EU – ECONO PROJECT **COUNTRY REPORT: NORWAY**

HOUSING AND TIMBER CONSTRUCTION IN NORWAY: STATUS, TRENDS AND PERSPECTIVES FOR SUSTAINABILITY

Wooden cupboard door, Rolf Jacobsen / GAIA architects

This report on housing, timber and sustainable construction in Norway has been commissioned by the EU ECONO project. The report surveys the status and the future of construction in Norway, in particular housing, in terms of energy consumption, ventilation, building materials, energy sources and other environmental aspects, with some indications of experience and results achieved. Energy norms, materials standards and other regulations are changing and a brief review is given of these developments. The main focus is on timber, wooden housing and wooden housing areas. The purpose of the report is to contribute towards an understanding of trends and towards development of criteria and designs for new, sustainable wooden housing.

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HOUSING AND TIMBER CONSTRUCTION IN NORWAY: STATUS, TRENDS AND PERSPECTIVES FOR SUSTAINABILITY

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1 INTRODUCTION

1.1 SUBJECT AND GENERAL SCOPE

The following report for the EU ECONO project discusses the status and future of housing in Norway. The focus is on sustainability considerations such as energy, building materials and indoor climate, and with a particular focus on timber innovation and wooden housing. Some indications are given of recent trends, experience and results achieved. Energy norms and other regulations will change soon and again in 2010; a brief review is given of standards and other probable new regulations.

The purpose of this report is to contribute towards an understanding of trends and to the development of ecological wooden housing. The report has been prepared in May-July 2006 by Chris Butters, GAIA Oslo AS, Norway, with inputs from relevant authorities and experts. See references and brief CV of the author in annex.

1.2 OUTLINE OF CONTENTS

-Summary of development, status and trends in the housing sector in Norway, with a few statistics on volume, categories, types of construction and procurement
-Main actors and influences in the housing sector
-Official initiatives and relevant issues in pending revised building regulations, public funding, research, development and support programs
-Present and probable trends with a focus on timber including perspectives for massive timber and other aspects of ecological/sustainable construction,
-General status in the field of sustainable design, architecture and construction
-Some conclusions and subjective evaluation regarding developments towards sustainable housing.

Low dense cluster housing in timber, Oslo
Giskehagen, Torp architects

2 HOUSING IN NORWAY: STATUS AND TRENDS

The housing sector in Norway has seen fairly stable development during the past few years, and the emergence of a few new trends that slowly influence the composition and types of housing being built as well as construction methods. Some of these main trends are summarised below.

There are 3,7 million buildings in Norway, of which 1,4 million are housing buildings containing a total of nearly 2,0 million housing units. The construction industry has a total annual turnover of about 180 billion NOK. Around 40% of all built square metres is housing.

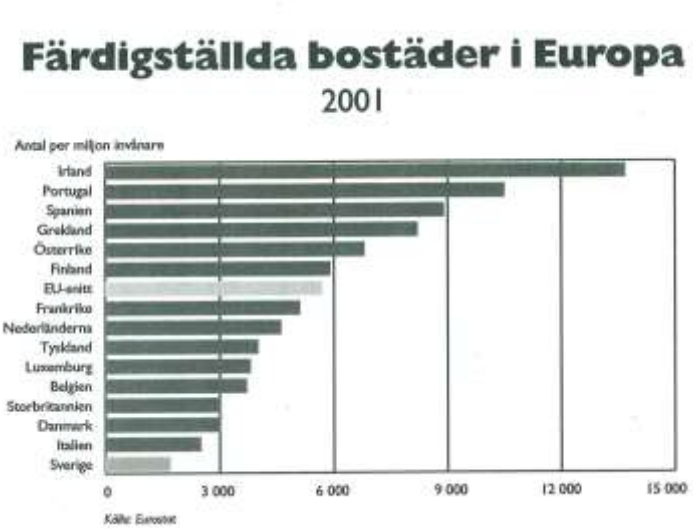
Total investment in housing has been over 50 billion NOK annually in the past few years. This represents around 3,4% of GNP and 18% of all investments.

2.1 Number of housing units

There are 1,960,000 dwelling units in Norway today. Housing construction was at a maximum in the 1960s and 1970s with up to 40,000 houses being built annually, i.e. 11 per 1000 inhabitants. There was a low point at the beginning of the 1990's. In more recent years, the figure has been between 25-30,000, i.e around 6,0 per 1000 inhabitants. This is slightly above the European average (see figure).

This means somewhat over 3,0 million square metres of new housing per year. Refurbishment comes in addition to this and may involve over 1 million sq.m..

In addition there are 380,000 holiday cottages, quite many of them being built or upgraded today to bigger size and higher standard. Over 20% of all households now possess at least one such cottage, and these are often shared between members of extended families. An increasing number are being used more often and are becoming close to "second homes". There are therefore discussions to change the property and taxation laws for these, and to make them conform to normal housing construction standards, such as for insulation, which is not required today.



Number of completed dwellings, Europe, 2001
Source Eurostat (Norway: about 6000)

2.2 Age of the housing stock

Pre 1920	11%
1921-1945	9%
1946-1960	17%
1961-1980	34%
1981-1990	17%
1991-2001	12%

2.3 Space use and size of housing:

The average size of housing per capita has increased steadily and according to some figures Norway now has nearly the highest space use per capita in the world, over 50 square metres per person.

This is likely to level off, both since less than 7% of the population is now living in housing defined as "cramped", and due to more urban lifestyles in smaller apartments, giving a movement, if small, away from the great dominance of big detached houses.

However, if holiday home space is included, and this is growing fast, then the overall space use per capita could still increase.

The housing stock is composed as follows:

Under 60 sq.m	12%
60-100 sq.m	31%
100-130 sq.m	17%
130-160 sq.m	16%
Over 160 sq.m	24%

The average size of new housing units built has, however, decreased somewhat from 128 sq.metres in 1998 to 115 sq.metres in 2002. This is amongst other reasons, partly due to smaller families and partly to a trend towards more urban apartments. The number of rooms per person is now about 4,2, whereas it was 3,6 in 1980.

Figure: average space per person and unit
Source: Arkitektnytt / Odd Iglebæk / SSB

GJENNOMSNITTLIG M² BOLIGAREAL PER HUSHOLDNING FOR ÅRENE 1973, 1981 OG 1986–2004, OG BOLIGAREAL PER PERSON 1980–2003

Tabell 3

År	Boligareal per person	Boligareal per husholdning
1973		88
1980	36	
1981	37	101
1982	37	
1983	37	
1984	39	
1985	39	
1986	42	103
1987	43	107
1988	44	107
1989	44	107
1990	46	111
1991	47	112
1992	48	114
1993	49	111
1994	49	115
1995	49	112
1996	50	113
1997	51	115
1998	51	111
1999	53	113
2000	51	
2001	52	115
2002	52	116
2003	54	117

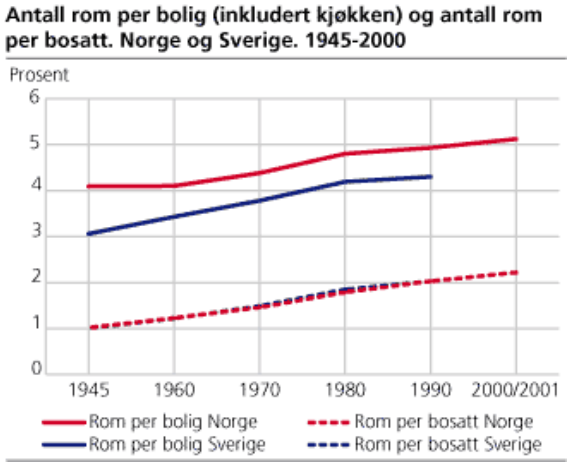
Boligareal er definert som samlet netto boligflate, dvs. innvendig areal ikke medregnet kott, kjellerbod eller andre boder. Definisjonen er den samme i alle undersøkelsene. Arealtall mangler for årene 1974–1980, 1982–1985 og 2000.

Tall for 2002–2004 er foreløpige. For årene 2002–2004 er gjennomsnittlig areal per husholdning beregnet på grunnlag av tall for nye boliger og boligareal fra bygge- og anleggsstatistikk og byggearealstatistikk i Statistisk sentralbyrå, og dels data fra forbruksundersøkelsen.

Kilde: Tall for 1973 og 1981 er hentet fra boforholdsundersøkelsen, mens levekårsstatistikken er kilden til tall for 2001 og 2004. Forbruksundersøkelsen er kilden til de øvrige tallene.

These figures illustrate how the rate of housing construction has slowed from around 1,7% per annum up to 1990, to nearer 1,1% now. In connection with overall replacement rate of existing housing stock, a figure of around 1% per annum is sometimes suggested. This seems to correspond to the reality.

The following figure illustrates how the number of rooms per housing unit has been higher in Norway than for example Sweden.



Number of rooms per dwelling (including kitchen)

2.4 Percentage of different house types

Norway is characterised by a very high percentage of individual detached houses. The breakdown is as follows:

Detached houses:	57%
Semi-detached / row:	21%
Blocks:	19%
Other:	3%

For comparison, in Sweden the percentage of detached housing is about 40%. However in Norway, in the past few years there has been a swing of several percent away from detached houses towards more apartment blocks. This seems likely to continue.

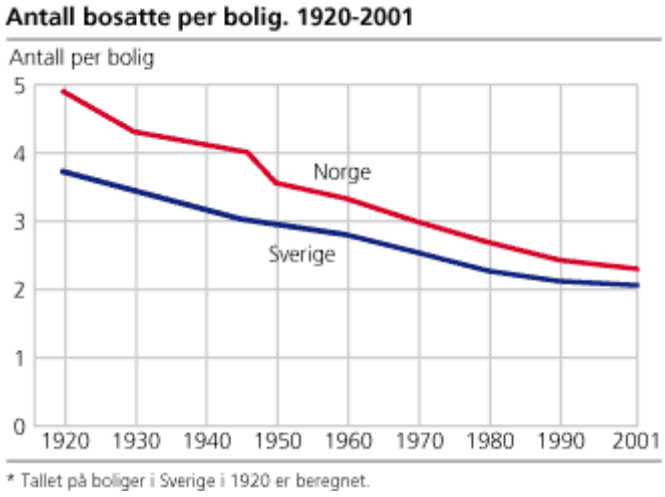
Nearly 66% of the total population lives in detached houses. Regionally there are very large variations. In some rural areas well over 90% of all dwellings are detached houses. Oslo has the lowest percentage with only 12% detached houses.

The typical “image” of the home in Norway is therefore also very much linked to the idea of a conventional freestanding house with nature around it.

The number of new detached or semidetached units constructed fell however from 11,000 in 2000 to 10,000 in 2005, whereas the number of units in larger blocks rose from 2,600 to over 10,000. This (as well as the decrease noted above in size of what is being built) also reflects that there is increased building activity in the main urban areas, therefore more apartment blocks and smaller type apartments. However, after a few years there is likely to be some saturation of the present high number of urban developments.

2.5 Number of persons per housing unit

In 1960 there were 3,3 persons per household. Today there are about 2,2 per household, and this is still decreasing but slowly now.

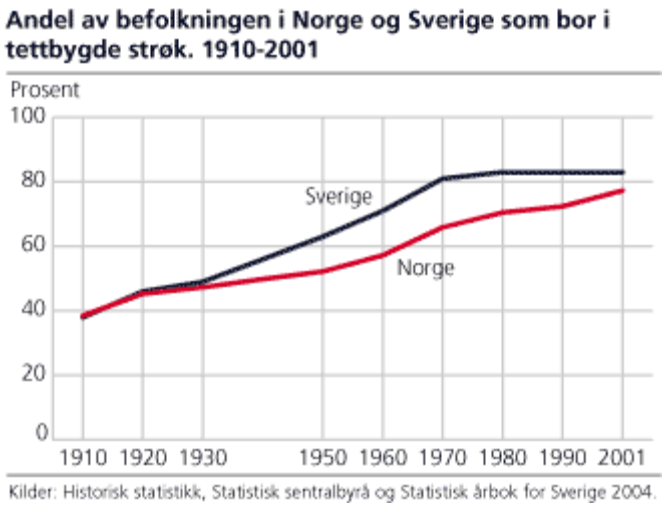


Persons per dwelling, Norway and Sweden. Source:

www.ssb.no/magasinet/norge-sverige/art-2005-03-14-01.html

2.6 Percent of population living in urban areas

This is now nearly 80%. Norway has been more rural and less centralised, and has lagged behind the other Nordic countries in this regard but the gap is smaller today. The urbanisation trend naturally influences the types of housing, overall density, and ecological footprint.



