The first certified Passive House in Norway

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1 Introduction

The engagement in Low energy and Passive houses in Norway has increased during the last years. A low energy building has a total net energy demand not more than 100 kWh/m²a (this includes all the electricity consumed in the dwelling), which indicates a space heating demand close to 30 kWh/m²a. An average dwelling unit in Norway consumes totally 214 kWh/m²a end energy. This is nearly the same as net consumption and primary energy consumption because the greater part of the Norwegian housing stock is heated by hydroelectricity power. The national building code has since 1997 required a space heating demand about 60-90 kWh/m²a. From august 2009 it will be limited to 40-60 kWh/m²a. This is better than in Germany. However, the energy consumption related to domestic hot water and especially to lighting and technical equipment is in Norway much higher than in central Europe. The main reason is not dark winters, but very cheap electricity over the decades after the Second World War. [Hahn 2005]

Some Passive houses are already completed in Tromsø in northern Norway and Skien southwest of Oslo. Some others are under construction, but none of them are designed according to the Passive house planning package or certified by the Passive House Institute [Andresen 2007]. The main problems are the high internal load and heat gain values used in Norway due to the low electricity prices as well as the big climatic differences between coast and inland, which counts for more than the difference between south and north. However, it will be developed a Norwegian certification standard which will be ready in 2009 [cf. Inger Andresen, working group XV in this compendium].

2 The Passive house NorONE in Sørumsand

"NorONE", a single detached house with a granny annexe, will be the first building in Norway certified by the Passive House Institute. In addition to the Passive House standard the owners' ambition is to be self-sustained with energy over the year. The project will be the first residential building in Norway equipped with a grid-coupled PV-panel (there are no subsidies for this in Norway). The project is located in Sørumsand, a small community east of Oslo, with a yearly mean ambient temperature of 6.2°C and a winter design temperature of -20°C. Global horizontal solar radiation is 970 kWh/m²a.

The owner family returned to Norway after having lived 17 years in Germany. They did not like the idea of generating as high internal loads as “normal” Norwegian inhabitants. On top

of that, the owner Harald Ringstad, an electrical engineer, has decided to install LED lighting with very low load and heat gain. After a conference about Low energy and Passive houses organized by The Norwegian State Housing Bank (Husbanken) in 2006, Ringstad contacted Husbanken to get support and a “competence grant” to realize a Passive house. He wished to cooperate with a German Passive house engineer and ended up with Stephan Blohm from “Passivbau” in Kaltenkirchen.

In general, the Norwegian State Housing Bank supports selected project attempts with “competence grants” to make it possible to put new ideas into practice. In this context it is important for the bank to transfer knowledge and experience to Norwegian consultants and the housing industry. In this case Husbanken organized workshops directed towards the Passive house project. The Building research institute SINTEF Byggforsk was engaged to qualify the calculations and the technical design concept. In addition to the "German" building envelope there are used Scandinavian components, for example the first Norwegian passive house windows.

Initially, the Norwegian architect Toril Grønvold was involved in the NorONE project to ensure that the German house, designed by Passivbau, adapted well to the site and the built environment and that the project related well to "good Architectural Practice." This collaboration ended unfortunately before realisation. Harald Ringstad wanted himself to take control and have full responsibility for the project, and engaged himself as the direct link between Passivbau and the local carpenter (also German). This practice is in Norway fully possible due to formal local authority procedures and approvals regarding detached houses. As a result, the house will hardly be presented as good architecture in glossy magazines, but rather be an example of the fact that a Passive houses can look "ordinary and normal".

Figure 1 and 2 **Outline by Toril Grønvold (left) and as built (right; balconies outstanding) Photo: Harald Ringstad**

2.1 Construction

NorONE is a large house with a total floor area of about 340 m² and a form factor of 0.65. In addition to the family dwelling there is an 80 m² flat to let in the basement. Both are planned with universal design as a condition and therefore suitable for wheelchairs. The main façade is directly south-facing. The windows are equivalent to 14.4 percent of the floor area and face mostly south and west. There are 2.4 m² north-facing windows only. The asymmetrical saddleback roof makes it possible to have south-faced windows in the attic, too.

