Skarpnes Village

IEA PVPS

Introduction

After building eight new residential building in Arendal (South Norway) according to the Norwegian passive house standard NS 3700, Skanska was invited to hold a presentation for the national research centre on Zero Emission Buildings (ZEB, www.zeb.no). As a result, it was decided that Skanska Norway should build the first zero-energy housing development in the country, Skarpnes Village. (Mr Roald Rasmussen, Skanska Norway) Within this framework, modern style residential buildings were equipped with BIPV modules integrated on the gable roof, coupled with traditional roof tiles and wooden cladding. Early-stage dimensioning of the BIPV system was performed by the Multiconsult consultancy company (Norway), whereas final stage simulations were performed by the BIPV system supplier Solcellespecialisten (Denmark). Skanska was responsible for the practical installation, using electricians from the local sub-supplier company, Nedig to connect to the grid. Grid connection and capacity related to the inverter were checked together with the local utility company, and the first house was occupied in December 2014.

Source: Successful Building Integration of Photovoltaics – A Collection of International Projects

Design approach

As Skarpnes was a ZEB pilot project, a series of workshops was arranged to evaluate possibilities, criteria and solutions. After the design and technology solutions were selected, the process followed the standard building development process in Skanska, in close contact with the research groups involved.

This project has been both interesting and educational. The requirements challenged the design team to think in new ways. The architects tried to combine a modern expression with the need to fit in with the existing settlement, consisting of traditional wooden houses. The houses therefore have gabled roofs. The walls are thick with hidden integrated technical solutions. As much as possible of the energy and material needs are sourced locally, using wood, low-carbon concrete and recycled gypsum, ground-well heat pumps for hot water and PV for electricity. (Mr Ole Bachke, Rambøll)

Aesthetic integration

The PV system is integrated into the gable roof of a modern style residential unit that also implements traditional elements such as roof tiles and wooden cladding. The BIPV system is made of black modules replacing conventional roof tiles and blends in well with the dark roof. The building is surrounded by buildings of similar style in a small village, sitting on top of a small hill in scenic surroundings. The Nidelva river passes the hill on its way to the ocean side, which is less than 2 km away.

Energy integration

The buildings are classified as ZEB-0 houses, which means that over the period of one year, the total balance between energy consumption and energy production should be zero. This is achieved by using 100 meter deep ground wells that are combined with a heat pump system for domestic hot water, space heating and hot fill laundry machines, thick insulation and a heat recovery ventilation system, and an efficient BIPV system calculated to produce almost 7,000 kWh/year. The first two years of measurements show that the BIPV system yield is slightly higher than anticipated, whereas the energy

consumption is somewhat higher than expected, mainly due to heating loads and individual user preferences.

Technology integration

The 32 PV modules are of 230 Watt black mono-crystalline silicon modules from Sunpower, which are mounted in-roof using the Solrif XL system from Schweizer. This involves using aluminium profile frames fixed to the substructure of wooden battens on a roof underlay, using special mounting clamps. Water-tightness is ensured using a special interlock of the modules' profile frames and sealing between the overlapping module edges. The modules are naturally back-ventilated due to the distance between the modules and the roof. There are no objects in the immediate surroundings of the building causing major shading impacts. However, at low solar angles in the early morning or late afternoon some buildings in close proximity may cause shading, and the boards at the end of the roof cast some shade on the end modules.

Decision making

The idea was initiated at the concept phase in an early planning stage. After around one year of discussions between Skanska and SINTEF, it was decided to build the Skarpnes houses as ZEB pilots, following the passive house standard but with additional measures to achieve zero energy. The final decision was made when support from Enova (a Norwegian public enterprise promoting energy efficiency and new technology for renewable energy utilization) was approved. The initiative to apply a PV system to the building was taken by project leader Roald Rasmussen, in discussions with research leader Marit Thyholt from SINTEF and Tor Helge Dokka from SINTEF/Skanska, who is in charge of the ZEB pilot buildings development. The decision was made because Skanska has a general strategy to be known as a leading green developer. Skanska had already gained positive experience with building passive houses, which were a sales success and had low additional costs compared to traditional houses. It followed that Skanska wanted to test the 'next step' moving towards zero energy.