Percent of population living in urban areas:

Sweden urbanised earlier than Norway

2.7 Amenities, cars and appliances

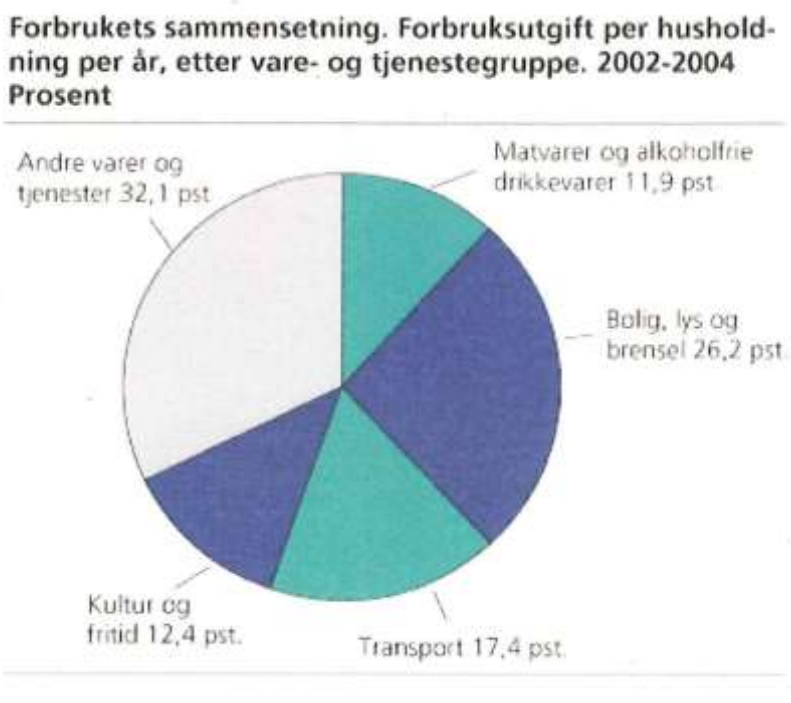
As in the other Nordic countries, most households now have quite a full range of home appliances. Nearly 80% of households own at least one car, and 30% own more than one vehicle. This may not increase very much in future since the remaining households are either car-free by choice or due to age or infirmity, plus a residual small percentage of low income households.

Amongst other possible new functions for housing, the most significant is probably that of space for home offices and information technology activities. This does not imply very major changes in house planning – not much more than a convenient office corner. The number of people who actually use a home office on a fairly regular basis is increasing too but not rapidly. (figure?).

The use of advanced and "smart" technology is increasing somewhat but again does not have very major influence on the size or planning requirements for housing, its effects are more on the level of construction and home management.

It is also of note that about 70% of all households in Norway have access to a garden, either private or common shared space.

The following diagram shows the breakdown of household expense consumption, years 2002-04, with the main categories being: Alimentation 11,9%, House and energy 26,2%, Transports 17,4% Culture and leisure 12,4%, Other goods and services 32,1%.



2.8 Home ownership

Self-owned: 61%
Association / cooperative ownership: 14%
Rented: 18%
Job related house / other: 7%

This means that in total over 75% of the population own their home. The total of rented housing including the last category is therefore about 20%. Norway still differs widely from for example

Sweden, in that most houses are owned and there is a very low percentage of rental housing. There is a lack of rental housing.

Households spend on average 26,2% (between 20% and 33%) of their total disposable income on housing, including energy. The highest figure is for single person households. These are high figures, and housing is the biggest expenditure item of households, followed by transport (17,4%), culture and recreation (12,4%) and food (11,9%).

2.9 Construction types

Timber frame is still the dominant construction type for small housing buildings, whilst concrete dominates as the main material for larger apartment blocks. Housing construction in timber thus still accounts for a majority of new units built today. Blocks and masonry account for only small fractions of the materials used in small houses, apart from cellars.

Use of timber is on the increase, with timber being used in new ways, both in housing and also in schools, commercial and other buildings. Construction technique with massive timber (brettstapel) is in its infancy in Norway but is attracting much attention. Interest is also growing for maintenance-free timber facades, for example using larch, heartwood, natural treatments etc.

2.10 Accessibility

A survey in 2001 showed that only 17% of housing units are accessible for people in wheelchairs. However, not all of these are suitable for wheelchair users to live in, that figure is about 7%.

Universal design is a priority focus today for new housing, and is discussed further below.

2.11 Energy consumption

The average energy consumption per household in 2001 was just under 22,700 kWh.

Energy consumption varies greatly between different housing types and household categories. The average free-standing house uses about 27,450 kWh, of which 21,350 kWh (78%) is electricity. In apartments, consumption is about 12,000 kWh (of which 91% electricity). Main reasons for this are that both the floor area and the number of persons are greater in free-standing houses than in apartments.

A study by the Western Norway Research Institute shows that in housing built after 1980, energy consumption per person is about the same for freestanding houses, row houses and apartment blocks. This is partly because of the differences in sizes of households, and also because the energy standard of houses has improved more than that of blocks.

Energy use in Norway is still growing, in contrast to the other Nordic countries and Denmark in particular, where there has been considerably more focus on energy efficiency.

The figure below shows that household energy consumption grew by 29% from 1980 to 2004, whereas the total area increased by 55%. Houses have thus become somewhat more efficient (lower energy intensity) but the growth of energy consumption has still been high – population for example only increased 13% in the same period.

Norway: Comparative growth in energy use, housing area, number of households and total population, for 1980 and 2004.

UTVIKLING AV ENERGIBRUK OG BOLIGAREAL

Tabell 1

Årstall	Tilført energi	Nyttiggjort energi	Boligareal	Husholdninger	Innbyggere
1980	37,1 TWh	32,2 TWh	152 mill. m²	1 523 000	4 091 000
2004[1]	44,95 TWh	41,4 TWh	237 mill. m²	2 023 000	4 606 000
Vekst	21 %	29 %	55 %	33 %	13 %

For elektrisitet regnes en nyttighetsgrad på 100 %. For olje er tilsvarende 80 % og for ved 60 %. Elektrisitetens andel av samlet tilført energi utgjorde 60 % i 1980. I 2004 var andelen steget til 74 %. Energitallene ovenfor gjelder for boliger.

For den samlede bygningsmassen ble det i 2001 anslått at samlet energitilførsel utgjorde 47 TWh. Det svarer til 38 % av Norges samlede energiforbruk uten energisektoren. Byggsektor har hatt størst vekst i energiforbruket i Norge de siste 30 år. Kilder: Enova/SSB.

[1] Foreløpige tall.

2.12 Energy sources

Electricity is the main energy source, nearly all from hydropower, with average consumption being 18,000 kWh. This is 79% of the total for the domestic sector. Due to hydropower, it is a particular characteristic of Norway that as many as 93% of households have electricity as their main source of heating. Most houses have additional heating options; additional sources are solid fuels (ovens for firewood etc) 59%; liquid fuels (heating oil or LNG gas) 21%; other 2%.

In very recent years there has been an emerging interest in gas, heavily promoted by the North Sea petroleum companies. This may be both for cooking and heating. In a few places, cities are already constructing or considering piped gas networks.

Some energy shortages in Norway in recent years have led to import of fossil fuel based electricity from for example Denmark, and there are now proposals to build a few thermal power stations fuelled by North Sea gas.

Bioenergy fuels including CHP from refuse, wood wastes, pellets etc, are generally increasing; some wind energy is developing.

Heat pumps also became popular, based on ground heat, water or air. In the case of heat pumps, the public subsidies led to rather uncritical use of heat pumps, in particular air-to-air types in inappropriate places, however this is now probably entering a more sober phase.

There has been a very big focus on water borne (mainly subfloor) heating systems in recent years, with large public subsidisation. However, opinions differ and experiences are mixed, and this may not continue for long.

In Norway there still tends to be a heavy focus on technological approaches. It is recognised now in most European countries that “passive” approaches are usually cheaper than technology solutions such as subfloor heating or heat pumps.

The figure below ilolustrates energy use in new and older buildings in Norway. It is important to note that newer buildings are NOT usually more energy efficient than older ones! This is partly due to more equipment inside the new buildings, but this result is still surprising. One reason is that many modern buildings such as offices are designed in an energy-wasting way with far too much glass.

DAGENS ENERGIBRUK (I GJENNOMSNITT) I NYE OG ELDRE BYGNINGER MÅLT I KWH/M²

Tabell 2

Byggeår	Kontorbygg	Hotell	Sykehjem	Skoler
Før 1931	201	235	272	187
1931–1954	257	277	287	175
1955–1970	238	267	257	181
1971–1987	227	280	268	186
1988–1997	272	264	277	187
Etter 1997	288	285	288	188

Kilde: Enova/Bygningsnettverkets energistatistikk 2004

2.13 Housing renovation

No complete figures have been found for the relative quantities of renovation/upgrading relative to new building in the housing sector. However, a useful indicative figure for the construction sector as a whole is that 38 billion NOK is spent annually on renovation/upgrading, compared to about 50 billion NOK on new construction. This suggests that renovation/upgrading accounts for over 40% of all housing construction in cost terms.

In area terms however, the figure will naturally be far less, since upgrading often involves small spaces, cost-intensive spaces such as bathrooms, or house improvements with no net added space.

Of the above 38 billion NOK, almost half is “do-it yourself” type purchases, improvements and upgrading, the other half is by professionals.

In Sweden, renovation accounted for around 50% as much turnover as new building (2005), which gives a confirmation that this activity is very significant.

2.14 Housing provision and market structure

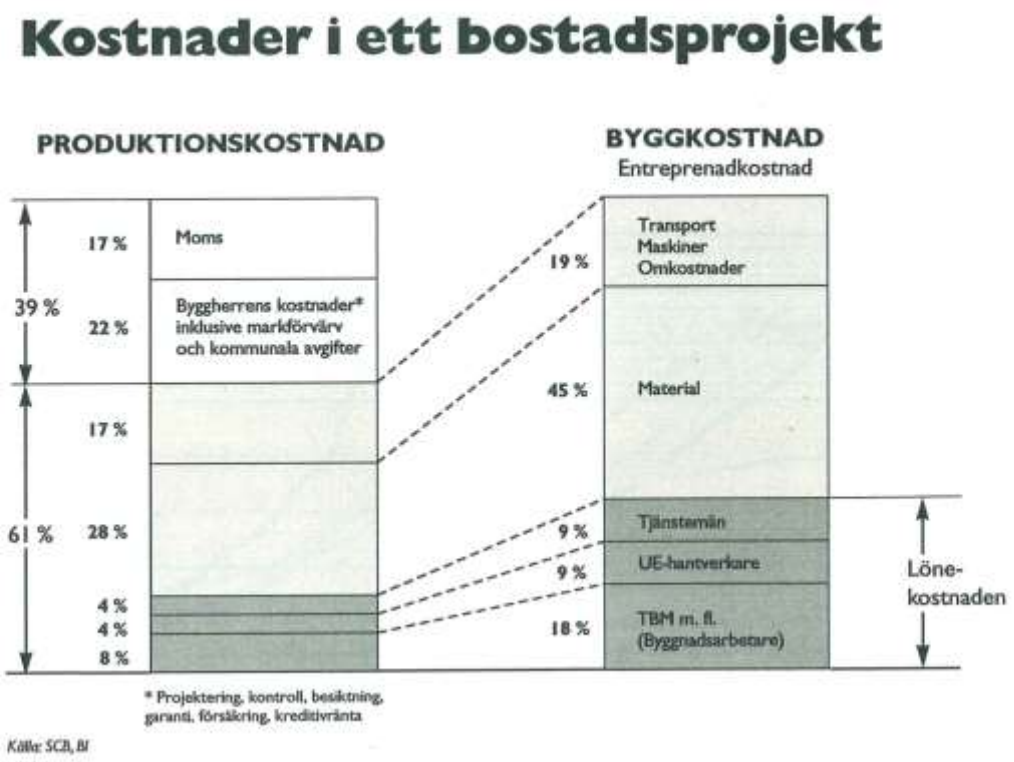
Generally, Norway has experienced the same movement away from public housing and state intervention towards a private sector dominated housing market. This includes developers and catalogue home builders, but even housing cooperatives and associations are considerably more constrained by market forces and profitability requirements these days.