The basement walls are made of expanded clay elements with additional insulation, whereas the other walls are prefabricated wooden elements with two layers of cellulose insulation. Also the roof is made of elements with cellulose insulation between TGI beams, oriented strand boards and impregnated wood fibreboards. All elements are produced by Holzbau Brüggemann in Neuenkirchen, Germany. The first Norwegian Passive house windows produced by NorDan were already available for the project, but external doors had to be delivered from Germany. For the U-values see table 1.

Slab on ground	0.08 W/m²K
External walls basement	0.13 W/m²K
External walls otherwise	0.10 W/m²K
Roof	0.10 W/m²K
Windows	0.77 W/m²K
External doors	0.75 W/m²K

Table 1 U-values as built. Thermal bridges are in sum negative.

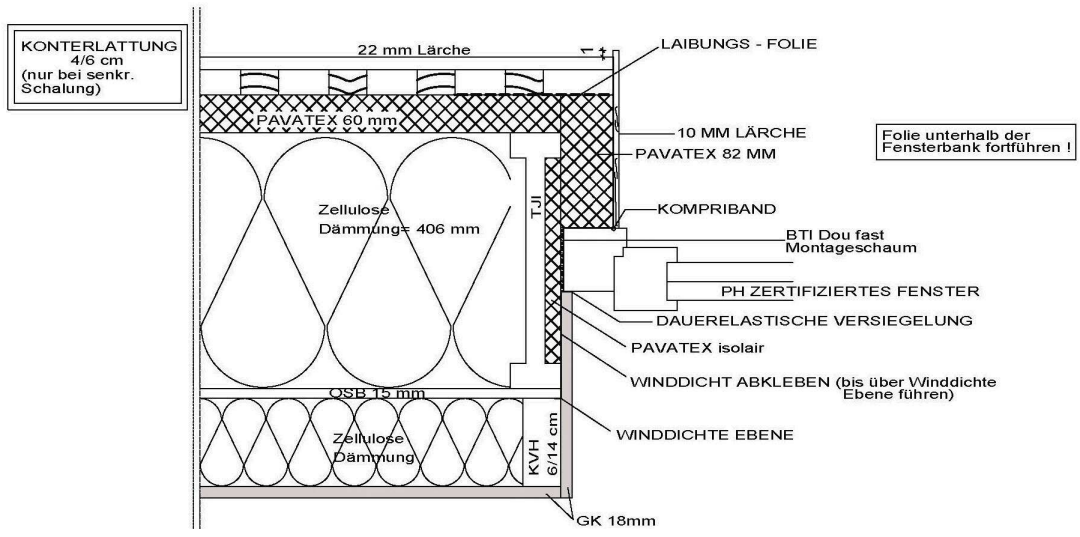

Figure 3 Wall construction and window. Illustration: Passivbau Stephan Blohm

After a discussion with Nordic Ecolabelling and on Husbanken's advice the owner decided that the insulation had to be cellulose without borax. The alternative, ammonium phosphate, is accepted, so that the Passive house can get The Swan, the official Nordic ecolabel.

2.2 Technical equipment

The ventilation system has 80 percent heat recovery and the air is preheated via a ground coupled heat exchanger. The remaining heat demand included DHW is covered by a grey water heat exchanger, vacuum tube solar collectors, an air-to-water heat pump and, if necessary, by auxiliary electrical heating. It is installed a water based floor heating system and a wood-burning stove, which is not needed, but nearly a "must" in Norwegian homes. LED lighting and A-labelled household appliances as well as a building management system is installed to reduce the electricity use to a minimum. All energy consumption will be monitored over some heating periods. The house shall also be equipped with a roof mounted, grid coupled PV-panel of about 5 kWp (37 m²).

