NORDISK ARKITEKTURFORSKNING
NORDIC JOURNAL OF ARCHITECTURAL RESEARCH

1

ISSUE 1 2013

NORDISK ARKITEKTURFORSKNING

Nordic Journal of Architectural Research

1–2013

Nordic Journal of Architectural Research
ISSN: 1893–5281

Submitted manuscripts
Manuscripts are to be sent to Madeleine Granvik (Madeleine.Granvik@slu.se), Claus Bech-Danielsen (cbd@sbi.aau.dk) and Anni Vartola (anni.vartola@aalto.fi) as a text file in Word, using Times New Roman font. Submitted papers should not exceed 8 000 words exclusive abstract, references and figures. The recommended length of contributions is 5 000–8 000 words. Deviations from this must be agreed with the editors in chief. See Author's Guideline for further information.

Subscription
Students/graduate students
Prize: 250 SEK, 205 DKK, 225 NOK, 27.5 Euro
Individuals (teachers, researchers, employees, professionals)
Prize: 350 SEK, 290 DKK, 320 NOK, 38.5 Euro
Institutions (libraries, companies, universities)
Prize: 3 500 SEK, 2900, DKK, 3200 NOK, 385 Euro

Students and individual subscribers must inform about their e-mail address in order to get access to the journal. After payment, send the e-mail address to Trond Haug, trond.haug@sintef.no

Institutional subscribers must inform about their IP-address/IP-range in order to get access to the journal. After payment, send the IP-address/IP-range to Trond Haug, trond.haug@sintef.no

Payment
Sweden, pay to: postgirokonto 419 03 25-3
Denmark, pay to: Danske Bank 1-678-0995
Finland, pay to: Sampo Bank 800013-70633795
Norway, pay to: Den Norske Bank 7877.08.13769

Outside the Nordic countries pay in SEK to SWIFT-address:
PGS ISESS Account no: 4190325-3, Postgirot Bank Sweden, SE 105 06 Stockholm

Published by SINTEF Academic Press
P O Box 124 Blindern, NO-0314 Oslo, Norway

CONTENTS

Picture on the front cover from ByBo's housing project «Løvåshagen». Photo: Knut Egil Wang

NORDISK ARKITEKTURFORSKNING
NORDIC JOURNAL OF ARCHITECTURAL RESEARCH

DAYLIGHT, VIEW AND FRESH AIR IN ENERGY-EFFICIENT HOUSING

SOLVÅR WÅGØ AND ELI STØA

Abstract

Post-war residential architecture in Norway is characterised by modernist ideals regarding daylight, fresh air and contact with nature, qualities that are regarded as essential for residents' well-being and health. An increased focus on buildings' energy consumption may have influenced these issues because smaller openings, thicker walls and restrictions on natural airflow are often elements of low-energy architecture. Does the design of contemporary low-energy housing therefore imply a modified understanding of daylight, fresh air, view, and visual and sensory contact with the outdoors and the significance of these qualities?

This article presents results based on a comparative and critical discussion of how qualities such as daylight, fresh air and view are dealt with by the architects in selected new energy-efficient housing projects in Norway. The article is based on interviews with architects at nine Norwegian offices and an investigation of six low-energy housing projects representing different technologies and design principles. The aim of the article is to examine whether the architects' experience presents a conflict between the focus on energy efficiency and the objective to create attractive housing solutions and whether the focus on energy efficiency has led to a modified understanding of some of the modernist ideals mentioned.

Key words:
Energy efficiency, architectural quality, design choices, daylight, view, fresh air

Introduction

Increased focus on the environmental effect of buildings and their energy consumption has led to the development of new building design concepts, which implies new possibilities and architectural considerations. Several architects are concerned by the fact that their work influences the global environment and see low-energy building physics and architecture as interrelated (Lauring and Marsh, 2008). However, efforts to increase energy efficiency in the built environment are mainly driven from a technological perspective at present. The architectural profession appears to be somewhat reactive, striving to address technical specifications and legal requirements rather than being proactive and approaching the challenge more fundamentally from an architectural point of view.

The debate regarding various design concepts illustrates this situation. *Low-energy*, *passive* and *energy plus houses* are distinguished mainly in terms of technological features, even though architectural implications may be obvious. Low-energy and passive house design[1] are ideally based on passive principles regarding orientation by, for example, gaining heat from the sun through designing large windows that face south and having small or no windows facing north. Heat from the activity inside of the house is reused by means of a balanced ventilation system with heat recovery, which is in contradiction to the ideal of utilising passive principles, a rather active technology. Some active solutions to utilise solar heat (solar cells or solar collectors) or a ground-source heat pump are often added. To deliver electricity back to the grid, an energy plus house produces more energy than the residents consume.

The term *active house* is in Norway used both as a building concept and as a reaction against the term *passive house*, which some find misleading; however, there is no agreed definition of an *active house* in Norway. The concept implies that residents are in control of their installations and that more focus is placed on utilising sun and daylight in active systems that are designed to either produce power (using the sun or wind) or to operate in conjunction with some mechanical devices to utilise renewable energy to provide heating and cooling.

The passive house concept represents what is often referred to as the present *best practice* regarding energy-efficient architecture in Norway and implies an airtight and well-insulated building volume, heat recovery from the ventilation system and windows with low U-values,[2] this concept has set the standard for Norwegian building regulations, and the Government suggests that this practice should be required for all buildings by 2015 (Ministry of the Environment/Ministry of Local Government and Regional Development, 2012). However, several actors within the building sector claim that the passive house standard (Standards Norway, 2010) adds a number of guidelines to energy-efficient design and implies recommendations that have questionable impacts on quali-

1 The Norwegian Passive House Standard, which was approved in April 2010, is based on the German Passive House Standard, which claims an estimated heating energy use of ≤ 15 kWh/m²/year and a total primary energy use of ≤ 120 kWh/m²/year. Local climate and varying temperature have been taken into consideration in the Norwegian Standard to a certain degree.

2 The restriction is related to glass area in relation to the heated housing area and the U-value of the glass. If the U-value is 1,2, the area of glass should not exceed 20 % of the total heated area. If the U-value of the glass is 0,8, a glass area of up to 30 % of the total heated area might be acceptable.

ties such as daylight and fresh air (Butters and Miller, 2004; Hatløy, 2011; National Association of Norwegian Architects, 2009).

Health researchers have also been critical of the passive house solution because it requires an airtight building volume and balanced mechanical ventilation systems rather than natural ventilation. Some researchers even claim that this concept engenders concerns regarding general well-being and health (Bakke, 2011). Regardless of this debate, the Norwegian Passive House Standard (Standards Norway, 2010), although not compulsory, has set standards regarding the energy needed for heating in new buildings. To reach maximum energy demands, the standard predicts that balanced ventilation systems with heat recovery are needed. Systems based on natural ventilation do not typically provide heat recovery.

Regarding daylight, the energy requirements in Norwegian building regulations (TEK 10) state that the glassed area, see note 2, in the facade should not exceed 20 % of the buildings total heated area (Ministry of Local Government and Regional Development, 2010). The guidelines to the regulations state 'satisfactory access to daylight' (satisfactory means an average daylight factor[3] of minimum 2%) as fulfilled when the glass area comprise minimum 10 % of the of the buildings total heated area. Some architects find the minimum daylight factor and the descriptions too vague. They fear that a strong and unilateral focus on energy efficiency and strict regulations regarding maximum glassed areas in facades will reduce daylight, architectural spatiality and visual contact with the outdoors (Butters and Miller, 2004). Other architects are alarmed that closed facades towards the north would decrease the possibility to obtain daylight and views in different directions.

3 Daylight factor: DF = 100 * Ein / Eext where Ein describes the inside illuminance at a fixed point and Eext describes the outside horizontal illuminance under an overcast or uniform sky.

The passive house concept and an increasingly more standardised building act may also challenge architectural freedom to design optimal floor plans, facades, orientation towards the view (Dokka and Hermstad, 2006) and site-specific architecture designed for different climates (National Association of Norwegian Architects, 2009). There are, as in many other North-European countries, reported problems with overheating during summer (Marsh et al., 2010; Orme et al., 2003; Thomsen et al., 2011). Some claim that energy saving requirements in the Norwegian building regulations have focused solely on winter conditions instead of taking summer conditions and climate change concerns with a falling heat demand and growing cooling demand into consideration. The actual effect of these efforts on energy efficiency is also questioned (Brunklaus et al., 2010; Nordby and Miller, 2010).