The construction sector (including designers etc) is characterised by many small companies, and extremely few with more than 200 employees. Even so, the few large firms do account for over 50% of total turnover. However the housing sector is more fragmented with smaller firms.

There is some import and export of houses and components, with no big changes in recent years.

2.15 Costs

Building costs in Norway are very high. However, at present the market is also very high so there is good profitability in the building industry (this applies to much of Europe). In the longer term, materials such as timber with low environmental impact, and which can be produced regionally, will probably become more competitive.



The above diagram shows a building costs breakdown for Sweden. The picture for Norway will be similar. It is to be noted that the materials costs generally, whether timber or other, are less than 30% of the total project costs. They are also less than 50% of total building costs. This means that future trends in timber use are not only a question of the materials costs.

3 MAIN ACTORS IN THE HOUSING SECTOR

3.1 The State Housing Bank (Husbanken)

Husbanken was an extremely important actor in housing up until the 1980s, not least through its favourable loans, but also in setting standards, leading development of housing models and as a centre of expertise. Rents were deregulated in the 1980s, tax deductions were reduced, and Husbanken no longer gave loans at very preferential rates.

In these more liberal times, its influence is still big. It still provides the main financing loans for about 60% of all new housing, and includes a focus now on care homes and other special priority areas.

A considerable part of the Bank's total annual loan framework of around 13,5 billion NOK is given in the form of basic loans. The loans promote key topics such as environmental quality and universal design, as well as providing housing for special needy groups, the disadvantaged and for housing in outlying districts. The loans may be used to finance new housing, upgrading, conversion to housing, and purchase of new or unused rental housing and promote housing policy goals that would not otherwise be achievable. The following are stressed in particular:
- Universal design: housing and housing areas with universal design, including provision for life cycle standard, provision of lifts and other accessibility qualities
- Environment: energy use lower than current regulations, improved indoor climate, measures to reduce radon emissions, recycling/re-used materials
- Good building style

Husbanken provides support and information, finances some research, and provides concrete incentives including some fairly minor grants for the policy priority areas. Grants to skills development have a budget of NOK 56,7 million in 2005. These shall be used amongst other purposes to stimulate environmental measures. Experimental and pilot projects with particularly high ambitions may be given grants in addition to loans, up to 90% of costs. Amongst other themes, the Bank has provided support to:
- development of low energy housing
- massive wood construction applied in "passive" houses
- development of environmental technology for housing and buildings
- environmentally friendly maintenance and management
- life cycle costing and durability
- user-friendly internet databases for selection of ecological materials and building components
- a database of best practice sustainable buildings
- recycling / re-use of building materials and products
- international cooperation

Husbanken is a directorate under the Ministry of Local Government and Regional Affairs, KRD.

3.2 The National Office of Building Technology and Administration

Statens Bygningsteknisk Etat (BE) has the administrative responsibility for the Planning and Building Act (PBL). BE is a directorate under KRD. BE is also an important resource and information centre regarding buildings and formal planning procedures. BE plays a central role in developing and formulating technical directives and guidelines, following up EU directives, and in international standardisation. A specific policy goal of BE is to contribute to development of a more environmentally sustainable and resource efficient housing and construction sector.

BE is at present preparing a revision of the planning and building regulations (pbl). Some significant features of this are discussed below.

One of the overall goals of housing and construction policy is to ensure healthy and environmentally sustainable building. This is elaborated in the Parliamentary proposition St.prp no.1 (2004-2005) of KRD. The housing proposition identifies six priority areas. These areas are:

1. To enhance space use efficiency and attention to biodiversity
2. To reduce energy use in the building stock
3. To document and reduce the use of hazardous substances in construction
4. To reduce construction waste and increase recycling / re-use of materials
5. To focus on high quality and good building style in the built environment
6. To ensure environmentally sound building management and maintenance

Accessibility for all shall be ensured by the principle of Universal Design. In 2004 the government presented a plan for universal design for various sectors (see: www.universell-utforming.miljo.no)

In 2005 a Building Costs Program was set up. This is a five year program in collaboration between the Ministry and the construction industry's organisations (BAE-rådet). The aim of this program is to reduce costs and enhance quality in housing and other buildings through better processes. The program's focus areas are increased client competence, development of buildings that are efficient to manage, reduced construction errors and increased productivity. Measures within the program will aim to reduce construction costs whilst at the same time ensuring sound environmental choices. For example, reduction of errors, better coordination and management of construction sites can result not only in lower costs but better quality, as well as reduced amounts of waste.

Although the aims of this program appear fairly ambitious, the actual budget is at most a few tens of millions. This reflects a rather typical Norwegian situation where there may be high ambitions, but with very little funding attached. Results are thus unlikely to be very significant.

3.3 The Ministry of the Environment (MD)

Being responsible for environmental policy, the Environment Ministry has overall responsibility for the following measures that affect the quality of the housing and construction sector:
- The Planning level of the Planning and Building Act
- Pollution legislation, including directives on pollution, emissions, recycling and wastes
- Legislation on Cultural Heritage
- The Environmental Information Act
- Legislation and directives regarding products control
- Research and information

3.4 The Directorate for Cultural Heritage (RA)

RA is MD's advisory and executive body for the management of cultural heritage, both architectural and archaeological monuments and sites as well as cultural environments. RA as well as other city cultural authorities (Byantikvar) have a significant influence on the development of existing older housing, and a special interest in traditional technologies, including environmental aspects – such as natural ventilation, traditional clay and lime plasters, eco-friendly timber techniques, natural paints, etc.

3.5 The Norwegian Pollution Control Authority (SFT)

A directorate under MD, SFT's mandate is to contribute to a sustainable society where pollution, products and wastes do not cause health hazards, impair well-being or damage nature's capacity for self-renewal. SFT focuses on the risks of damage to human health and environment from chemical substances and products, and thus has a significant influence in the construction sector.

3.6 GRIP Foundation for Sustainable Consumption and Production

GRIP is a foundation under the Ministry of the Environment. GRIP's objective is to contribute to increased value creation with lower environmental impacts.

3.7 The Directorate of Public Construction, Statsbygg

Being the state's builder, property manager and developer, Statsbygg is a very major player in construction and in environmental efforts in the sector. Statsbygg is Norway's largest actor in the civil property market, with approximately 2.2 million square metres of buildings. Statsbygg executes planning, construction consulting, property management and control of construction projects on behalf of ministries, directorates, universities and colleges.

3.8 The Ministry of Petroleum and Energy (OED)

OED is responsible for petroleum and energy policies. The Norwegian Water resources and Energy Directorate (NVE) and Enova, a public enterprise, are under the ministry. Within OED, some of the activities of both NVE and Enova are extremely important for the environmental state of housing and buildings. OED is responsible for the Energy Act and its directives, support to research and development in the field of energy, and support to measures to switch towards more environmentally sound energy production and use.

3.9 The Norwegian Water resources and Energy Directorate (NVE)

NVE administers the nation's water and energy resources. Goals are to ensure integrated and sustainable management of resources, effective power distribution and contribute to energy efficiency.

3.10 Enova SF

Enova is a governmental program to promote conversion to more sustainable energy production and consumption, energy savings, reduced dependence on electricity, and development of new renewable energies. Enova SF was set up in June 2001 and is financed from the Energy Fund, which is financed by an extra tax of 1 øre per kilowatt hour on the general electricity consumption tariff.

Enova has a particular program aimed at energy use in housing and commercial buildings, which covers both new construction and renovation.

Enova aims by 2010 to improve the Norwegian energy situation by the amount of 12 Terawatt hours, through reducing energy demand growth significantly more than would be the case without

such intervention, as well as by increasing the production of new renewable energy. Of this at least 3 TWh is to come from wind power and 4 TWH from production of heat. The total energy target for Enova's annual programs in the housing and building sector in 2004 was 325 GWh; for 2005 it is 440 GWh.

These goals are achieved by binding contracts with public and private sector building owners, who are invited to implement projects with concrete goals for energy savings and/or conversion. Enova also focuses more widely than on energy alone, for example on strategy and market penetration, design education and long term skills development

3.11 The Housing Cooperatives and Associations

These are still big players in the housing market. The Norwegian Federation of Cooperative Housing Associations NBBL groups about 250,000 housing units or 15% of the national total. NBBL and its members are large investors in and managers of housing. In Oslo these groups comprise 40% of all housing. NBBL's member associations build around 3,000 units per year. Environmental issues are included in their policy documents, and they have executed some pilot projects in this field.

However, these groups have to comply with competitive market type requirements to a far greater extent today. This is a disincentive to innovation as well as to social housing.

3.12 The private sector

Most apartment blocks and similar are initiated by developers, whereas a large percentage of individual houses are constructed by house building companies. Relevant organisations for these are respectively the property developers organisations, such as NBEF, and the federation of house producers Boligprodusentene (see annex).

Most small housing is constructed by the housing companies. The Boligprodusentene group comprises about 800 firms covering more than half of all houses built in Norway. They have an agreement with Enova on a target to build all their houses with 20% lower energy use within a few years.

In the private sector of construction and housing, several development programs are under way, often in collaboration with the state. These include programs focusing on increased energy efficiency, environmental quality, materials declaration, resource management and prefabrication, as well as more standard themes such as economic efficiency, industrial innovation and skills development.

In this author's view, however, these programs are still rather small, and are far from comprehensive in their understanding of sustainability issues.

3.13 The timber sector

In the field of timber innovation, the program Trefokus can be noted, as well as the collaboration of Trefokus and others on timber development including the forestry and timber industries, Tresenteret, and the public financing program Innovasjon Norge. More discussion of the timber sector is given below.

3.14 Market leaders - Sustainable building

There are very few groups working proactively today in the field of sustainable planning and construction in Norway.

Norwegian Architects for Sustainable Development, **ECOBOX** (formerly NABU), a self financing program within the National Association of Norwegian Architects, is actively promoting this field including design tools, passive and low energy design, ecomaterials, massive timber, bioclimatic planning and other sustainability themes. ECOBOX has 5 employees, limited public funding, and therefore a fairly small but important portfolio of activities.

A few **NGOs** including the Society for Nature Conservation (NNV), The Ideas Bank (Idebanken), Bellona and Green Everyday (Grønn Hverdag) have some activities relating to housing, energy, materials and consumption.

There are technical companies and consultants in the field of energy, waste systems, heat recovery, biological water systems etc. Amongst practicing architects and engineers, the **GAIA group** is one of very few with broad information, educational and dissemination activities in this field.

Some **Ecolabelling** systems are becoming more common and include both household appliances as well as, to some extent, building materials.

There is little proactive teaching work at Norwegian **schools of architecture and engineering,** and this is a serious weakness today considering the growing need for qualifications in ecology, energy and sustainability in the design professions.

3.15 Political pressures

There is still little focus around the fact that the construction sector is the "40% sector", being in fact responsible for a larger part of emissions and energy use than either industries, or transports, which attract most attention. This seems to be due also to construction being a fragmented sector and that there is no really strong lobby to create this focus.

The strong lobbies are for example those of the oil and gas industries, traditional engineering and construction materials. Housing lobbies for their part, are vocal mainly on more conventional themes such as financing and tax conditions, costs, or reductions in bureaucracy.

Housing and construction questions are, as the above survey of actors shows, handled by directorates under the Ministry of Local Government and Regional Affairs. This Ministry thus has very broad and politically important affairs as its main concern, and it is not surprising that housing and construction are not likely to be the Minister's main interest or focus. And the Environment Ministry, responsible for planning issues, is also often likely to focus most of its attention on more controversial issues of pollution and nature conservation. The structure of these Ministries thus means, in my view, that it is unlikely that sustainable planning and construction will receive very much attention. A dedicated Ministry might be a far better solution.

4 EMERGING POLICIES, REGULATIONS ETC

Some of the main public policy directions have been highlighted above. In summary, these include a slowly increasing focus on all aspects of sustainability, but in particular on energy.