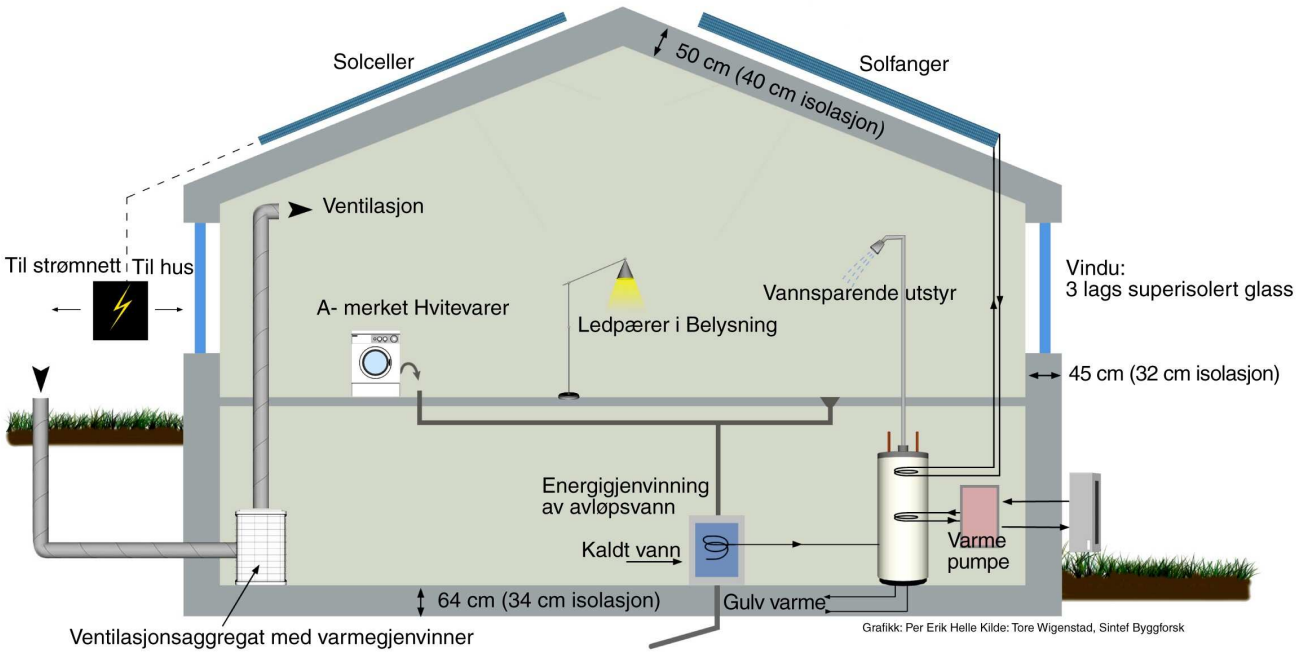

Figure 4 System of technical equipment (symbolic only; cm insulation not as built)
Illustration: Stavanger Aftenblad

2.3 Results of PHPP-calculations and air leakage test

The calculated space heating demand is 14 kWh/m²a, the space heating load 9.7 W/m²a and the specific total primary energy demand 85 kWh/m²a, based on German primary energy factor 2.7. The air tightness was proved by a blower door test which had a result of 0.39 h^{-1}. That means probably that NorONE is the most air tight building Norway ever has seen. All plans and calculations are now verified by the Passive House Institute, but the last

documentation for the ventilation system is still missing (as pr February 2008). However, the certification will be completed before the conference.

3 Critical discussion

The energy supply system has many components. According to researchers from SINTEF Byggforsk, the system is complex, and has too many components to be cost-efficient. This is mainly due to the heat pump in addition to both the grey water heat exchanger and the solar collectors - both delivering most of the required heat. The remaining heat demand is very low, so that the heat pump costs more than it saves [Wigenstad 2007]. With other words, good ecology, bad economy. Nevertheless, the owner gets subsidies for both the heat pump and the wood-burning stove – the two components with lowest cost efficiency, apart from the PV-panel.

4 The owner's first weeks in the Passive house

The owner's family, three persons only, moved into their new and large house in November 2007, about a month later than planned. Some equipment was also delayed, so that monitoring could not start before February 1st. There is no tenant in the basement-flat yet. The heating system started up ten days after moving in, so the family had to make use of the stove during these ten especially cold days. Nevertheless, it was no problem not warming up the bedroom. Today, with floor heating switched on, they already say it will be too hot using the stove at the same time. Solar gains are noticeable, and the air quality feels good after starting up the ventilation system. In January it was many mild days about 0° C. The first days of February have been a bit co lder. Monitoring results from two months will be reported in the power-point-lesson at the conference.