Even though much of the debate relates to limited elements, such as window openings and ventilation systems, such discussion could also be regarded as a critique against a merely technological approach to

architectural challenges. In fact, the focus on energy efficiency may be regarded as a threat against fundamental architectural qualities, such as daylight, fresh air and contact between indoor and outdoor environments, which have been vital to Nordic residential architecture since the modern movement. The critique that has been raised by architects could thus be explained by a fear that basic architectural ideas are threatened and that their professional integrity is being challenged.

In this article, we will discuss how architects approach the challenge of combining the architectural ideals of daylight, fresh air, view and visual contact with the outdoors with efforts to design more energy-efficient housing. How does focusing on energy efficiency affect these architectural ideals? May the emphasis on reduced energy demand inspire new architectural expressions or is it rather felt as a straitjacket?

Daylight, view and fresh air – a legacy of the modern movement

Daylight and fresh air became important issues in housing design in the early 20th century.

This development can be traced to several central aspects of the modern movement which have been crucial components in architectural debates during the last century.

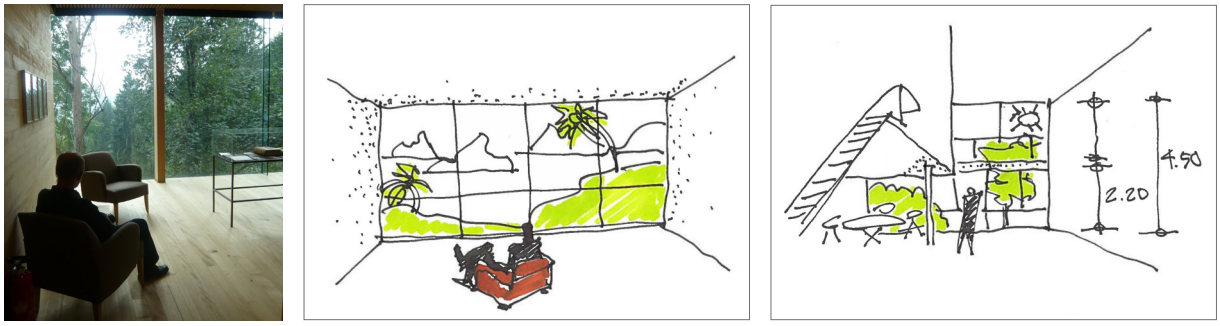


Figure 1: A seamless transition between the indoor and outdoor environments became an essential aesthetic ideal of modern architecture. Left: Inside of the Women's Museum and Fire Station in Hittisau, Austria, which was completed in 1997.
ARCHITECTS: CUKROWICZ NACHBAUR ARCHITEKTEN. RIGHT: AUTHORS' FREE SKETCH AFTER LE CORBUSIER (LE CORBUSIER AND BUHL, 1965). PHOTO: S. WÅGØ

A new era – a new aesthetic

The modern movement implied freedom from history, tradition and place. Architecture needed to find new justifications because aesthetic principles, such as the use of geometric forms and symmetry, were no longer legitimised by reference to classical order. Instead, solutions were expected to respond to present needs, social intentions, hygienic requirements and a new *zeitgeist*. The idea that all objects, including buildings, belong to the present time and thus need new expressions was strong among the avant-gardists in the early 20th century: *«Modern man, who no longer dresses in historical garments but wears modern clothes, also needs a modern home (architecture) appropriate to him and his time...»* (Gropius, 1926/1970, p. 95).

These ideas appeared during a period of extensive scientific and technological development. Industrialisation, mass production and the introduction of new building materials provided opportunities for new architectural expressions. Le Corbusier's identification of the '*five points towards a new architecture*' in 1926 became, although controversially, intrinsic for modern architecture and was directly extrapolated from the technological possibilities presented by reinforced concrete, steel and glass (Wilson, 2007):

1. The supports: The house is raised on load-bearing columns, the garden is beneath
2. Roof gardens
3. The free design of the ground plan
4. A horizontal window
5. The free design of the facade

(Le Corbusier and Jeanneret, 1926/1970, pp. 99–101)

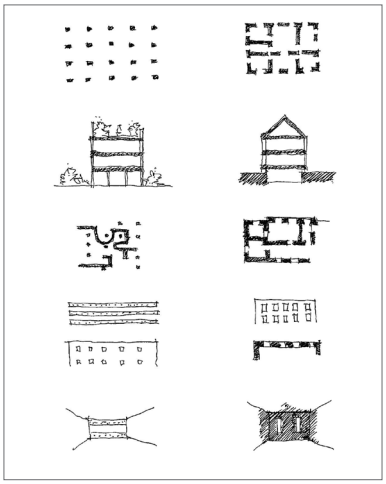


Figure 2: Illustration after Le Corbusier and Pierre Jeanneret: Complete works 1910–1929.

Dynamic spatiality

With modern architectural principles came a new comprehension of space with free, open plans and increased transparency between inside and outside environments. Space became indefinite and dynamic but also diffuse and even abstract. The fluid relations between spaces and between indoor and outdoor environments were emphasised rather than the characteristics and limits of the rooms themselves (Bech-Danielsen, 2004). Individual spaces were not perceived as isolated but as part of a *«dynamic spatial sequence of spaces – a non-hierarchic totality of coherent and intertwined space»* (ibid., p. 83). A dynamic relationship was established not only between the inside and outside environments but also within the house, both horizontally and vertically. Le Corbusier introduced what he termed a 'promenade architecturale', or an architectural walk through the house, *«to enable movement between floors, achieving different views and glimpses into the different zones of the house»* (Findal, 2007, p. 28). In addition to the rooms and volumes following a horizontal logic, the architecture was perceived throughout the different levels and floors. A new open and vertical organisation, in which the rooms were connected by a centrally located staircase, provided free spatial communication (Colomina, 2005).

Nature in architecture

The notion of nature as something divine and clearly separate from culture gradually changed during the 18th century (Bjerregaard, 2005). With an increased denial of a common religious frame of reference, culture and nature gradually came to belong to the same category. For architecture, this convergence implied that the principal division between a building and the surrounding nature no longer applied: *«The elimination of the difference between 'the tree' and 'the building' as a kind of ba-*

sic condition of modernity. In this sense the recent 200 years of building boundaries all 'dissolved' boundaries between inside and outside» (ibid., p. 13). Other elements of modern architecture, such as the green roof garden and the building lifted on pillars with the garden stretching beneath the house from the surrounding area, are expressions of the close integration of nature as a restorative element in architecture itself. Nature-related aesthetics became a coherent part of the house, in which view and the contact between inside and outside environments and between building and nature were combined.

Residential health and well-being

An important issue for architects in the early decades of the 20th century, particularly after the First World War, was to improve the living conditions of the working class. Embedded in the ideas of freedom from the past was a reaction against the cramped and bad housing conditions that were then prevalent in the growing industrialised cities. Daylight and fresh air became important housing qualities, not only as symbols of modern life, individual freedom and the break with history and tradition, but above all because of their important effects on health. Modern architecture was regarded as an alternative to the suffocating industrial city (Bech-Danielsen, 2004). To ensure that each apartment obtained as much direct daylight as possible, buildings were oriented according to the sun and view rather than to existing urban structures and street patterns.

Architects in the 1920s focused on creating access to sun and daylight by orienting facades to the east/west, typically with bedrooms and kitchens to the east (morning sun) and living rooms to the west (evening sun). Cross ventilation through buildings was actively used to provide fresh air. Green spaces between the buildings and on rooftops were seen as having restorative effects and as places for recreation, physical exercise and sunbathing. Nature and green spaces became the modernist metaphor of good health (ibid.). Large windows facing the sun were to provide as much health-bringing daylight to the residents as possible. The sun itself was believed to have a cleansing effect. Simple white surfaces with no unnecessary ornaments either inside or outside also contributed to the clinical character of modern architecture (ibid.).

Towards a more sensual and site-specific modernism

Although some ideas placed on the agenda during the early days of the modern movement maintain their relevance, several aspects of this movement have been highly debated and contested. Modernist ideas thus developed and took many directions. A confrontation arose in the 1960s, when regionalism emerged as a counter to the schematic, poor and hostile functionalism, resulting in a call for more site-specific architecture.

Figure 3: Site-specific architecture was typical of one direction taken by Nordic post-war modernism, as illustrated here by architect Knut Knutsen's own summer house in Portør, Norway. Knutsen was among those architects who emphasised the relation between building, site, landscape, resource use and sustainability (Knutsen, 1961)
(ILL. FROM THE YEARBOOK «ARKITEKTUR I NORGE» 1995. INV.NR.NAMF.01472.019.)