4.1 THE PLANNING AND BUILDING REGULATIONS

The main overall changes and trends in the Planning and Building Regulations (pbl) and attached Guidelines (veiledning) in recent years, including the last major revision in 1997 and the present revision, can be summarised as follows:

- all requirements are in terms of performance, NOT specific solutions
- there is more requirement for internal follow up and self- control systems by the designers
- responsibility for solutions chosen is more privatised
- focus on more effective building management may lead to a new law within a few years.

Sustainability is being introduced as a general overall principle. However, sustainable construction needs first to be defined more clearly. In the longer term, sustainability is fairly sure to become a leading principle for building legislation – including both building, and area planning.

Universal design is gradually being introduced (and it comes under the concept of sustainable development). At present, it is only weakly covered in the regulations, by for example requirements for elevators and handicap access. The building authorities note that this issue will need to take into account the difficult topography in Norway.

BE has produced a handbook for Universal design, is evaluating how universal design can be introduced into the regulations, and is working on quality definitions for Norsk Standard so as to develop standard descriptions of requirements.

For all major upgrading and refurbishment, the same energy standard is to be required as for new construction. This will follow the coming EU directive. The Energy Directive is coming into force in Norway and will have significant effects on construction practice.

Ventilation is also being reviewed, and the new EU directive may make it difficult to achieve energy targets without using mechanical ventilation in future – even though in principle, one may use any solution provided it fulfils the required performance. There is debate whether this will be a positive development, both due to the costs, indoor climate concerns, different opinions as to the necessity of mechanical ventilation in different building types, and since some would prefer to develop natural ventilation solutions.

The laws focus on performance, and therefore there are not specific regulations or advice regarding building materials or wastes. These are covered within for example pollution control legislation, product legislation etc. However, lifecycle requirements may well be included in future.

Later phases of a building's life cycle, such as indoor climate and construction waste disposal, are covered by other legislation. In part, the production phase of buildings is covered by Industrial Safety and Environment legislation. However, it is to be noted that present building laws regulate the production / construction phase, and do NOT address the use phase. This is a major issue if one wishes to address sustainability.

4.2 RENOVATION OF EXISTING HOUSING

There is an increasing focus on the importance of the existing building stock. Due in part to fairly stagnant population growth, it is often said that "the housing of tomorrow is already built…". Although this should not be exaggerated, existing housing will play a very large role for a long time, and therefore should be a key focus for energy efficiency and other improvements. This also applies to improving the environmental and social quality of outdoor areas and housing areas seen as a whole, not only the individual buildings.

BE has recently produced a guidebook on this theme, looking at different types of existing housing buildings. The particular focus of the guidebook is environment and sustainability (the undersigned was involved in preparing chapters on energy, building products and healthy ventilation). The EU Energy Directive is also coming into play since existing buildings must receive an energy performance certificate. In addition there are clearer energy requirements for upgrading of existing buildings.

As noted above, Husbanken and others will also encourage more and more housing renovations where functional attention is paid to universal design, both within apartments and in the outdoor common areas.

Traditional wooden building in Norway: Old fish warehouse in Bergen, converted to housing, with heat pump, passive solar, etc. Architects Butters / Bruskeland / Haukeland

4.3 ENERGY

Energy is becoming one of the biggest drivers of change in the construction sector. This applies both to thermal insulation requirements, as well as to products and life cycle criteria.

The following diagram illustrates the large improvements in energy efficiency that have been achieved in Sweden. Much the same is true in the case of other European countries such as

Denmark, Germany, Netherlands etc. The picture in Norway is not the same. There have been smaller improvements but Norway is falling somewhat behind in this field. Due partly to incoming EU energy legislation, Norway is likely to catch up during the next 10-15 years. This will also influence choices of materials.

Energieffektivare byggnader

Användning av köpt energi per år

	Elenergi (kWh/m²)		Värme (kWh/m²)		Totalt (kWh/m²)	
	Samtliga	Nya hus	Samtliga	Nya hus	Samtliga	Nya hus
Småhus (120 m²)						
År 2000	35	35	115-155	70-115	150-190	105-150
År 2005*	35	30	125	60	160	90
Flerbostadshus (75 m²/lgh)						
År 2000	40-45	35	130-200	140	170-245	175
År 2005*	35	35	165	85	200	120
Kontorslokaler						
År 2000	95-125	95	45-115	45	140-240	140
År 2005*	90	80	110	40	200	120

*Prognos

Källa: Miljövårdsberedningen "Tänk nytt, tänk hållbart! – att bygga och förvalta för framtiden"

Energidebatten belyser sällan hur användningen av energi kan bli effektivare och därmed mera lönsam. I stället handlar debatten nästan uteslutande om tillförsel av ny energi. Miljövårdsberedningen har lämnat en rapport till regeringen om effektivare energianvändning. Enligt deras prognoser är det för uppvärmningsändamål inom bostadssektorn som de största energieffektiviseringarna kommer att ske. Sänkt skatt på energieffektiva hus, skärpta byggregler och hårdare villkor för elvärme är några av förslagen i rapporten. Boverket har fått i uppdrag att analysera och konkretisera förslagen.

I nya småhus är energibehovet för uppvärmning mindre än i äldre hus och denna trend förväntas fortsätta under de kommande 10 till 20 åren. Detta åstadkoms bland annat genom bättre isolering, energiåtervinning på ventilationssystemet, bättre lufttäthet samt bättre tillvaratagande av energi från solinstrålning och överskottsvärme från apparater.

Motsvarande effektiviseringar är inte lika framträdande vad gäller energianvändningen för varmvatten och för hushållsel. Det finns dessutom en tendens att elanvändningen ökar utan att ge en effektivare total energianvändning.

More energy effective buildings – Sweden

Electricity use has not changed much, but heating need has been greatly reduced in new housing. In Norway, the same trend is only beginning now, showing that Sweden and Denmark made far greater efforts to improve energy conserving building standards and practice

One part of the EU Directive on Energy in buildings concerns indoor air and ventilation. Generally higher requirements for ventilation may be difficult to achieve with natural ventilation solutions, and thus force the use of mechanical ventilation (in most cases with heat recovery). This may have energy saving advantages in many cases, but limits designers' options. Mechanical ventilation also raises many potential problems – not least considerable extra costs. In addition mechanical ventilation may be associated with a range of problems related to high air movement, noise, maintenance, and energy consumption. There are different philosophies in this field and it appears unwise that the Directive will in practice enforce one way of thinking.

Choice of ventilation should be considered in an integrated way. Indoor climate and in particular humidity problems may be solved far more effectively by passive means – including using hygroscopic building materials.

One should be looking for optimal overall efficiency (including health), not technical efficiency alone (the engineering attitude). Enforcing mechanical ventilation, in particular in small buildings such as housing, has a considerable effect on construction practice – and costs. In my view, natural ventilation and passive design solutions are likely to prove cheaper and healthier in the long run, and this kind of legislation is therefore likely to be reversed within a generation.

4.4 ENERGY PLANNING

There is increasing awareness that urban area planning and energy planning need to be integrated. Naturally, housing areas will be more efficient from the energy systems point of view if they are compact and rationally planned. Good energy planning is important both on the level of the individual buildings, and the overall housing areas.

On the individual level, it is essential that houses be oriented correctly if one is to make future integration of solar energy possible (especially on roofs), and this is a focus of an ongoing study in Bergen city as well as a focus of the EU Concerto program. On the level of overall area planning, the number and layout (as well as mixed use) will determine whether local energy plants for district heating systems (DHS) will be feasible economically. Such systems include for example local CHP (combined heat and power) plants fuelled with bioenergy, solar energy or combinations with for example gas, wastes and wind power.

On the other hand, this raises the very important issue of conflicts between low energy buildings and DHS. An area designed with low energy houses will be less profitable for a piped district heating network, since much less energy will be delivered/sold per unit length of pipe network. And conversely, an area where there is a DHS (with obligation to connect!) will make it less profitable for anyone to build a low energy house. This also implies a loss of individual freedom of choice.

These and related issues are certain to gain increasing attention. The goal of better integration of energy planning and area planning is already included in official policy documents. The revised PBL intends to focus on this area, with increasing requirements on towns and municipalities for energy planning to be integrated with urban and space planning. Particular focus is for example on promoting transition from electricity to water-borne heat, effective district heating, renewables and efficiency.

In other words, whatever the solutions chosen, there will be more focus on the larger-scale energy implications of different housing localisation and typology.

4.5 THE EUROPEAN UNION

A wide range of existing or coming EU legislation on energy, products, chemicals, wastes, life cycle environmental requirements etc, will have an increasing influence on construction as well as procurement. In general this will increase the environmental quality of housing and reduce energy use. Amongst legislation relevant for housing are the following:

- Directive on Building Products, 89/106/EØF: Requirements regarding health, hygiene and environment. Follow up should stimulate more environmental declarations for building products and increased use of such products.
- Directive on Drinking Water, 98/83/EF: Shall ensure that materials used in water supply systems do not emit hazardous substances

- Directive on Buildings, 2002/91/EF: Has as its purpose to improve energy use in buildings. The background is that there is a large potential for increased energy efficiency in the building sector which can contribute both to reduced climate gas emissions and increased security of supply.
- Directive on Heat Producing Units for Space Heating and Hot Water Boilers, 78/170/EØF
- Directive on Hot Water Boilers, 92/42/EØF and supplementary directive 93/68/EØF: Contains efficiency requirements for new hot water boilers using liquid or gaseous fuels, in order to promote energy efficiency.
- Directive on Noise, 2002/47/EF: Comprises requirements for noise both in and outside buildings.
- Directive on Evaluation of Environmental Impacts of Certain Plans and Programs, 2001/42/EF: Requirements for environmental impact assessment of general plans that create premisses for construction, and area plans that may have consequences for environment, nature or society.
- Directive on Impact Assessment, 85/337/EØF, as modified in 97/11/EF
- Directive on Environmental Information, 313/1990/EØF
- Directives on Waste, 1999/31/EF, on Combustion 94/67/EF, on Special Waste 91/689/EØF and Directive on Waste 75/442/EØF.
- RES-Directive 2001/77/EF: Promotion of renewable energy in the internal electricity market, following specific targets.
- Directive on Cogeneration of heat and power, 2004/8/EF amended 92/42/EØF: Promotes cogeneration based on useful heat demand
- Four Directives on Chemicals, 67/548/EØF, 99/45/EF, 76/769/EØF, 92/32/EØF
- Directive on Quotas, 96/61/EF: Provides the basis for the introduction in the EU of a quota system for climate gases.
- Directive on VOC in Paints and Varnishes, 2004/42/EF: Supplements Directive 1999/13/EF limiting emissions of volatile organic compounds (VOC's) originating from the use of organic solvents, to achieve lower levels of solvents in these products.
- Directive on Public Procurement, 2004/18/EF: Environmental protection requirements are built into directives on public procurement.
- Directive on Discarded Electrical and Electronic Products, 2002/96/EF: Imposes on manufacturers and importers the financing and collection of past EE waste.
- Directive on Household Appliances, 92/75/EØF: Covers the energy and resource use of household appliances by means of labelling and standardised product information.
- Proposed Directive on Chemicals – REACH: Will replace over 40 existing directives and statutes.
- Proposed Directive on Persistent Organic Compounds: Regulates production, distribution, use, emissions and disposal of substances covered by the global Stockholm Convention on persistent organic compounds (POP) and ECE and the ECE Protocol under the convention on long distance transboundary air pollution.
- Proposed Directive on Ecodesign: Concerns the framework for "ecodesign" requirements for energy consuming equipment.

4.6 INTERNATIONAL INFLUENCES

In addition, international environment-related developments and agreements, etc, as well as liberalisation policies, will have an influence on construction including housing.

Main topics on this agenda are:

- biodiversity / land use
- energy and climate emissions
- hazardous substances and wastes
- free trade in products and services

The first of these is unlikely to have much influence on the localisation or planning of housing areas in a foreseeable future. Even though some sites may be unfavourable for housing, for climatic reasons, or ecologically sensitive, other considerations such as attractive location and costs usually take precedence in practice.

Items 2 and 3 have been discussed above and will cause significant changes, mainly due to existing and coming EU legislation.