The Norwegian State Housing Bank promised to give 150 000 Norwegian crowns to invest in a PV-plant - nearly 20 000 Euros and equivalent to about 50 percent of the costs. There are no ordinary subsidies for electricity generation with solar cells in Norway. Harald Ringstad has a contract about delivery of not needed power to the local electricity supplier, but with normal low power prices this will be a losing deal. Therefore, the installation of the plant depends on additionally grants. Ringstad has in this case negotiated with the national energy agency Enova, as well as with many Norwegian energy suppliers and PV-manufacturers, but has not been successful. Solar cells are in Norway often used for small cottages without grid-coupling. Here the average output over the year is not substantially lower than in central Europe. In spite of that, the lack of subsidies makes it difficult to use PV for ordinary buildings. So today it is not sure that Ringstad finds it interesting and feasible to install a PV-panel.

5 Conclusions for Passive houses in Norway

The PHPP-results show that a Passive House can be built in the climate zone around Oslo, with the same design concept as it is done in central Europe and with acceptable insulation

thickness. Anyhow, a detached house has to be very compact, must not have too large window areas and needs more insulation. The local temperature is not as low and critical as most people think. The heat input from the sun is comparable with northern Germany. The overall climatic conditions are better than in the Helsinki region at nearly the same northern latitude.

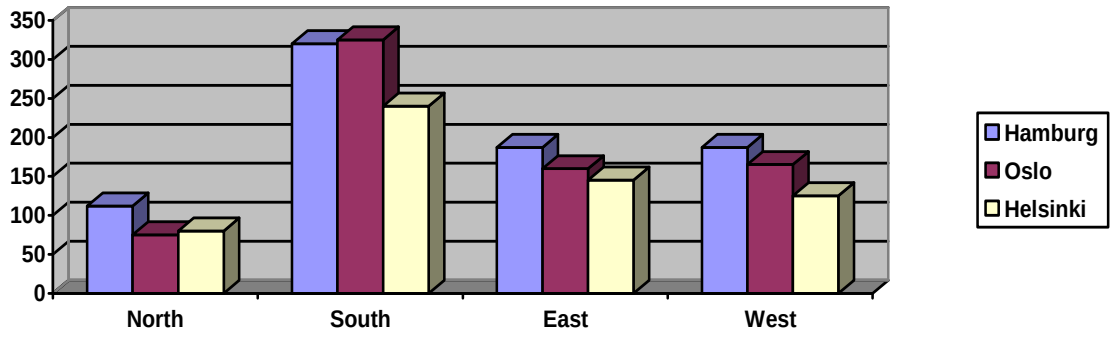

Figure 5 Solar radiation (kWh/m²a) on different façades. Reference: Passivbau Stephan Blohm

The Norwegian inland areas can be much colder than Oslo. There are many coastal areas with warmer climate than in the Oslo region - ie the south west coast is warmer than specific parts of Germany. The majority of the Norwegian inhabitants live in regions where it should be possible to build Passive houses. Even so, the preliminary results indicate that it can be difficult to design smaller detached houses with Passive house standard. NorONE is very compact and has a large heated floor area. At the same time, the owner is enthusiast with technical expertise.

So it will be crucial to develop Passive house concepts concerning smaller detached houses for “normal” owners without extraordinary ambitions or know how. Therefore, and considering that to thirds of all inhabitants live in detached houses, The Norwegian State Housing Bank now supports a new project north of Oslo to develop such a concept. In this effort the experience from NorOne and the enthusiasm from the Ringstad family will be of great help.

6 References

[Hahn 2005] Ulla Hahn, Michael Klinski: Vom Niedrigenergie- zum Passivhaus – Stand der Projekte in Norwegen, Conference compendium 2005, page 441

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[Wigenstad 2007] Tore Wigenstad, Notat 004, record to the owner 2.7.2007