In the 1930s, criticism was already being raised against 'the international style'. Nordic architects, such as Alvar Aalto and Erik Gunnar Asplund, questioned whether the ideals of purity and reduction that were mainly comprehended visually should be the only or main design qualities (Pallasmaa, 2011). These architects asked for qualities that also appealed to other senses, such as tactility, sound and smell. This line within modernist thought can be followed throughout the 20th century and is emphasised by architectural theorists, such as Juhani Pallasmaa in several of his writings. According to Pallasmaa, architecture is perceived through a *«polyphony of the senses»* (ibid., p. 12):

> *Every building has its auditive, haptic, olfactory and even gustatory qualities that give the visual perception its sense of fullness and life […]. Just think of the sensations of a warm and moist breeze, joyful sounds and smells of plants and seaweed magically conveyed by a Henri Matisse painting of an open balcony door in Nice.* (ibid., p. 12)

This perspective on modern architectural qualities has constituted the background of our analysis of architectural qualities in new housing projects in Norway. The layout of external walls, the way in which openings are placed and designed, how openings may be used to let in not only light and view but also the outdoor air, are essential elements that should be investigated in low-energy architecture. We will thus focus on visual, auditory and olfactory qualities and look more closely into how these architectural elements are considered in the 6 case studies, and later in the article, we will examine how architects themselves treat these qualities within a regime that places particularly high value on the reduction of energy demand. First, however, we will briefly comment on how the aforementioned qualities are considered in terms of architectural measures.

The visual and sensory relations between the inside and outside environments and their impact on spatial qualities

In addition to the orientation of the building according to sun, wind and climatic conditions, the design of the building envelope is essential for energy demand; however, it is also essential for providing access to day-

light, visual contact and other types of sensory contact with the outside (auditory, olfactory and the perception of fresh air). In the design of the transition zone, window openings are active architectural instruments. The experience of space is given by being inside and looking out through small openings (holes in the walls) or being inside and be confronted with the outside through openings of floor-to-ceiling height. The Japanese architect Tadao Ando puts it this way:

> *I would like man and nature to confront each other, and to have a tension maintained with regard to each other. I want to create a place where that will occur.* (Hien, 1998, p. 115)

As mentioned above, emphasising transparency in modern architecture implies dissolution of the relation between the inside and outside and between man and nature. The transition zone is where the dynamic relationship between the indoor and outdoor environments takes place. For our purpose, it is useful to distinguish between a visual relation (daylight, visual contact and views) and a sensory relation (sounds, smells, the cool breeze and the warmth of the sun). Even if these concepts are connected, it is important to consider them separately to identify various architectural impacts and possible conflicts.

Daylight, view and visual contact with the outdoor environment

There is a need to distinguish between 'daylight' as in overcast sky and 'sunlight' as in clear skies. The daylight factor is influenced by the illuminance under an overcast or uniform sky. Daylight and spatiality are influenced by the size and design of windows. Theoretically, the optimal form of an energy-efficient building is a compact and airtight cube or preferably a sphere to minimise heat loss; openings should face south to utilise passive solar heat and be as closed as possible to the north. This idea conflicts with retaining daylight and views in different directions. Other possible conflicts might be related to the design of the facade; insulation thickness will affect the depth of the windows and therefore decrease daylight. Layers and foils in windows that have low U-values[4] will influence transparency and visibility, daylight and colour rendering. Nearby trees or buildings, protruding roofs, sun-shading devices and balcony elements cause shadow and visually limit the perceived outdoor space. These elements will affect the daylight conditions greatly. Placement of windows in the wall and size of windows will highly affect the daylight factor, see note 3.

To achieve optimal daylight conditions, a window placed high in the wall or windows that allow the transmission of daylight from different directions are more effective than floor-to-ceiling height windows if the glass area is the same. Rooms with daylight that comes from only one direction will require the use of artificial light to avoid contrasts (Matusiak, 2012). Another conflicting goal is overheating when floor to ceiling-

4 The U-value (coefficient of thermal transmittance) measures how effectively a building component, e.g., a wall, roof or window, retains heat inside of a building. For those living in a warm climate, the U-value is also relevant because it also indicates how long the inside of the building can be kept cold.

height windows are oriented towards the south-west. Typically in Norway, the problem with overheating is worse in spring and autumn, when the solar altitude angle is low (Thomsen et al., 2011).

Daylight and visual contact with the outdoors may appear to be similar concepts, but it is important to keep them somewhat separate. Visual contact with the outdoors, *at one with nature* or *confronted* with the surroundings, will be easier to experience through a large floor-to-ceiling height window than through, for instance, a window placed high in the wall, even though the daylight factor might be satisfactory. The daylight factor is thus not sufficient as an indicator for quality of the light or the visual contact with the outdoor environment (Matusiak, 2012).

Airing and sensory contact with the outdoor environment

Contact with the outdoor environment through natural airing or access to the outdoor environment appeal to the auditory, olfactory and tactile senses. Sensory contact with the outdoor environment will be influenced by the possibility of opening windows and balcony doors as well as obtaining access from the apartment to a balcony, terrace or garden. The surroundings may offer sensory impressions from traffic, the twittering of birds, water, people, children playing, orientation and climatic conditions, greenery and outdoor space close to the apartment. Well-insulated apartments are not exposed to much sound from the outside. It is easier to be aware of noise from the ventilation system when outside sounds do not disguise it.

The most important factors for natural ventilation are stack effect and cross ventilation. Passive houses are designed to handle short airings, and cross ventilation on hot summer days is part of the passive house design concept. However, ventilation in passive houses is normally not provided by natural airing. In fact, airing through windows could be regarded as a problem rather than a benefit. Sleeping with the windows open during the night or leaving the windows open as one leaves the home is possible, but it is not a part of the concept and may lead to unwanted heat loss and extended electricity use. As in most of the cases that we investigated, ventilation should be handled by a balanced ventilation system with heat recovery.

Method

Because the Norwegian Building Act and the passive house concept focus on a compact and airtight building volume, it appears relevant to investigate how the relation between the inside and outside environments is handled. Two methodological approaches were selected. First, informants for qualitative interviews were selected based on a mapping of a number of recent housing projects representing different approaches to energy concepts and architectural design. Second, six architects respon-

sible for the designs were contacted for in-depth interviews. Qualitative interviews and conversations with three further architects and experts were conducted to capture the diversity in the architects' approaches to architectural challenges and possibilities within the design of energy-efficient housing[5]. The main source for finding relevant projects was the web-based database with selected energy efficient architecture (NAL Ecobox), in which examples of sustainable architecture, design and planning in Norway are presented. Other sources were architectural journals and newspapers. All cases are presented by Enova[6] and the Norwegian State Housing Bank[7] as examples of the current *best practice*, and some projects have been carried out in collaboration with researchers at SINTEF Building and Infrastructure, who represent the leading expertise on energy-efficient architecture in Norway.

Out of a *pool* of approximately 20 projects, 6 were selected. The criteria for selection were that the projects should be designed for multifamily housing, produced for *the mass market* and represent different architectural solutions and energy design concepts. We aimed to determine whether the architects experienced conflicts between a focus on energy efficiency and the aim to create attractive housing solutions and to examine how they considered energy efficiency in architecture and its effects on housing qualities, such as daylight, fresh air and view. In addition to interviews and site inspections, we also studied photos, drawings and information regarding energy design to investigate how the relationship between the indoor and outdoor environments was handled.

5 Interviewees: Architects at Løvåshagen: Jan Haaland and Rigmor Sletnes, ABO Architects. Architects at Røa: Frederica Miller, Gaia architects. Architects at Storelva: Rosemarie, Karen and Odd Steinsvik, Steinsvik architects. Architects at Marilunden: Wilhelm Eder and Christine Biesel. Architects at Skadbergbakken: Ane Dahl, Helen & Hard Architects. Architects at Klosterenga: Per Monsen, Gasa Architects. Other interviewees: Per Knudsen, PK Architects. Svein Skibnes, Svein Skibnes Architects. Geir Brendeland, Brendeland and Kristoffersen Architects.

6 Enova SF is owned by the Ministry of Petroleum and Energy and was established to take a leading role in promoting environmentally friendly restructuring of energy consumption and energy generation in Norway.

7 The Norwegian State Housing Bank was established in Norway in 1946 to meet the need for proper housing after World War II. This bank is the Norwegian government agency responsible for implementing Norwegian housing policy at the national level.