Timber as a "natural" material will be favourised by these considerations in the future, in particular where it can be used without long transport distances and without chemical preservatives or paints. Timber buildings are also being discussed as a form of medium term carbon sequestration.

The last item will lead to some import of houses, particularly timber houses, from countries where production costs are lower, such as the Baltic countries. It may also lead to import of other construction materials for the same reason. Many of the first generation of massive timber constructions are being imported directly from producer countries such as Sweden, Austria or Germany, however most future production is likely to be local.

International influences in housing:
Zero energy and passive houses – even "plus-energy" houses, as here, which produce more energy than they consume.
Solarsiedlung, Freiburg, Germany - Architect Rolf Disch

5 PROBABLE TRENDS IN HOUSING

5.1 Housing volume, types and size

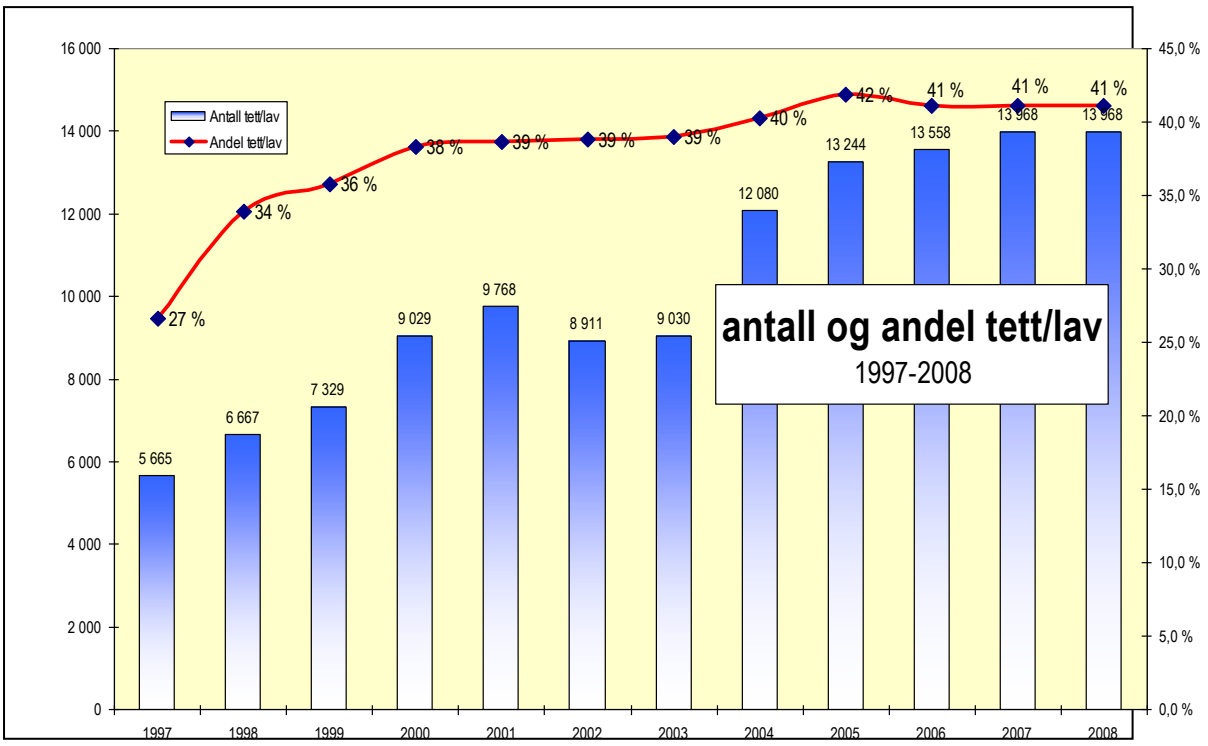
There is likely to be a continued movement towards more compact settlement patterns and thus denser housing typologies. However, this will not necessarily reduce the predominance of timber housing, given the new interest in multi-storey massive timber solutions.

As noted, there is a small movement towards slightly smaller average size housing units, both for demographic and cost reasons, and due to policy. In addition the Federation of Building Industries foresees some saturation in the market for larger size dwellings.

Almost 30,000 dwelling units were built in 2005. Until 2008 the volume is estimated to be slightly lower, around 26-28,000 units. Apartments in blocks accounted for nearly 50% of the total due in part to very high activity in the major cities, this is expected to decrease somewhat. Prices are also expected to flatten out. However, though property markets appear to be very overheated in some countries, no drastic fall is foreseen in Norway for a few years. This may or may not prove to be the case.

The market in leisure homes however is experiencing strong growth, with over 500,000 sq.metres now being constructed yearly, and long waiting lists.

The percentage of detached houses is falling, which would reduce the use of timber, since larger apartment buildings are more often built using more concrete, masonry and steel. But this is partly compensated by a fairly large rise in low-dense housing (up to 4 storeys) where a considerable amount of timber is also used – as well as by the increase in holiday homes, the vast majority of which are in timber.



Increase in low-dense housing: (up to 4 storeys and excluding detached houses)
From 27% to 42% of all new housing – 1997 to 2005 – and doubled volume

Source: www.Prognosesenteret.no for www.Byggutengrenser.no

From the statistics given earlier, it can be inferred that the probable demand for housing in Norway will be fairly stable, and might rise if holiday homes are included. The demand for timber appears to be slightly rising. See more discussion of building materials below.

Modernistic holiday house entirely in timber
Architect: Todd Saunders

Norway is a rich country with expanding consumerism. It is therefore improbable in the foreseeable future that there will be much trend towards reduced consumption in terms of costs, size or standard of housing. Holiday housing is increasing very rapidly at present.

In the area of housing procurement, it seems likely that small to medium scale actors will continue to dominate investment and construction in housing. Little social housing is being built. Targets for a minimum percentage of social and assistance housing in new housing areas are often achieved now as part of agreements with developers (public-private partnerships, utbyggingsavtaler).

5.2 Technology and production

There is a trend towards prefabrication but the housing industry, at least for small buildings, is not very advanced in this field. Prefabrication offers advantages both of cost, and of environmentally clean and waste-reducing production. This trend is likely to continue. As an example, the large company OBOS have acquired a factory in Sweden and are planning a development with 600 houses using this system.

There is a trend towards more technology in houses, in particular items such as heat pumps, heat recovery ventilation systems, automatic controls, etc. In my view this is encouraged rather uncritically by marketing forces, and advanced technology in housing should be kept to a reasonable minimum, since it is often not controlled, maintained or understood properly by average users. (by contrast, in large buildings it is easier to ensure well qualified maintenance and operation). Advanced systems may be best in theory, but simple systems are better when we consider real people, in the normal domestic sector.

6 ENERGY

6.1 General

Energy from hydropower has traditionally been very cheap in Norway, and this is probably the main historical reason why interest in energy conservation and alternatives has been low in Norway. The electricity market was however deregulated 15 years ago.

Rising energy prices are probably the biggest single force driving increased interest in ecologically sustainable building.

Although energy is only one aspect of sustainable building, and is thus often over-focused as a "specialist" issue, the focus on energy does seem to lead to a wider appreciation of the other important issues such as healthy materials, natural ventilation, embodied energy, recycling etc.

Husbanken now has the ambitious goal that 50% of all houses it finances in 2010 should be low energy standard. There is also growing interest in passive houses, and the first few projects are being designed or built at present. It is said that there are now over 2,000 houses being planned or built to low energy standard. However as of today there are only a few dozen in existence. The first three or four houses built to achieve passive energy standard are only nearing completion today.

The private sector and housing companies are being encouraged to follow suit, but appear to be rather conservative, since their market is not yet actively demanding low energy standard or other ecological features.

There is also a big lack of experience in practice with low energy buildings and alternative ecological solutions in Norway. This is aggravated by the low attention paid to R+D and generally to lack of post-occupancy evaluation and monitoring.

Timber low energy house, Stavanger
Architects GAIA Lista

The above shows that Norway is lagging some years behind other European countries. In Germany, Austria, Switzerland, Sweden, Denmark and the Netherlands there are already hundreds of low energy houses and dozens of passive standard buildings.

6.2 The EU Energy Directive

This directive with its corresponding Norwegian follow-up is the main piece of coming legislation that will affect construction. Basically, energy efficiency standards are to be raised for all building types, including renovations. In addition the requirement for energy performance certificates will force designers, property developers and others to raise their awareness of energy issues.

One of the main effects is thus psychological: it focuses attention on environmental design. Energy as such is only one issue, but it does tend to foster awareness of other sustainability issues such as embodied energy, life cycle sustainability, indoor health etc.

Norwegian requirements are being developed in conformity with EU Directive 2002/91/EC, and imply a reduction of the energy requirements for buildings including housing of about 30%. These targets are not very difficult to achieve compared to today's state of the art in low energy design. However, most professionals in design and construction in Norway do not have experience with low energy design, and therefore a lot needs to be done.

The proposals are to enter into force in January 2007, with a transitional period of 2 years. Buildings are divided in to 13 categories, and there are to be 2 models for achieving the requirements: 1) based on calculating the energy needs (rammekravmodellen), and 2) based on providing given energy solutions (energitiltaksmodellen).

PROPOSED BUILDING CATEGORIES:	ENERGY GOAL:	
Small houses	125 kWh/m2.year	
Apatment blocks	110	
Kindergartens	130	
Offices	140	
Schools	105	
Hospitals	285	
Health institutions	220	
Hotels	200	
Restaurants	210	*source: KRD 05/1435-23 KEK, 13.06.2006,*
Sports buildings	160	*Hearing document – changes to TEK and SAK*
Commerce buildings	235	*related especially to EU Energy Directive*
Culture buildings	145	
Light industry	155	*and: SINTEF Byggforsk 2006: Nye Energikrav*

These requirements have been calculated as being directly cost effective on a socio-economic basis, though the payback times may be up to 12-18 years. They will reduce energy demand by about 5 TWH and climate emissions by an estimated 1,6 mill. tons CO2, after 10 years.

The energy certification system is being developed by thje Ministry of Petroleum and Energy, and must be provided for all new buildings as well as in the case of sale/rental and refurbishing of all existing buildings over 1,000 sq.metres.

All renovations over 1,000 sq.metres will be required to achieve the same energy standard as new construction. Using part renewable energy must also be evaluated in proposals.

Holiday homes (over 80 sq.metres) are for the first time to be included, with the same energy requirements as for housing.

The main concrete features included in the energy proposals for buildings are the following:

- maximum glass area to be 20% of floor area
- walls U = 0,16 W/m".K
- roof U = 0,13 W/m".K
- floor U = 0,13 W/m".K
- windows/doors including frame U = 1,1 W/m".K
- minimum cold bridges
- air tightness 1,5 ach at 50 Pa (= 0.1 ach infiltration)
- 80% efficiency (year average) for heat recovery
- CFP (fan efficiency) maximum 2,0/1,0 (day/night) for offices, 2,5 for housing
- automatic external shading or other solution to avoid cooling need
- temperature lowering (night and weekend) specified for various building types

The proposals would exempt buildings in traditional log construction, on the grounds that it is important to maintain traditions. However, no alternative solution for such buildings is proposed (such as requiring increased thermal standard in roofs or windows to compensate for the poorly insulated log walls).

The air tightness standard does not seem particularly strong, and more importantly, a mechanism is needed for requiring air tightness testing before building completion.

The proposals also aim to make mechanical ventilation virtually compulsory. This is in the view of this author and others, a step in the wrong direction and is being contested. Modern building regulations, including in Norway, have the basic principle of posing quality requirements, not linked to specific technical solutions but so that designers may fulfil the requirements in any manner that works. Enforcing mechanical ventilation departs from this principle; many are opposed to mechanical ventilation for cost and health reasons; and the proposal would eliminate the possibility of natural ventilation – at a time when exciting new solutions for natural / hybrid ventilation are attracting interest in many countries.

This proposal is in addition, unnecessary. It would also be in direct contradiction to the stated intention of the law which is to encourage renewable energy and passive solutions. Natural ventilation like passive solar heating is based on increased use of local, renewable energy flows.

The proposals specify a single climate zone for all of Norway. The old system with six different climatic zones was abolished around 1980, and it would seem more appropriate to reintroduce some form of climatic zones.

