nordic industries' competitive situation, including eliminating or preventing new barriers to trade in the Nordic countries in these areas.</p>		
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Survey of green legislation and standards in the construction area in the Nordic countries

Background Note

The Nordic prime ministers have charged the Nordic relevant ministers with developing a number of specific areas of cooperation to enhance growth and welfare in the Nordic countries. The assessment is that the Nordic countries can and should be a pioneer in dynamic green and sustainable solutions.

This report deals with green building. The aim is to support the development of a leading global market for green building in the Nordic countries; especially seeking an overview of the trade barriers and opportunities that currently exist in the form of different requirements in legislation, standards and norms.

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