Energy-efficient housing – a presentation of six Norwegian cases

Figure 4: The selected Norwegian housing projects

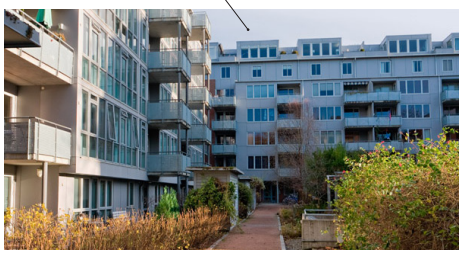
Løvåshagen, Bergen. ABO Architects. Completed 2008.
PHOTO: KNUT EGIL WANG

Storelva, Tromsø. Steinsvik Architects. Completed 2008.
PHOTO: SOLVÅR WÅGØ

Skadberg-bakken, Sola, Stavanger. Helen & Hard Architects and PPAG Architects (Austria). Phase 1 completed 2010.
ILL.: THE ARCHITECTS

Marilunden, Stavanger. Eder Biesel Architects and Nonconform (Austria). Completed 2008.
PHOTO: SOLVÅR WÅGØ

Røa EcoHousing, Oslo. GAIA Architects. Completed 2009.
PHOTO PROVIDED BY M. RUDOLPH-LUND



Klosterenga Ecology Housing, Oslo. GASA Architects. Completed 2000.
PHOTO PROVIDED BY THE ARCHITECTS

The goal of energy efficiency was held in common for all of the investigated projects. Not all projects involved passive houses, but all aimed at having lower energy consumption than required by the building regulations and reducing the buildings' environmental impacts. Various efforts were made to achieve these goals. All projects were well insulated. Mechanical systems were installed in most cases to reduce heat loss and achieve a comfortable indoor temperature. Except Røa Eco-housing, do all of the studied housing examples have a balanced mechanical ventilation system with heat recovery. At Klosterenga Ecology-housing it is possible to switch off the mechanical system during summer. All projects were supplied with electricity from the grid.

Passive and *low-tech* design principles, such as zoning, space-efficient plan layouts, the use of daylight and the possibility of controlling solar heat in double facades, and natural ventilation through stack effect and cross ventilation, were utilised in some of the projects. Solar collectors were installed at Løvåshagen, Klosterenga and Storelva. A ground-source heat pump supplies the dwellings' need for space heating and hot water at Storelva, Røa, Marilunden and Skadbergbakken. The salvageability of materials, their capacity as heat and indoor climate regulators, and the hygroscopic capacity of massive wooden elements that were used to achieve healthy and comfortable indoor climates are utilised to various degrees.

Løvåshagen passive and low-energy housing, Bergen

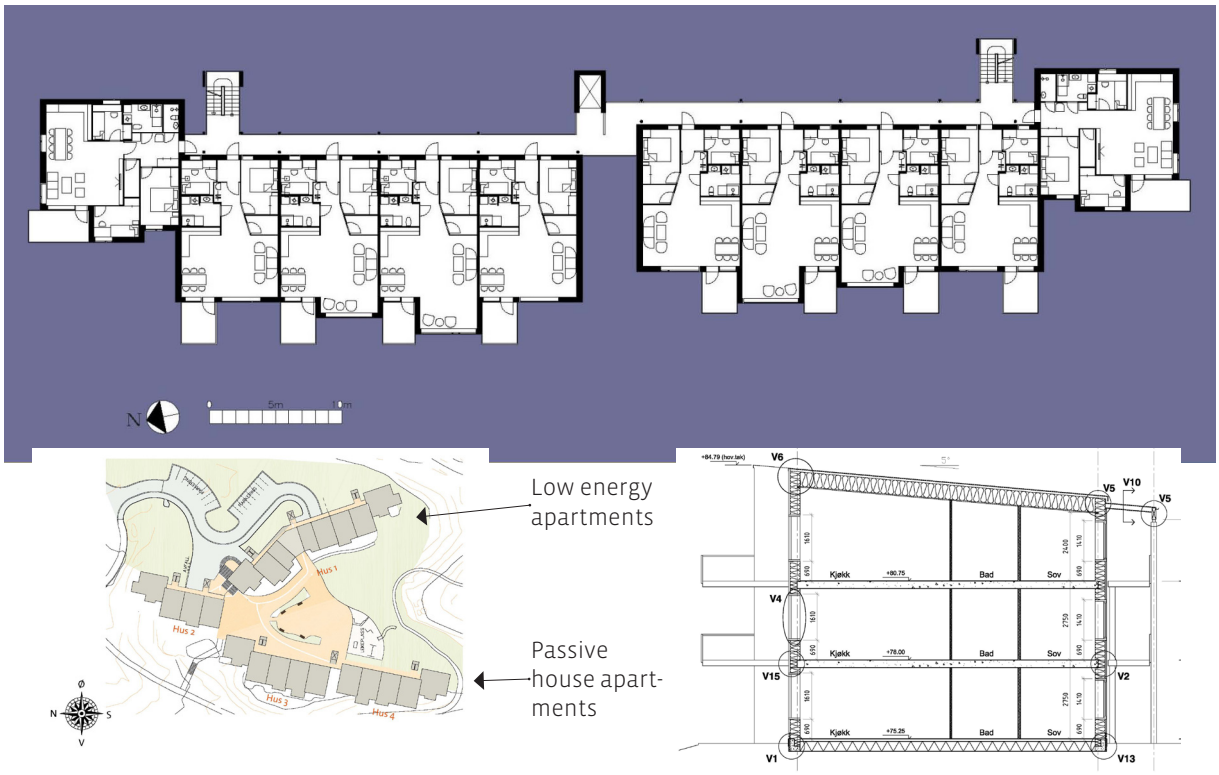


Figure 5: Site plan, layout plan, section, and illustration by ABO Architects.

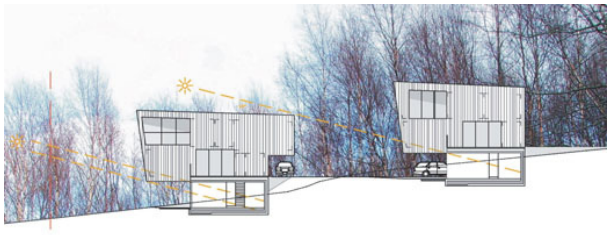
Løvåshagen is situated in a quiet location surrounded by woodlands in Fyllingsdalen, 6 km from Bergen city centre. This site contains both passive and low-energy dwelling units, implying a well-insulated building envelope, large windows facing south and west to utilise passive solar heat, small windows facing north and east and balanced ventilation with heat recovery.

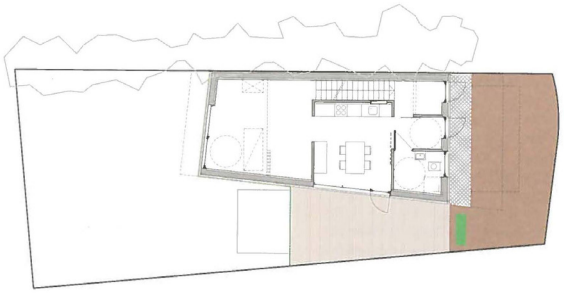
The width of the southwest facade is generous, offering the inhabitants the opportunity to experience the greenery and common outdoor area. To the northeast, the facade is more closed and has relatively small windows in the bedrooms facing the entrance area at the gallery outside.

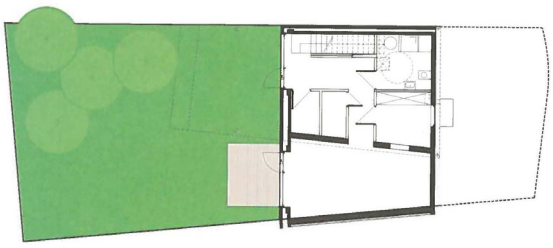
Except for the corner apartments, all of the apartments have one-sided daylight and views. The depth of the apartment is too large to raise the level of daylight in the entrance area.

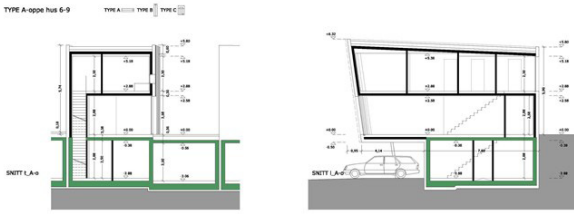
The balcony allows the door to be opened and the smells and sounds from the outside greenery and birds to be let into the apartment. The balcony railing is transparent and provides the feeling of an extended room and fluid transition between the living room and surrounding woodlands.