The proposals also introduce Universal design into the building laws, however not yet as real requirements but rather, at this stage, to "increase focus and awareness". In future this is likely to become more concrete. At that point, the definition of universal design should also be expanded to include healthy indoor climate and materials in consideration for people with asthma and allergies.

The above proposals have been developed for the building authorities by, amongst others, SINTEF, and are at present in a round of hearings. This author's office is involved in preparing comments with the Architects Association, and will submit several critical comments, as the above comments indicate. The final proposals are likely to be approved towards the end of 2006.

7 MATERIALS

There are some small trends towards more ecological building materials. This is accentuated by policy intentions, as well as by Norwegian and EU legislation on products, energy, chemicals etc. One result of this kind of legislation is simply that ecological alternatives become relatively more cost competitive. Some new materials trends are as follows.

7.1 Biomaterials

Interest in biomaterial construction methods such as straw bale, earth, clay etc is still marginal in Norway, but may well increase as experience is gained and the advantages of these become clearer. There is for example a new initiative to produce pressed straw boards, similar to the industrial material Stramit which was on the UK market until some 20 years ago. In some European countries, clay-based boards, plasters and paints are now available commercially and this will therefore also arrive in Norway in due time.

Production of plastics from plant matter also seems likely to increase. Today's polymers are nearly all derived from fossil fuels which are of course both climate emission sources, and rising in cost. The increased focus on biomass uses generally should strengthen this trend. It is worth remembering that some very early plastics such as Bakelite were made from maize.

7.2 Recycled materials

Producer lifecycle responsibility, coupled with a big program on reduction of construction wastes co-funded by the state and the industry, has led to increasing re-use of materials. This includes materials such as asphalt, concrete and bricks, as well as gypsum (plasterboard offcuts), glass, etc.

There have been studies and large development programs for recycling concrete (such as RESIBA). Up to around ¼ of recycled concrete can be mixed in as aggregate in new concrete for many uses, and this can be specified as a requirement in new works. The concrete industry is very active in this field, and also looking at energy efficiency and other environmental issues. In general therefore the concrete industry is becoming more environmentally friendly, but still faces major challenges. This is due not least to carbon, since the basic chemistry of cement production means that about ¾ ton of carbon is released for every ton of cement, and this can not be avoided (even though recarbonisation reduces the net emissions somewhat).

In association with this author and NABU, Bente Nuth Leland is publishing a book on re-use. This includes a focus on design for re-use. Re-use will increase, and this favours timber. However, issues such as the legal guarantee for re-used materials and components are not easy to resolve.

7.3 "Natural" finishes

Although one must take the term "natural" with a pinch of salt, there is an undoubted move away from many of the more chemically suspect products in paints and finishes in our society, such as solvents, heavy metals, etc. More sustainable / ecological products include natural oils, water based paints, waxes, clay and lime based plasters, etc.

In addition there is a move towards untreated surfaces, not least to reduce maintenance costs. This trend is in favour with architects and designers who like to use materials in such a way that their natural expression is highlighted.

7.4 Insulation

Insulation materials have by many been considered a problem from the ecological point of view. There is now an interesting new product coming on to the market - insulation mats made from recycled textiles. Named "Ultimat", it is mainly wool and cotton, requires 1/3 as much energy to produce, is cheaper, and has otherwise the same properties as conventional insulation. In addition, recycling textiles avoids many thousand tons of climate gas emissions. Discarded textiles produce methane which has 21 times the effect of CO2 as a greenhouse gas. The available raw material in Norway could theoretically supply as much as around 30% of the total insulation market.

In addition the same process is being developed to produce building boards with properties similar to plasterboard, chipboard and fibreboard, with much lower weight and a much cheaper price. Other alternative insulation materials include cellulose fibre, foamed recycled glass, wool and flax.

7.5 Other materials

For the building products market, no good statistics are available. However, a few trends in recent years can be found, partly from a survey executed by Prognosesenteret, even though these only include two categories of buildings, low-dense housing (excluding detached houses) and smaller public buildings under 7,500 square metres. Even so this survey gives useful indications.

Prefabricated concrete elements are on the increase (1,7 million sq.metres of hollow floor elements in 2005). "Natural" materials generally such as stone also seem to be popular where cost permits. There are also signs of increased interest in masonry. Timber use is increasing significantly, although it is not possible to specify exactly where this is occurring – see next section.

7.6 Conventional materials

Surprisingly, there are no comprehensive statistics on use of construction materials. The building industry itself does not have such statistics either. A few trends can be discerned from special studies or else deduced approximately from other statistics. Existing statistics are also aggregated in ways which make it impossible to establish the figures for construction purposes. A fuller picture would require exhaustive investigation of industry production and consumption statistics.

Figure A: Use of timber in public buildings

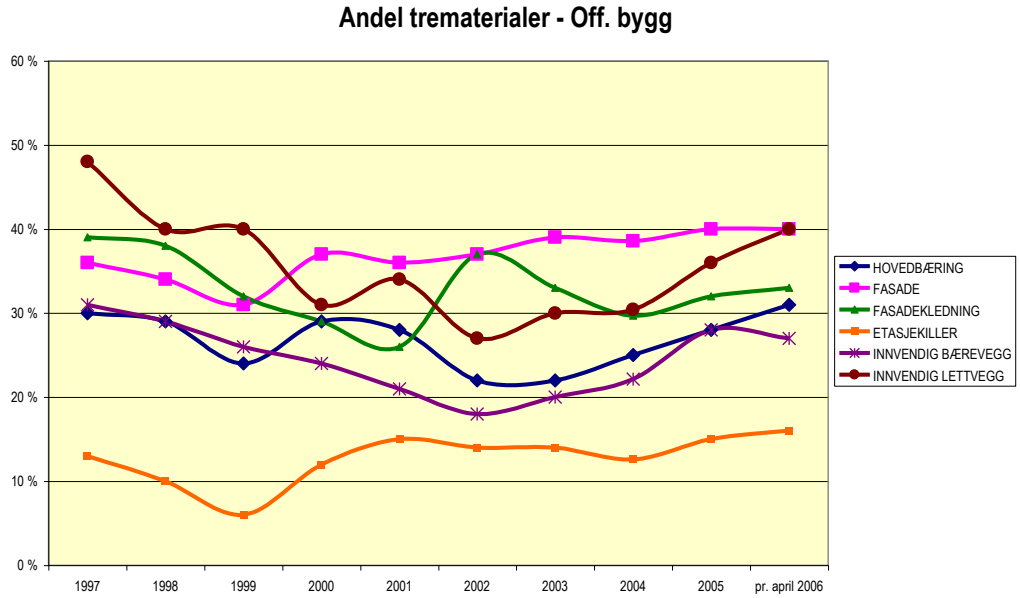


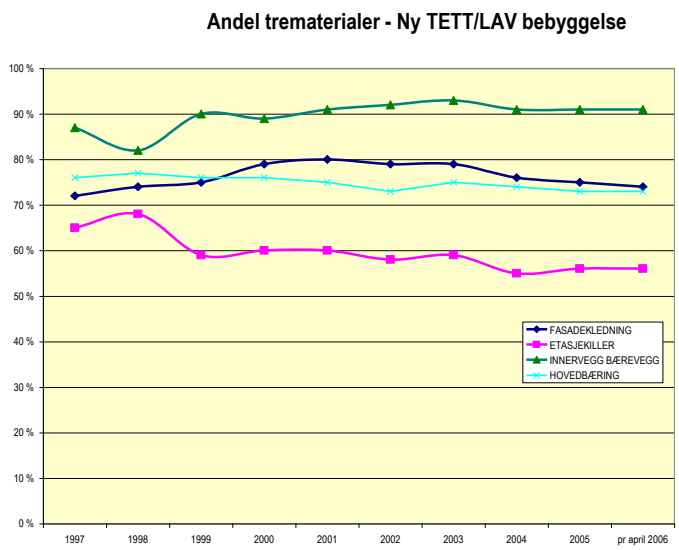
Figure B: Use of materials in small to medium size public buildings

Materialvalg offentlige bygg										
Andel sementbasert	1997	1998	1999	2000	2001	2002	2003	2004	2005	pr. apr. 2006
HOVEDBÆRING	45 %	46 %	58 %	47 %	49 %	51 %	50 %	48 %	46 %	44 %
FASADE	45 %	40 %	53 %	40 %	45 %	44 %	45 %	44 %	42 %	40 %
FASADEKLEDNING	43 %	41 %	43 %	44 %	42 %	36 %	39 %	38 %	35 %	34 %
ETASJEKILLER	76 %	86 %	91 %	80 %	76 %	78 %	79 %	81 %	79 %	78 %
INNVENDIG BÆREVEGG	51 %	52 %	63 %	63 %	70 %	66 %	62 %	61 %	54 %	54 %
INNVENDIG LETTVEGG	10 %	10 %	12 %	18 %	14 %	17 %	11 %	0 %	11 %	11 %
Andel stål / metall	1997	1998	1999	2000	2001	2002	2003	2004	2005	pr. apr. 2006
HOVEDBÆRING	23 %	25 %	18 %	24 %	23 %	27 %	28 %	27 %	26 %	25 %
FASADE	12 %	22 %	21 %	17 %	14 %	17 %	8 %	12 %	13 %	14 %
FASADEKLEDNING	4 %	5 %	3 %	5 %	6 %	4 %	4 %	4 %	5 %	6 %
ETASJEKILLER	11 %	5 %	2 %	6 %	8 %	7 %	7 %	6 %	3 %	4 %
INNVENDIG BÆREVEGG	17 %	19 %	10 %	13 %	10 %	16 %	18 %	16 %	18 %	18 %
INNVENDIG LETTVEGG	41 %	47 %	48 %	50 %	49 %	55 %	58 %	52 %	48 %	47 %
Andel tre	1997	1998	1999	2000	2001	2002	2003	2004	2005	pr. apr. 2006
HOVEDBÆRING	30 %	29 %	24 %	29 %	28 %	22 %	22 %	25 %	28 %	31 %
FASADE	36 %	34 %	31 %	37 %	36 %	37 %	39 %	39 %	40 %	40 %
FASADEKLEDNING	39 %	38 %	32 %	29 %	26 %	37 %	33 %	30 %	32 %	33 %
ETASJEKILLER	13 %	10 %	6 %	12 %	15 %	14 %	14 %	13 %	15 %	16 %
INNVENDIG BÆREVEGG	31 %	29 %	26 %	24 %	21 %	18 %	20 %	22 %	28 %	27 %
INNVENDIG LETTVEGG	48 %	40 %	40 %	31 %	34 %	27 %	30 %	30 %	36 %	40 %

Figure C: Use of materials in small to medium size public buildings

Materialvalg tett-lav boligbebyggelse										
Andel sementbasert	1997	1998	1999	2000	2001	2002	2003	2004	2005	pr. apr. 2006
HOVEDBÆRING	15 %	14 %	14 %	13 %	12 %	12 %	11 %	14 %	16 %	17 %
FASADEKLEDNING	25 %	22 %	20 %	19 %	16 %	17 %	17 %	19 %	23 %	23 %
ETASJEKILLER	31 %	29 %	33 %	30 %	31 %	34 %	33 %	40 %	41 %	41 %
INNERVEGG BÆREVEGG	1 %	2 %	2 %	4 %	6 %	4 %	3 %	4 %	3 %	3 %
Andel stål / metall	1997	1998	1999	2000	2001	2002	2003	2004	2005	pr. apr. 2006
HOVEDBÆRING	9 %	9 %	10 %	11 %	13 %	15 %	14 %	12 %	11 %	10 %
FASADEKLEDNING	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
ETASJEKILLER	6 %	5 %	5 %	5 %	6 %	4 %	4 %	3 %	3 %	2 %
INNERVEGG BÆREVEGG	4 %	5 %	6 %	4 %	3 %	4 %	4 %	5 %	6 %	6 %
Andel tre	1997	1998	1999	2000	2001	2002	2003	2004	2005	pr. apr. 2006
HOVEDBÆRING	76 %	77 %	76 %	76 %	75 %	73 %	75 %	74 %	73 %	73 %
FASADEKLEDNING	72 %	74 %	75 %	79 %	80 %	79 %	79 %	76 %	75 %	74 %
ETASJEKILLER	65 %	68 %	59 %	60 %	60 %	58 %	59 %	55 %	56 %	56 %
INNERVEGG BÆREVEGG	87 %	82 %	90 %	89 %	91 %	92 %	93 %	91 %	91 %	91 %

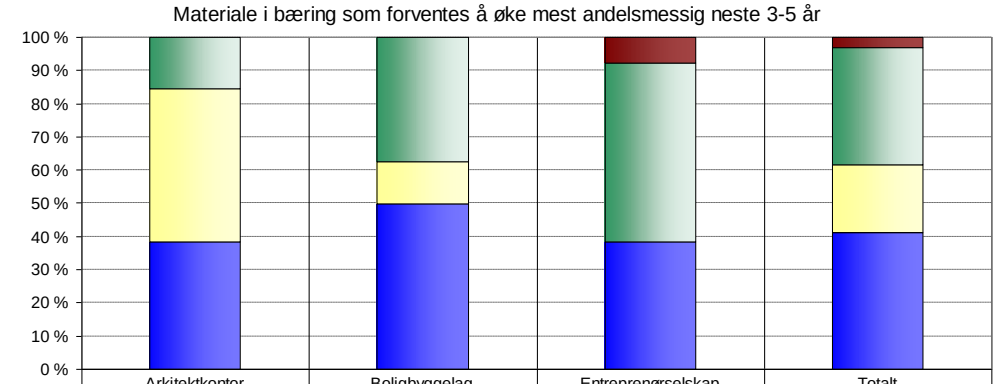
Figure D: Use of materials in low dense housing buildings



The following figures also from Prognosesenteret refer to only one type of housing, i.e low dense housing of up to four storeys, but give a good indication of perceptions from some main actors: architects, housing companies, and construction firms.