Initially, the houses were designed with both solar thermal collectors and PV modules. At a late stage, the solar thermal collectors were removed and replaced by extra PV modules as this was considered to be more economical than the added costs and complexity of plumbing required for the solar thermal system. Building integration of PV was chosen for aesthetic reasons. A gable roof was planned at an early stage to optimize the annual energy output required to achieve ZEB status.

Lessons learnt

Skanska wanted to build top modern houses and in addition gain new knowledge about the grid interaction and what it feels like to live in zero energy houses. These aspects are investigated in the two national research projects «Electricity Usage in Smart Village Skarpnes» and «Evaluation of Buildings with Low Energy Usage, EBLE». It has been challenging and exciting to be part of this work, it is important to stay at the forefront of the market development. (Mr Roald Rasmussen, Skanska Norway)

The biggest challenge for the building developer was not the project design or building process, but to find solutions that ensured economic feasibility. A slow market in 2014-2015 affected all housing

developments in general and was not the best time for selling new ZEB houses, which were a little more costly (10-15%) than conventional houses due to the range of technically advanced solutions employed. Five ZEB houses were sold, where the BIPV system costs represented a small percentage (~3%) of the total overall cost of 4.5 million NOK (536 k€). The house owners expressed great enthusiasm about their energy-friendly homes and suggested that the high building standard should be better marketed to improve sales of new ZEB homes. Overall, the building developer is pleased with the construction and implementation of the BIPV system and would choose the same solution again. The PV technology integration combines contemporary with traditional design. The all-black PV modules are integrated into the roof as if they were conventional roofing components, blending with the traditional black tiles on the gable roof. The BIPV system performs well in the cold Nordic climate and represents a valuable source of electricity for new low energy housing developments.

Since standard modules and mounting products were used, the cost of this BIPV system (i.e. € 2.11/Wp plus installation costs similar to normal roof installation costs) is not much higher than for conventional building attached or ground-mounted PV systems. In today's market, this system represents an economically feasible system with high replication potential.

PROJECT DATA

Project type	New construction
Building address	Øvre Fagerhei, Nedenes (Arendal), Norwegen

BIPV systems

BIPV SYSTEM DATA

Architectural system	opakes Dach
Integration year	2015
Active material	monokristallines Silizium
Module transparency	Opaque
Module technology	Glass-backsheet, hidden PV, standard modules
System power [kWp]	7,36
System area [m²]	40
Module dimensions [mm]	1583 x 792
Modules orientation	Süden-Osten, Süden-Westen
Modules tilt [°]	32
Annual FV production [kWh]	7000

BIPV SYSTEM COSTS

Stakeholders

Main building designer

Ole Bachke (Rambøll Norge AS)

BIPV system designer

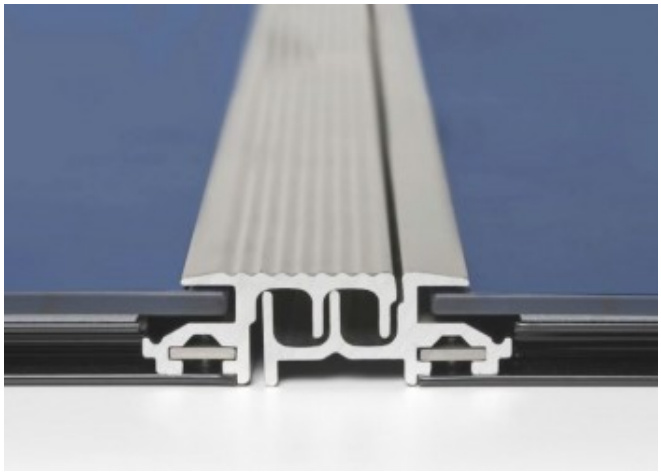
Multiconsult AS, Solcellespecialisten A/S

BIPV components producer

SunPower
51 Rio Robles San Jose, California, USA
1-408-240-5500
https://us.sunpower.com/
Ernst Schweizer AG
Bahnhofplatz 11, Hedingen, Switzerland
+41 44 763 61 11
https://www.ernstschweizer.ch/en/home.html

Skarpnes village © Skanska

Building site after BIPV installation © Inger Andresen (ZEB Sintef/NTNU)



BIPV module interlock (Solrif by Schweizer)

Mounting of the BIPV modules © Skanska

Skarpnes zero energy village © Skanska

Case study author:

Anne Gerd Imenes