Marilunden low-energy housing, Stavanger









Marilunden comprises two rows of houses with 5 units in each house that are joined together in the basement. This site is located on a west-

Figure 6: Sun study, ground and first-floor plans, section and site plan by Eder Biesel Architects & Nonconform.
PHOTO BY LISE BJELLAND/ «DITT HUS», PROVIDED BY MICHAEL AITKEN AND FAMILY.

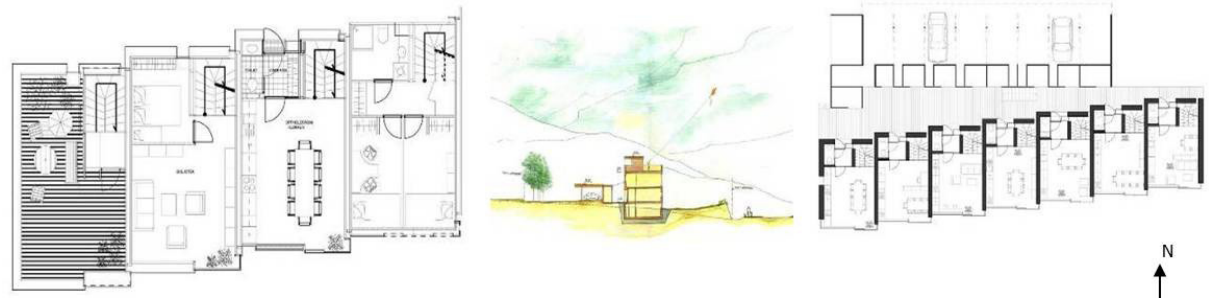
oriented slope 10 km from Stavanger city centre and is a part of the 'Norwegian Wood' project[8].

Windows are oriented towards the south and west, and sun-shading devices are delivered as standard. Facades are closed to the north to secure privacy on the terrace and in the apartments. The living space in each unit is distributed on three floors. The kitchen, living room and large terrace are located on the second floor and oriented towards the west.

Daylight, visual and sensory contact with the outdoors is very present throughout the apartments. The windows are of floor-to-ceiling height. It is possible to open part of the window in all rooms to let air in. The living room have daylight and views in several directions and both visual and direct contact with a private outdoor terrace and a garden. The facade facing the slope leans downwards in the direction of the slope, thereby providing the experience of a close relationship to the outdoor environment.

8 Norwegian Wood was one of the largest projects of Stavanger 2008 – European City of Culture. The project was intended to promote the use and knowledge of wood as a sustainable building material.

Storelva passive housing, Tromsø



The row houses at Storelva are located in a suburban neighbourhood in Kvaløya, 10 km from Tromsø city centre. The complex consists of seven units, each of which has three floors and a roof terrace. The building volume is relatively closed towards the north and dominated by very large glass surfaces towards the panoramic view of the fjord and mountains to the south.

Figure 7: Situation, section and floor plan by Steinsvik Architects.
PHOTO OF LIVING AREA BY RAVN STEINSVIK.

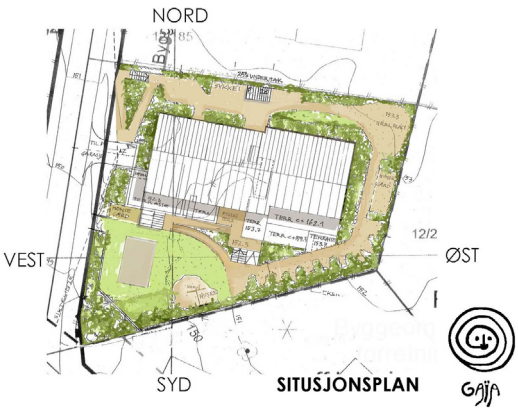
The apartments are provided with daylight and views in several directions. The seven units are separated by a small shift in the facade that provides a glimpse towards the east. Windows facing north are tall, narrow openings in the massive wooden wall.

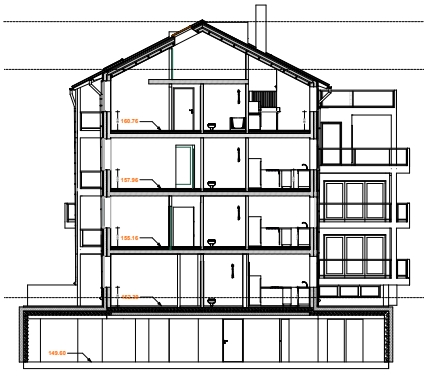
These windows provide daylight and views to the staircase, the entrance and one of the three bedrooms. Small windowpanes in the larger windows can be opened.

The use of daylight and passive as well as active solar heat and the opportunity to experience visual contact with the outside natural environment are important design features. However, the sensory relation to nature appears to be less focused than the importance of view, sun and daylight.

The windows are designed for short airings, and there are no balconies or access to the outdoor environment, except to the entrance and roof terrace.

Røa Eco housing, Oslo





Røa Eco housing is an extension of a former one-family house with 9 apartments. It is situated in an urban neighbourhood in Oslo West, 6 km from the city centre. Røa Eco housing is based on passive design principles, including orientation, the use of passive solar heat and zoning.

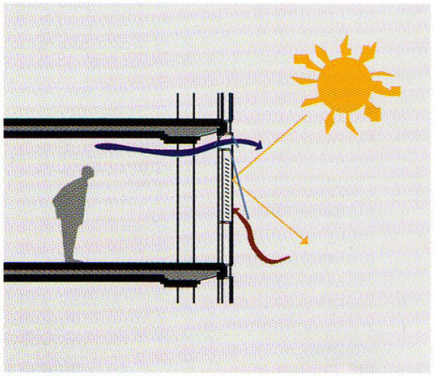
Figure 8: Site plan, second-floor plan and section by Gaia Architects.
PHOTO OF THE KITCHEN AREA PROVIDED BY MARI-ANNE RUDOLPH-LUND.

A healthy indoor climate has been emphasised by the use of hygroscopic materials (massive wood) and natural ventilation through airing panels located on the top of south-facing windows and beside north-facing windows. The bathroom and wood-burning stove are placed as a hot core in the middle of the apartments with bedrooms to the northeast and living and kitchen areas to the southwest.

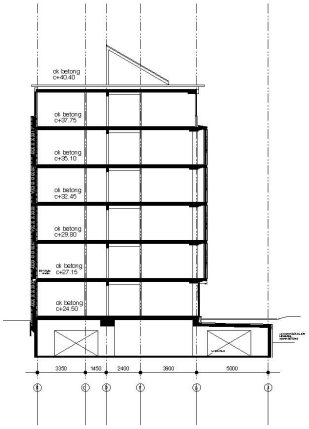
Windows in the living rooms facing the terrace or the French balcony at the end wall facing west are of floor-to-ceiling height, whereas all of the other windows are highly placed (from 900 mm above the floor up to ceiling height). The southwest-oriented site provides a view from the apartments to the street. The hills and Oslo fjord are seen in the distance. The openings are not large, implying *looking out* rather than being *confronted* by the outside environment. Overhanging terraces and frosted balcony barriers provide solar shading and shelter from outside view but constitute limitations on sun, view and daylight conditions and do not create a seamless transition with the outdoor environment. Three free facades provide daylight and view in two or three directions as well as direct access to the outside environment.

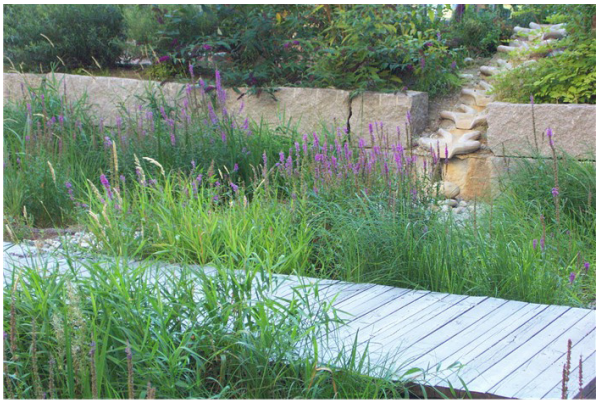
The living area has access to a terrace and *French balcony*. Some of the apartments have a balcony from the bedrooms towards the northeast or from the kitchen towards the east, providing the opportunity to either go outside or to experience sensory impressions from the surroundings. The balconies provide opportunities to get fresh air, the heat from the sun and the sounds and smells from the outside environment, but noise, dust and traffic will likely reduce the positive nature of this experience, at least during rush hours.