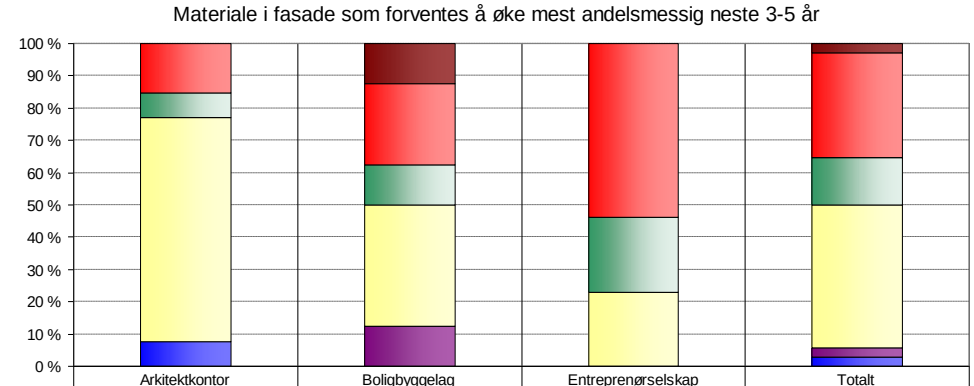
Perceptions vary very widely. Both figures show that the construction industry has far lower expectations as regards future timber use than architects and housing companies. It seems questionable whether this is in tune with real developments, and it does not reflect what has been happening during the past 5-10 years. On the other hand, architects' low expectations for concrete may reflect preference rather than realistic trends.

Figure D: Trends for future load bearing materials
As seen by architects, housing companies and construction firms (nb: for low dense housing, but excluding individual detached houses)



	Arkitektkontor	Boligbyggelag	Entreprenørselskap	Totalt
Leca	0,0%	0,0%	7,7%	2,9%
Tegl	0,0%	0,0%	0,0%	0,0%
Betong	15,4%	37,5%	53,8%	35,3%
Tre	46,2%	12,5%	0,0%	20,6%
Glass	0,0%	0,0%	0,0%	0,0%
Stål	38,5%	50,0%	38,5%	41,2%

Figure E: Trends for future facade materials
As seen by architects, housing companies and construction firms - for low dense housing excluding detached houses (nb: architects responses for glass, probably very high, are not included)



	Arkitektkontor	Boligbyggelag	Entreprenørselskap	Totalt
Leca	0,0%	12,5%	0,0%	2,9%
Tegl	15,4%	25,0%	53,8%	32,4%
Betong	7,7%	12,5%	23,1%	14,7%
Tre	69,2%	37,5%	23,1%	44,1%
Glass	0,0%	12,5%	0,0%	2,9%
Stål	7,7%	0,0%	0,0%	2,9%

8 TRENDS IN TIMBER

8.1 General uses of timber

We can distinguish between five main areas for timber in buildings: external facades, floors, structural timber, internal walls including load bearing walls, and internal surfacing including furnishings and the like.

For buildings of more than 3-4 floors, materials other than timber such as concrete and steel have continuing advantages due to structural, fire and acoustic requirements. One exception to this is the new trend of massive timber.

There are no collated statistics available regarding the consumption of timber in housing. However, the overall consumption of timber has increased significantly, see figure below. It is worth noting that there has been a very large increase in prefabricated timber components.

	2001	2002	2003	2004	2005
Høvellast	1 402 836	1 329 165	1 359 966	1 456 853	1 660 000
K-limtre	48 103	47 632	46 732	48 738	49 974
PreFab	217 136	261 288	308 735	356 494	422 310
Trevare	293 086	298 838	342 940	385 339	451 780
Annen heltre	354 126	338 537	343 133	369 177	411 709
Sum	2 315 288	2 275 459	2 401 505	2 616 602	2 995 773
	2001	**2002**	**2003**	**2004**	**2005**
m3 tre per cap	0,50	0,49	0,52	0,57	0,65

An additional driver for increased timber use in construction, is the forestry industry which in recent years has lost much income from paper and pulp, and is therefore looking for new markets.

As noted, climate change and the goal of carbon sequestration may also become a significant driver for increased timber use in construction.

In general, therefore, timber use is increasing, and amongst reasons for this are considerations of environment as well as embodied / life cycle energy, compared to products like cement and steel. This is likely to continue.

8.2 Tropical / imported timber

NABU has collaborated with the Rain Forest Foundation to produce a brochure on avoiding the use of illegal tropical timber (attached). The focus here was also on encouraging more use of local timber including deciduous species, which have been neglected for some decades. Government policy is now moving strongly in the direction of a total ban on the import of tropical timber, until such time as certification systems as advocated by FSC and others becomes more reliable.

Siberian larch from eastern Europe and similar products have also become popular, but these can also be associated with unsustainable if not illegal forestry practices, in addition to the long transport distances involved. In general there has been a big increase of interest in constructive timber preservation and non-treated facades.

8.3 Massive timber

Massive timber technology is receiving a lot of attention. This was a major focus of our work in my last few years as leader of NABU, with workshops, seminars, study tours and dialogue with the timber industry. A few production units are starting, and the first massive timber constructions have been built including a four storey student housing block in Trondheim. A handbook on massive timber is forthcoming, following the Swedish one a couple of years ago. An additional issue has been the potential for carbon sequestration by increased use of timber in construction, and several reports have been written about this by amongst others Bjørn Berge of GAIA Lista.

The large Moelven industry reports about 60 orders for massive timber so far for 2006. It would in my view however be a pity if the massive timber industry should become dominated by one large producer such as Moelven, rather than leading to a variety of smaller and regionally based factories. The Moelven system is also based on synthetic glues, not the most ecological solution. The dowelling types such as *diagonal dubelholz* appear to be the most ecological.

Spread of massive timber may also be influenced by future carbon taxation if carbon sequestration in timber construction becomes a valued solution. With massive timber, the volume of timber in a normal house can be increased from about 30 kg/sq.m to over 150kg/sq.m

It is however not easy to predict the future demand for timber, since this will depend partly on how much the massive timber trend spreads. In my view, time will show that massive timber technology is really advantageous for certain functions, whereas more conventional stud walling for example may continue to be the easiest option. Some uses of massive wood floor slabs, for example, seem to have clear advantages, in particular their simplicity, but not when the timber element is combined with separate ceiling layer, top screed etc (as in for example the Swiss Bresta system). It may also be that prefabrication with brettstapel is about equally advantageous as other methods, but it remains to be seen how much of the construction industry would switch to massive timber.

Massive wood student housing, Svartlamon, Troindheim
Architects Brendeland Kristoffersen

8.4 Wood polymer products

New timber based products are also emerging on the market based on sugar and heat treatment (Wood Polymer Technology, Kebony Products), and these are anticipating big expansion in 2006. These wood-based products seem to offer good functional qualities combined with good looks and the environmental advantages of avoiding toxic chemical treatments such as CCA.

8.5 Other timber trends

For the reasons noted above, including environmental reasons, there is likely to be increased interest in new uses of timber or part-timber solutions. This can include various board, chipboard and laminate products, furnishings and fittings, structural timber, and roundpole/ log construction.

In the near future EU and other legislation regarding products, energy and environmental pollution, will make a wide range of other materials increasingly more expensive, or unacceptable, and timber will show a comparative advantage.

Innovation in timber is promoted by various bodies, including the Trefokus program, Treteknisk Institutt and Innovasjon Norge, as well as with financing from within the timber and forestry industries themselves.

Innovative uses of timber are appearing today in various building types, including for structural uses, landscape architecture, facades etc
Here: Lillehammer art gallery, Snøhetta Architects.

9. TRENDS IN SUSTAINABLE BUILDING

There has been little development in terms of ecological quality and sustainable architecture/ construction in Norway. The levels of awareness are low amongst all actors – designers, industry, politicians and the public. Nevertheless, these trends are emerging quite clearly in other parts of Europe. This will influence Norway, but it means Norway is likely to be more of a follower than a leader in this field. The following are some perspectives.

9.1 Influences for change

There are two main vectors that can influence construction in a more ecological direction. The one is market forces and consumer demand; the other is market intervention. This latter includes both "carrots" and "sticks" – that is, both incentives, and regulatory pressures including product and lifecycle-focused legislation.

Consumer demand for "green" or ecological solutions is low at present. However, it is in my experience higher than conservative marketers think. Consumers who are indeed interested in buying green homes, simply do not get the information or the possibilities to find such products. They therefore do not even try - and are thus not visible as a market.

The experience of NABU shows clearly too that quite many municipalities and other public sector actors have a serious desire for ecological housing areas and buildings. The public sector can also justify investments with a longer payback time. However, there is little public sector activity in housing.

On the other hand, investors and major private building companies express interest but say there is no demand as yet. Almost none of them are proactive in their approach to ecological innovation. This is regrettable. By comparison, in other European countries, at least a few financial leaders, including banks and housing associations, have taken an innovative attitude and these have had a significant influence on trends as a whole. The Ringgaarden Boligforretning in Denmark is a good example of this, and has been a creative and influential leader in innovative sustainable housing.

Two areas that do however attract increasing focus, are energy costs, and concerns about indoor climate especially in schools.

9.2 Energy

Energy efficiency (EE) and renewables (RES) attract increasing attention since they have both the "carrots" of offering consumers lower energy bills, and the "sticks" of climate change and increasing efficiency regulation such as the EU Directive.

Norwegian policies in this area generally follow those of Europe, with a few years delay, and there are few things of special note in the Norwegian situation. The new Husbanken goal that 50% of all new housing should be low energy housing by 2010 is an ambitious step forward however.

9.3 Indoor Climate

This area is still underfocused. Although it is naturally difficult to quantify the health costs of bad indoor climate, estimates of these costs to society have been made in all the Nordic countries, and range in the billions of kroner. These figures, even if only approximate, are very strong evidence and should be used more to lobby for indoor climate research and development. Translated into

costs, they suggest that it is justifiable to spend several hundred kroner per square metre more on good materials and other indoor climate measures.

A main focus area is schools and kindergartens, since many of Norway's schools are in a very poor state, and would in fact have to be closed if one followed strictly the laws on working environment. The health of children is also a topic that engages people strongly.

The response of the ventilation industry is to see a huge potential market for new ventilation systems. Opposed to this is our view - shared by many - that a lot of the indoor climate problems can be solved by simpler means. These include simple architectural remodelling (which HVAC engineers often do not even consider); maintenance and cleaning routines; and re-using natural ventilation systems that exist in many of the older school buildings.

Simpler solutions would also be many times cheaper. In existing buildings, to install a modern mechanical ventilation system one often has to rip the old building apart, and spoil the architecture. Generally it is a difficult and messy operation, and extremely costly.