Klosterenga ecology housing, Oslo



Dobbelfasadens funksjoner sommer.





Klosterenga is situated in the eastern part of Oslo city centre, 2 km from Oslo Central Station, and provides 35 two-, three- and four-room apartments sized 53–100 m², all planned with an extensive focus on ecological efforts.

Klosterenga is constructed using concrete, steel and bricks. A double facade with high, narrow windows faces the courtyard towards the south and provides plenty of daylight and views for the residents. Blinds between the panes of glass prevent overheating and provide visual shelter from outside view and neighbouring apartments.

A more closed brick-wall facing north and the public park constitutes an architectural contrast to the double glass facade.

Figure 9: Typical floor plan, section, illustration of how the double facades is supposed to work during summer and photo (corner apartment and the common garden)

PROVIDED BY GASA ARCHITECTS.

Apartments are planned according to zoning principles with living rooms to the south, bathrooms in the middle and bedrooms to the north.

The ventilation system is a combination of natural ventilation and balanced mechanical ventilation. The natural system provides fresh air from the outside, which is preheated in the 35 cm layer between the sheets of glass in the double facade facing south. When needed, cold air can be admitted from the north-facing windows. All housing units have daylight from more than one side and a private balcony. Balcony railings in perforated steel plates constitute a visual shelter but block more of the daylight than the transparent railings used at the French balconies in the corner apartments.

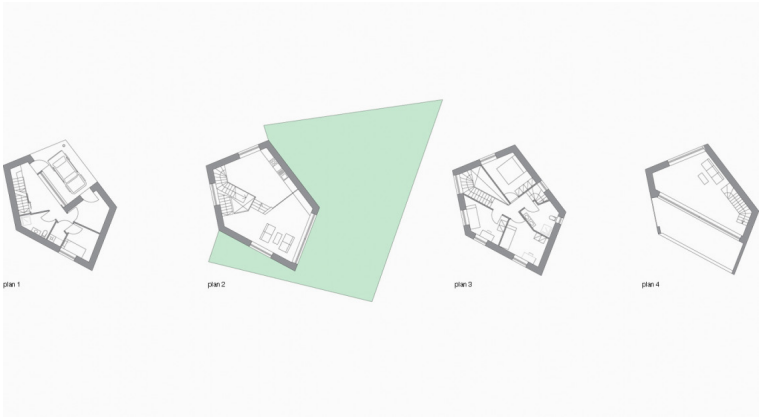
Ecological issues in the Klosterenga project includes water saving and cleaning installations, the reuse of ecologically cleaned water, garbage sorting, local composting and the greening of outdoor areas, where the residents socialise and can grow vegetables and herbs.

Skadbergbakken passive housing, Sola

Skadbergbakken is located in the centre of Sola, a suburb located 12,7 km away from Stavanger city centre and is a development area with housing, a kindergarten, service offices, and infrastructure surrounding public spaces and playgrounds. When completed, the area will consist of a combination of single-family houses, 4- and 5-family residences and blocks of flats. In total, 113 housing units are planned.

Inspired by the traditional housing typology in this area, the buildings are gathered around six 'farm yards'. The goal is to create lively, social meeting places for both children and adults. All buildings are 5-cornered which imply innovative solutions regarding daylight conditions and views in several directions. The project aims to have passive house standards by including massive wooden elements. It has balanced ventilation with heat recovery.

There is wide variation in the design of the openings in the facade, which create a dynamic relation between being inside *looking out* through small window openings and being *confronted* with the outside through floor-to-ceiling openings, often related to access to an outdoor space on the rooftop or a terrace. The tension between what is experienced as wide and what is experienced as narrow also occurs in the difference between rooms of double height and those of single height and in the experience of moving between them. The terraces are *carved out* from the building volume and provide the possibility of remaining under a roof while outdoors. The design offers the possibility of remaining outdoors even when it is raining but might decrease daylight in the indoor area. However, the most interesting qualities are the daylight conditions and dynamic spatiality of the room sequences.



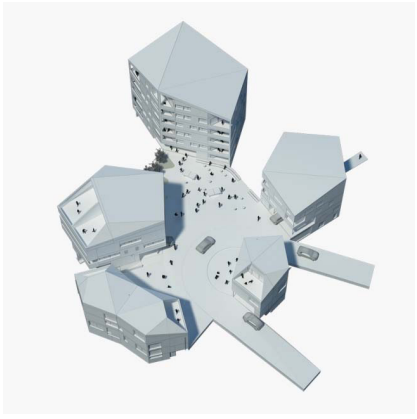


Figure 10: Building development plan, typical floor plan, axonometric illustration by Helen & Hard Architects and PPAG Architects (Austria).
PHOTO: EMILIE ASLEY

What is achieved in these projects?

The impact on daylight, view and visual contact with the outdoors

Shallow apartments and daylight access from two or more directions will have great impact on the daylight. Some of the investigated apartments are too deep to achieve sufficient daylight conditions[9]. Combined with protruding balconies and the growing forest outside, the access to daylight has been reduced. This is a typical problem for a lot of apartments that are built today; too deep, too narrow and with daylight from just one side. The cases studied here show, however, that energy-efficient housing design may give rise to new architectural possibilities in terms of increased daylight, view and sensory contact with the outdoor environment. Such as in Marilunden and Skadbergbakken daylight and

9 It has not been a part of our study to measure the daylight factor in the apartments and consider whether the daylight conditions are sufficient according to the Norwegian building regulations. Our evaluation is an appraisal based on the lay-out plans and on-site visits in different apartments.

view in different directions have been emphasised in the planning, and resulted in apartments with particularly good daylight conditions. Interestingly, our informants appear to find support among other actors involved in the projects and refer to what they call 'serious builders', who accept more insulation in roofs and walls to compensate for a greater glass area when it benefits housing qualities, such as access to daylight and views.

Energy-efficient windows with lower U-values, see note 2, and improved detailing imply that the risk for cold drafts and the need for electric radiators below windows are reduced. This design feature provides opportunities for allowing the window surface to be placed at floor level and thereby offers a closer relationship between the inside and outside environments. Radiators placed in front of windows have hitherto disturbed the possibility of a seamless transition between the indoor and outdoor environments. The ability to avoid installing electric heaters is thus a positive implication of the use of improved windows in energy-efficient housing.

Figure 11: Unbroken view from apartment at Storelva (left), Marilunden (middle) and Løvåshagen (right).
PHOTO LEFT (STORELVA): RAVN STEINSVIK, MIDDLE (MARILUNDEN): LISE BJELLAND/ «DITT HUS» AND RIGHT (LØVÅSHAGEN) NAL ECOBOX.

Passive houses have more insulation than conventional housing, resulting in thicker walls. This design feature has been a subject of discussion among architects because thicker walls might decrease the amount of available daylight. This feature might also be the object of new architectural solutions and new uses. Our informants did not emphasise this as a new design-possibility, but we observed that extensive window frames were utilised for different purposes in the six cases.

The impact on airing and sensory contact with the outdoor environment

Access to a balcony, open window, terrace or garden is emphasised as an important housing quality by all of the architects that were interviewed and has become a vital design feature in all six projects. How air openings are accentuated depends on the energy design concept. At Storelva, the openings for short cross ventilation are quite small, stand out from the façade and are marked with different and strong colours (photo 11, figure 12), whereas the air openings at Marilunden, Løvåshagen and Skadbergbakken are simply a part of the ordinary window and do not require any attention.

Direct access to an outdoor balcony or garden for spontaneously enjoying the outdoor breeze (photo 1, figure 12), allowing the outdoor area to become an extension of the indoor living area, to take part in life outside of the house or just to be opened and let nature in, is emphasised in all of the cases. The architects at Løvåshagen have argued for the balcony as an important design feature to create attractive facades, in addition to the usability aspect. (photo 4 and 5, figure 12). At Storelva, the private outdoor space is a roof terrace that enjoys a magnificent view (photo 13, figure 12), but there is also a common outdoor area by the entrance (photo 12, figure 12). At Marilunden, it is possible to stay in the sun until noon in the outdoor area by the entrance that faces east and then to move on to the terrace to enjoy the sun there in the afternoon (photo 7, figure 12). The surrounding woodlands provide a place for and the possibility of recreation and play (photo 6, figure 12).

Figure 12: The 6 housing projects examined and architectural solutions related to sensory contact with the outdoors or airing. Photos and illustrations 5, 9, 10, 12 and 13 are provided by the architects.

PHOTO NO. 8: LISE BJELLAND/ «DITT HUS»

OTHER PHOTOS: SOLVÅR WÅGØ

Architectural implications

By investigating recent Norwegian housing projects, we have seen on one hand that energy efficiency has resulted in quite a large variety of architectural solutions, and on the other hand that efforts to reduce energy use do not necessarily contradict important housing qualities. Architectural qualities like having daylight, view and fresh air, is highly emphasised by the architects as important to implement in energy efficient housing.

Emphasising architectural qualities

According to Gram-Hanssen and Jensen, sustainable design has been associated with 'grass root alternatives' or 'the green building as an energy-saving device', and the debate has been referred to as 'a techno-centric versus eco-centric debate' (Gram Hanssen and Jensen, 2005, pp. 165–183). This rather dualistic interpretation of architectural approaches appears to have changed or at least supplemented by an attitude that emphasises architectural qualities. Informants in our study, who had been working with eco-houses in the 1970s found the architectural expression of that time a bit 'baggy' and expressed gratitude and joy towards 'the new and fresh architecture coming from Austria'. Lately, most of the informants had undertaken study trips to Austria and Germany and regarded Austrian passive houses as ideals to follow and as representing a kind of *new modernism* in which materials, detailing and other architectural features are related to regional building traditions.

The 'sustainability concept' is associated by our informants with high-quality architecture and not necessarily with green design features. Reducing the buildings' carbon footprint and carrying out considerate planning of relatively dense but thriving and friendly residential neighbourhoods is expressed as the most important aspects of creating sustainable residential areas. Our informants state that it is primarily important to be 'honest'. Some of them claim that focusing on architectural qualities, such as the use of daylight, having a view in different directions and allowing the possibility to air the building naturally, has become even more important to them because it increases the reputation of energy-efficient architecture. *«We want to prove that energy efficient housing should not be attended with straight lines and boring boxes.»* and *«The energy efficient focus should not overrule architecture but be integrated. Energy efficiency should be associated with architecture with attractive design, housing quality and clever solutions. This was important before but is even more important now!»* These informants state that architects will always attempt to achieve optimal qualities based on given premises related to site, climate, the consumption of energy and resources, area efficiency and economy. Architecture combines many different disciplines to find the best solution for a specific project. For most architects, given premises and natural conditions provide inspiration that can be drawn from during the design process.

How are daylight, view and fresh air in low-energy design dealt with by the architects?

The six projects studied demonstrate that a focus on energy efficiency does not provide a particular aesthetic expression. However, the manner in which daylight and air are handled in low-energy design clearly influences spatial and aesthetic qualities.

The architects' attitudes varied, and the investigated projects indicated different lines'. Two of the projects are passive housing, two are low-energy housing and two may be labelled 'eco-housing', which implies that other environmental issues, such as those regarding materials, water and sewage systems, food production, the buildings' footprint, and urban planning, have been considered. The architectural firms Gasa and Gaia, which have been addressing ecological architecture for several decades, both use 'low-tech' approaches in their projects at Klosterenga and Røa. The double facades and brick facade at Klosterenga are active elements of the project's energy design and influence the transparency between the indoor and outdoor environments in addition to heating, cooling and ventilation. The design of Røa Eco-housing is based on natural ventilation principles, which have influenced the use of airing panels beside windows and a relatively closed architectural expression with smaller, highly placed windows.

Steinsvik architects have been occupied with sustainability and what they call 'regional modernism' for many years. They have been involved in the development of passive houses designed for Northern Norwegian conditions but are rather sceptical of the new regulations. The row houses located at Storelva are designed using the architects' own technical solution, which is based on passive principles. Their attitude that 'the sun is the most important energy source' has been expressed architecturally by large south-facing glass facades.

At Skadbergbakken, Helen & Hard's main focus was to secure spatiality, daylight and views in different directions in a compact, five-cornered building volume. They did not consider heating and ventilation as a part of the architecture, and these features have just been added as technical systems. At Marilunden, Eder Biesel has had a similar approach, and also other informants express the same attitude: scepticism towards balanced ventilation systems, but acceptance of it as part of the passive house standard. On the other hand. ABO architects added balanced mechanical ventilation at Løvåshagen and believe that this feature has resulted in a higher level of comfort for the residents. For the architects at Løvåshagen, the balconies and other protruding elements have been important aesthetically; *«we had a nice dialogue with the builder and the energy advisors regarding this. We saw it as important to signal that the Løvåshagen housing area was different and wanted to use happy colours and a fresh and 'future-oriented' architecture to achieve a better reputation for energy-efficient architecture.»*

Most of our informants related the concept of 'housing quality' to spaciousness, floor-to-ceiling height windows, visible contact with the outdoors and direct access to a private balcony or garden. As stated by one of the informants, their work «*...is based on ideas rooted in modernism*». The aims to utilise daylight and view have released creativity among the architects. Daylight, spaciousness and usability (e.g., flexibility in use and furnishing) are strongly dependent on the width of the facade. In housing blocks or row houses, this dependency implies shallow apartments with more extensive outer walls, which also implies more insulation or possible heat loss. Using more creative architectural measures in the design of a housing block, this case study demonstrates that floor plans can be organised such that daylight and views are fully utilised in more than one direction.

Access to fresh air and sensory contact with the outdoor environment through an open balcony-door is also highly emphasised. The architects have a more defensive attitude towards airing and appear to leave this issue to energy advisors. However, they still claim that the best solution has not yet been developed and believe that residential experience and response will demand better solutions.

Attitudes towards regulations and technology

The roles of the Building Act and the Norwegian Passive House Standard and the impact of these two important incentives on visual and sensory qualities have been a subject of discussion during all interviews. It appears that this issue is often discussed among architects. The informants state that the focus on energy demands for heating is exaggerated in the building regulations. They claim that the Building Act and the Passive House Standard have set 'a too narrow approach to environmental issues' and have 'a one-sided focus on energy for heating'. The rules are perceived as very rigorous and 'maybe necessary for the unserious actors without architectural competence and without this mindset in the backbone.' In response, architects call for a more holistic approach in which other environmental aspects, such as area efficiency, floor planning, the utilisation of sun and daylight and the impact of use, are considered through involvement with the residents.

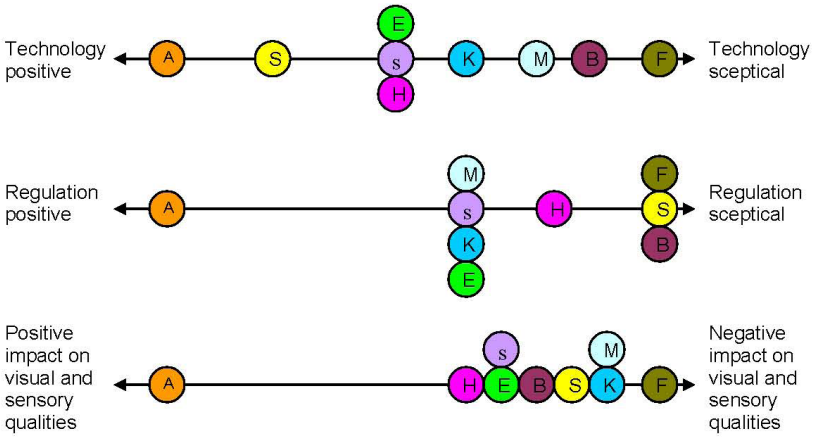


Figure 13: The interviews considered relevant topics regarding how architects address technology, building regulations and the passive house standard and whether architects think these considerations will have a positive or negative impact on visual and sensory qualities. Each coloured circle represents a view held by one architect.
ILL.: SOLVÅR WÅGØ

All of the interviewees welcome the aim of lowering energy consumption but fear the policy instruments used (e.g., that regulating glass area will reduce daylight and spatial qualities while not reducing energy consumption significantly). It appears that the architects are more sceptical towards the regulations than the technology itself.

Figure 13 illustrates that many of our informants fear that these incentives will have negative impacts on visual and sensory qualities in homes: *«Regulations have never been an initiator for creating architecture of high quality.»* Our informants are thus not necessarily *techno-sceptical* in general but experience the regulations as overruling their architectural competence and believe that technology alone cannot solve the issue of energy efficiency. Although most informants do not want to appear to be *reactionary*, they question whether technology will solve the problem of high energy consumption in homes or rather contribute to higher consumption. Even if one of the most *technology positive* interviewees states, *«building passive houses is not 'hocus pocus'», he retains an open mind regarding «better solutions not yet developed.»* Other informants search for solutions that involve simple and robust technologies and are critical of the strict regulations regarding the use of glass and the focus on a compact building volume and fear that technical advisors are setting guidelines that will not benefit architecture.