Groups such as NABU and GAIA architects have cooperated extensively in the past ten years with health organisations, medical specialists, public bodies, schools, and with innovative engineers, to promote simple solutions, including where feasible natural ventilation. However, there are simply not the resources to be heard, faced with the very powerful ventilation industry.

A similar issue arises in the case of the "passive buildings" today. One of the main solutions in achieving the passive house energy standard is extreme air tightness combined with mechanical ventilation and heat / energy recovery. This is in fact very similar to the generation of so-called "superinsulated" buildings in North America in particular, in the mid 1980's. And the same question must be asked now as then: could we be saving energy at the expense of healthy indoor climate? Are these houses too air tight and sealed from the moisture point of view?

This topic relates closely to the issue of technology in buildings, discussed further below.

9.4 Technology

Technology in houses, in particular items such as heat pumps, heat recovery ventilation systems, automatic controls, etc, is on the increase. In my view this is sometimes encouraged uncritically by the sales industries. Advanced technology in housing should be kept to a reasonable minimum since it is often not controlled properly, maintained, or understood by average users. Advanced systems may be best in theory, but simple systems are better given real people.

It should be underlined that this applies mainly to housing. In larger commercial and other buildings, it makes more sense to have advanced systems, since the scale of the construction is larger, and since this makes it feasible to have permanent, well trained building managers / operators as well as regular control routines. In private houses, on the other hand, the conditions are quite different. One is dealing with small family consumers who normally have no knowledge of, nor interest in, the technical systems that may be in their cellars or above their ceilings. Misuse and lack of maintenance is therefore far more common.

This is critical for mechanical ventilation since many studies have shown that poorly maintained systems are likely to become serious health hazards – and, far from improving indoor air, can become the worst sources of indoor pollution.

Naturally, many modern IT-based solutions for control of energy use are of great value. But the scale of application is critical, and technology is always dependent on good users, however good it may be in engineering theory.

The Norwegian Building Research Institute, for example, recommends mechanical ventilation with heat recovery for all housing. We are very sceptical to this. Their view is based on the assumption of effectively air tight houses, and of good user maintenance. Fine in theory – but in the real world, most houses are still built quite leaky. In that case, the uncontrolled air exchange is in fact providing a large part of what is necessary. Adding on a mechanical ventilation system to that is therefore often unnecessary or uneconomical.

When one uses healthy, non-emitting materials and user-controlled ventilation, the total need for air exchange decreases. Then heat recovery also becomes less interesting economically!

In essence, mechanical engineering is a cure – but healthy building design should be prevention.

Buildings will certainly be built more air tight as focus on this increases, but it is unlikely to become very strict. Experience in North America showed that builders could be trained to achieve very high air tightness, with difficulty, but that this often did not last. In addition, tight buildings require a very clear humidity strategy, otherwise even worse problems for indoor air may arise. The alternative, which we advise, is to work carefully with hygroscopic materials, and a design strategy based on breathing construction fabric. It is important to add that this still allows one to produce very low energy buildings.

During the present revisions of the building regulations, the industry has applied pressure to make mechanical ventilation compulsory. The same has happened in Denmark. Fortunately, the authorities have so far resisted this. Their reason is that building regulations today are not based on specific technical solutions; the basic (and very sensible) philosophy is that one may use any system that provides the required quality.

However, this still leaves an extra burden on designers who wish to use alternative solutions (for ventilation, as well as for energy or materials), since the performance of non-conventional alternatives requires extra documentation to be submitted by the designers..

There is thus a bias in today's system that makes the introduction of alternatives more difficult. There is also a built in bias that favours complicated, technological solutions as opposed to simple and passive design solutions.

9.5 Financial systems and costs

Today's financial system demands short payback times, partly through the discounting system. This works against long term sustainable solutions in all countries. Greater focus on lifecycle costing will help, but only to a limited extent.

Although macroeconomics is outside the scope of this report, it has a major effect on innovation in housing investments and choices, as in other sectors. Sustainable solutions both for site ecology, construction materials and energy systems, often require slightly larger first cost investments and have a longer than "normal" payback time.

On the other hand, quite many ecological alternatives are becoming attractive purely on a cost basis, and this will lead to product substitution. Examples are systems for biological wastewater treatment, biofuels such as pellets, and the new building materials mentioned above. The same is

also the case for an increasing number of options in renewable energies and energy efficiency in buildings including housing.

Regulatory and legislative pressure appears certain to increase – as the long list of relevant EU directives given above bears ample witness to.

Financial incentives such as grants and soft loans are in place for ecological measures in housing in Norway. However, these are not substantial enough to cause a rapid shift in housing choices. In Norway as elsewhere, there has also been increased attention to themes such as market penetration. This is extremely important to achieve spreading of ecological housing solutions, since it involves information as well as perceptions. There is also a need for more pilot projects.

9.6 Perceptions about housing

As in other countries, "ecological" housing has been seen as something marginal and often strange looking. In Europe this is no longer really the case, now that there are hundreds of low energy and ecological buildings, of all types, and built in many different styles. Norwegian perceptions and preferences relating to "the home" are well documented by trend researchers and others as being particularly conservative, in comparison to the other Nordic countries. "Modernistic" or innovative design is gaining interest, but slowly. For most Norwegians, a house is a detached bungalow with a pitched roof, its own garden and conventional building style. Norway is thus also behind other countries in understanding ecological alternatives in housing.

9.7 Research and development

Natural ventilation was mentioned above. In R+D today it is often a requirement that financing should be at least 50% from the private sector. This is a main reason why almost no R+D happens in the field of natural ventilation. What industry is going to fund research that leads to less technology and fewer products being sold?

The same problem applies with R+D for the area of intelligent passive design solutions. These solutions may be the most effective and the cheapest, but they do not get funded. The only remedy for this is that European and national authorities become aware of this systemic weakness, and devote special funding to areas where commercial funding is not likely to happen.

9.8 Legislation and tools

As noted, national and EU legislation on environment, buildings, energy and products will have a major effect on future construction.

Standards and environmental requirements are required as a basis for legislation. Tools for design and specification have the same need. Materials declarations are one important element in this. In Scandinavia the Svanemerke system is quite well established; the Swedish BASTA system is developed in cooperation between the four largest construction consortiums (NCC, Skanska, JM and Peab).

In Norway, the Federation of Building Industries (in particular Byggevareindustriens Forening) is active in developing the system known as EPD, designed in conformity with the international ISO standards and based on LCA for products and quantified, standardised data. Statsbygg and some others in the construction sector have been developing systems. The National Association of Norwegian Architects (NAL / ECOBOX) is developing a product evaluation system, see www.ecoproduct.no .

9.9 International cooperation and exchange

Norway is a small country and R+D therefore tends to happen within a rather small establishment, composed of a limited number of experts. These same experts will often be the ones who assess applications for new research. This leads to the danger of a lack of plurality in viewpoints and approaches, as well as in fields of competence.

Former Nordic cooperation is now partly being replaced by European cooperation. Norway has until recently not been very active in the European arenas. However, in the field of sustainable building and housing, international cooperation is particularly important. As noted elsewhere, Norway is lagging behind and it is likely that Norway will pick up influences from outside in this field, more than being a leader.

From the point of view of Norway, the remedy for this should be to place extra priority on international research and cooperation. In practice, despite much political discussion on the topic and the large surplus of oil money, Norway spends less on research than other EU countries.

9.10 Education and information

It seems to be the case in many countries that the education system is lagging behind when it comes to introducing new topics and approaches. This is certainly true in the field of energy, environment and sustainability. Schools of architecture, engineering and building science are seriously behind. This means that they are producing tomorrow's professionals who still lack understanding of these topics.

In addition, this risks leading to a rebound effect, since environmental projects will therefore often be designed by people without good skills, and may not work well, thus leading to a general discrediting of ecological solutions and a public impression that they don't work. Several Norwegian examples of this could be given.

Generally, information on ecological building and housing alternatives is hard to come by. This is a special problem in small countries such as Norway, where publications as well as channels of information are few. In addition, Norway is a country of great distances – compared to say Denmark, with a similar population but where one can probably find a wind generator, an ecological house and an organic farm anywhere within 20 minutes drive. In Norway, one may have to drive for a day! This has two consequences: firstly, information centres are few and far between; secondly, the force of example spreads very slowly. When one has a neighbour whose "ecological house" can be visited and seen to work, then new solutions do spread.

A conclusion from this is that countries like Norway need to place exceptional emphasis on pilot projects, dissemination and information.

10 CONCLUSIONS

In summary, there is in my view reason to believe that there will be a significant and lasting movement towards more ecological solutions. How fast this happens, depends partly on information and active market incentives, partly on pressure-creating issues such as climate change, and partly on more proactive efforts by committed professionals.

Timber is if anything, a rather special case where innovation offers a win-win situation for most of the actors in the value chain. The forestry sector has a declining income and huge volumes of low grade conifers which can be used for products such as massive timber. The wood processing industries stand to gain new activities. Professionals and architects like timber; and so do consumers. Timber offers regionally decentralised economic activity. In addition come the various environmental benefits. In view of international climate negotiations, the potential for carbon sequestration means that even the Foreign Ministry is interested in increased timber use!

The goal of more sustainable housing and construction involves, of necessity, shifting both consumer perceptions and industry practice. It involves moving the market in a certain direction. Without bigger public incentives and pressure, however, a shift towards more sustainable building is likely to be slow.

This is therefore a field that deserves more funding for research, development and information. However as noted Norway appears to be significantly behind some other countries in this field. It has a small market as well as a rather insular mentality, and few cases of market leadership or ecological innovation are likely to come from Norway; rather, Norway will follow influences and impulses from outside.

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11 REFERENCES AND LINKS

11.1 Principal sources

Statistics Norway and various governmental and Ministry information; Eurostats.
The State Housing Bank
Bente Nuth Leland, architect Berkana AS, (re-use, interviews with the industry, other info)
GAIA architects
The National Office of Building Technology and Administration
Boligprodusentene
Sveriges Byggindustrier. Fakta om byggandet, 2005 www.bygg.org/files/marknad/pdf/FOB%202005.pdf
Byggeindustrien, see nr.13/2005, and discussions

11.2 Links

Public:

Ministry of Local Government and Regional Development	www.krd.dep.no
- State Housing Bank (Husbanken)	www.husbanken.no
- National Office of Building Technology and Administration	www.be.no
Ministry of the Environment	www.md.dep.no
- The Directorate for Nature Management	www.dirnat.no
- The Products Register	www.produktregisteret.no
- The Directorate for Cultural Heritage	www.riksantikvaren.no
- The Norwegian Pollution Control Authority	www.sft.no
- Environmental State of Norway	www.miljostatus.no
Ministry of Modernisation	www.mod.dep.no
- The Directorate of Public Construction (Statsbygg)	www.statsbygg.no
Ministry of Petroleum and Energy	www.oed.dep.no
- Enova	www.enova.no
- NVE	www.nve.no
Statistics Norway	www.ssb.no

Research and Information Institutions:

Building Research Institute	http://www.byggforsk.no
Norwegian Institute for Urban and Regional Research	http://www.nibr.no
SINTEF	http://www.sintef.no
Norwegian University of Science and Technology, NTNU	http://www.ntnu.no
Norwegian Institute for Cultural Heritage Research	www.niku.no
Trefokus	www.trefokus.no
Tresenteret / Treteknisk Institutt	www.treteknisk.no
Innovasjon Norge	www.innovasjonnorge.no
Prognosesenteret	www.prognosesenteret.no

Design and Construction industry

Boligprodusentene	www.boligprodusentene.no
Byggenæringens landsforening (BNL)	www.bnl.no
Bygg Uten Grenser (Mur- og tunge materialer)	www.byggutengrenser.no
Grønn byggallianse - nettverk for eiendomsnæringen	www.byggalliansen.no
Norges Bygg- og Eiendomsforening	www.nbef.no
Hyttetorget (leisure homes centre, Oslo / Sandefjord)	www.hyttetorget.no
National Association of Norwegian Architects (NAL)	www.arkitektur.no/ecobox
ECOark database	www.arkitektur.no/ecoark
GAIA architects	www.gaiaarkitekter.no