Some of the interviewees state that they are opposed to modernist ideas of *«the house as a machine for living»* (referring to Le Corbusier's famous statement in 1924). They want people to relate to nature and argue for a closer relationship between human beings and nature. They fear that modernist ideas regarding a functionality that should 'fit all' and is solely related to practical issues do not have the varied needs of residents in mind. The informants moreover fear that the focus on technological solutions and demand for balanced ventilation with heat recovery adopted in the passive house standard may undermine a responsibility towards nature, perhaps without even reducing energy consumption, which was the original aim.

Conclusion: Are modernist ideals still valid?

The informants in this study agree with the effort to reduce energy consumption in housing, but visual qualities, such as access to sun, views and daylight, are reluctantly compromised. In fact, the informants consider these qualities as important success criteria for energy-efficient housing and important to the reputation of energy-efficient architecture.

The case studies illustrate that energy efficiency has resulted in a manifold of architectural expressions, and the interviews verify that the architects manage the new challenges and restrictions in different ways.

Although the legislation challenges various visual qualities, such as access to daylight and views, architects are not willing to let the regulations rule their architecture. Instead, they search for new design solutions that will benefit both perceived qualities and energy efficiency.

Most informants still express strong criticism of the policy instruments and even believe that the building code restrictiveness regarding maximum glass area does not have any significant effect on reduced energy consumption. In fact, modernist ideals appear to overrule energy-efficient efforts that do not benefit architectural qualities. Architects see it as a duty to fight for housing qualities, particularly good daylight conditions. However, in regard to airing, most of our informants express resigned acceptance of balanced ventilation as a part of the passive house strategy. Although they still find it important to be able to air buildings naturally, they have more or less given up on influencing this aspect of the planning process.

To conclude, this study shows that the focus on sensory qualities, particularly on visual relations with the outdoor environment, appears to have been strengthened by a stronger emphasis on energy efficiency among architects engaged in the design of low-energy housing. Seeing these qualities as threatened but still crucial for peoples' well-being and health, architects regard raising the awareness of these qualities as necessary for the reputation of energy-efficient housing. Our informants call for a more holistic approach to environmental aspects and are afraid that the one-sided focus on reducing energy loss, in the legislation, will have negative impact on access to daylight, views and the possibility of airing naturally.

Based on a strong belief in scientific and technological progress, the early modernists emphasised the human ability to create, improve and change their surroundings. However, history has demonstrated that these ideals not only resulted in a promising and successful development but also led to the construction of poor quality housing areas. Lessons learnt from post-war reconstruction and functionalist urban planning have provided reasons to question the use of universal norms and regulations as the main instruments to improve housing qualities for all people. By introducing a strict policy solely focusing on energy demand for heating without considering individual habits and needs and approaching environmental challenges in a more holistic manner, the risk is that history will repeat itself. Our informants represent a counterbalance to this tendency, and their architecture provides a valuable contribution to the discussion about how to reduce energy consumption in the Norwegian housing stock without compromising architectural qualities.

Acknowledgements

We would like to acknowledge the interviewees who kindly spent precious time to share their knowledge and opinions and for showing genuine interest in our topic.

An early version of this article was presented and discussed at the Passive House Norden Conference in Helsinki in 2011. We would also like to thank other colleagues who provided valuable input and participated in discussions.

Literature

Bakke, J. V. 2011. Varsler om helserisiko ved passivhus. *Aftenposten*, 19.01.

Bech-Danielsen, C. 2004. *Moderne arkitektur: hva' er meningen?*. Århus: Systime.

Bjerregaard, L. M. 2005. *Forsegling & symbiose: naturvidenskab og naturromantik – en dialog i moderne arkitektur: belyst via studier af grænsen mellem inde og ude*. Århus: Arkitektskolens Forlag.

Brunklaus, B., Thormark, C. & Baumann, H. 2010. Illustrating limitations of energy studies of buildings with LCA and actor analysis. *Building Research and Information*, 38, pp. 265–279.

Butters, C. & Miller, F. 2004. Déjà vu og det designløse huset? *Arkitektnytt*, 12, p. 9.

Colomina, B. 2005. The Split Wall: Domestic Voyeurism. In: Cornelissen, H. ed., 2005. *Dwelling as a figure of thought*. Amsterdam: SUN.

Dokka, T. H. & Hermstad, K. 2006. *Energieffektive boliger for fremtiden. En håndbok for planlegging av passivhus og lavenergiboliger*. Trondheim: SINTEF Byggforsk.

Findal, W. 2007. *Funksjonalismens boliger: form, funksjon, komfort*. Oslo: Pax.

Gram-Hanssen, K. & Jensen, J. O. 2005. Green buildings in Denmark. From radical ecology to consumer-oriented market approaches? In: GUY, S. & MOORE, S. A. eds., 2005. *Sustainable architectures: cultures and natures in Europe and North America*. New York: Spon Press.

Gropius, W. 1926/1970. Principles of Bauhaus production. In: Conrads, U. ed. Programs and manifestoes on 20th-century architecture. Cambridge, Mass.: MIT Press.

Hatløy, S. 2011. Arkitektur eller termos. *Arkitektnytt*, 4, pp. 28–29.

Hien, P. T. 1998. *Abstraction and Transcendence: Nature, Shintai, and Geometry in the Architecture of Tadao Ando*. Dissertation.com.

Knutsen, K. 1961. Mennesket i sentrum. *Byggekunst*, 4, pp. 129–146.

Lauring, M. & Marsh, R. 2008. *Architectural quality of low energy houses*. Passivhus Norden 2008. Trondheim.

Le Corbusier & Buhl, O. 1965. *Menneskenes bolig*. København: Vintens forlag.

Le Corbusier & Jeanneret, P. 1926/1970. Five points towards a new architecture. In: Conrads, U. ed. *Programs and manifestoes on 20th-century architecture*. Cambridge, Mass.: MIT Press.

Marsh, R., Larsen, V. G. & Kragh, M. 2010. Housing and energy in Denmark: past, present, and future challenges. *Building Research & Information*, 38, pp. 92–106.

Matusiak, B. 2012. *What daylight factor do not tell*. Trondheim: Faculty of Architecture and Fine Art, Norwegian University of Science and Technology.

Ministry of Local Government and Regional Development 2010. T*EK 10, Forskrift om tekniske krav til byggverk* (Byggteknisk forskrift / The Planning and Building Act).

Ministry of The Environment/ Ministry of Local Government and Regional Development 2012. *Meld. St. 21, Norsk klimapolitikk*.

NAL Ecobox. Ecobox Project data base; www.arkitektur.no [Online]. NAL Ecobox. [Accessed].

National Association of Norwegian Architects 2009. *Høringsuttalelse til ny teknisk forskrift til plan- og bygningsloven*. Oslo.

Nordby, A. S. & Miller, F. 2010. Environmental Paradoxes in the Building Industry. *Arkitektur N, The Norwegian review of Architecture*, 3, pp. 34–39.

Orme, M., Palmer, J. & Irving, S. 2003. Control of Overheating in Well-Insulated Housing. In: P*roceedings of ASHRAE/CIBSE Conference (24–26 September) – Building Sustainability, Value & Profit*. ISBN: 190328743X, CIBSE, London, Great Britain.

Pallasmaa, J. 2011. *Dwelling in time. Daylight and Architecture, 16, pp. 11–16.*

Standards Norway 2010. *Kriterier for passivhus og lavenergihus: boligbygninger*. Lysaker: Standard Norge.

Thomsen, J., Hauge, Å. L., Denizou, K., Jerkø, S., Wågø, S. & Berker, T. 2011. *User evaluations of energy efficient buildings: the interplay of buildings and users in seven European case studies.* Oslo: SINTEF Academic Press.

Wilson, C. S. J. 2007. *The other tradition of modern architecture: the uncompleted project.* London: Black Dog Publ.

Biographical information

Solvår Wågø, PhD student
Place of work:
Norwegian University of Science and Technology (NTNU), Trondheim, Norway
Faculty of Architecture and Fine Art
Department of Architectural design and Management
Address: 7491 Trondheim, Norway
E-mail: solvar.wago@ntnu.no

Biographical information

Eli Støa, Professor
Place of work:
Norwegian University of Science and Technology (NTNU), Trondheim, Norway
Faculty of Architecture and Fine Art
Department of Architectural design and Management
Address: 7491 Trondheim, Norway
E-mail: eli.stoa@ntnu.no