Near zero energy building with steel solutions – case study

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SSAB & Ruukki

SSAB Special Steels
Global steel and service partner in value-added Advanced High Strength Steels (AHSS) and Quenched & Tempered steels (Q&T)

SSAB Europe
Nordic-based steel producer of high-quality strip, heavy plate, and tubes

SSAB Americas
North America-based steel producer of high-quality heavy plate

Tibnor
Nordic full-service steel distribution partner

Ruukki Construction
European provider of energy-efficient building and construction solutions
Our business units and comprehensive product portfolio

RESIDENTIAL ROOFING
- Roofs, rainwater and safety systems
- Installation services

BUILDING COMPONENTS
- Panels, profiles, claddings, accessories, design services

BUILDING SYSTEMS
- Design, manufacture and installation of frames and envelopes

RUSSIA
- Building systems components and roofing
Solutions to nearly zero energy buildings
Holistic approach for the design

- Optimized building envelope with excellent air-tightness
- Energy efficient HVAC and lighting systems
- High recycled material content in the frames and envelopes
- Building integrated solar applications
- Renewable energy sources for heating and cooling

Important issues: Design management & co-operation
Case: Cost efficient nearly zero energy building
Case – HAMK Sheet Metal Centre
Cost efficiency driving energy efficiency

Building use: Research centre for metal structures
Users: HAMK University of Applied Science, Ruukki Construction
Owner: Hamk Oy

Architect: Ajan Arkkitehdit / Structural design: Tasoplan Oy
Energy efficiency concept: Ruukki Construction Oy
HVAC design: AX-prosessit Oy
Floor area: 1500 m²
Targets & features for the project

• Target of the project was to realize near zero energy building as a profitable investment for the owner – comparison made with “conventional building”

• Another target was to fulfil forthcoming nZEB regulations already in 2015

• Building owner and Ruukki committed to energy and life cycle efficiency already in the early project planning phase

• Special attention was paid on the control of energy efficiency and holistic approach from the design to the execution

• Building energy simulation was used from the very beginning of the project
Near zero energy solutions

Minimizing energy need

- Optimized thermal insulation and excellent air-tightness with Ruukki® energy panels and roof elements
- Ventilation heat recovery 80%
- Energy efficient LED-lighting
- Effective utilization of day-lighting + lighting control
- Integrated radiant heating and cooling

Utilisation of renewable energy

- Ground energy heat pump + Free ground cooling
  - Energy piles (60) + 2 heat wells
- Roof integrated solar heat collectors
- Facade integrated solar PV
Cost efficient near zero energy hall
Ruuikki solution vs. conventional solution

Net present value of extra investment for nZEB with 6% interest rate, 4% increase in energy price.
Steel frame
Fast and light construction
Sandwich panel system for walls

Energy efficiency

Air-tight panel system cuts life-cycle costs and carbon dioxide emissions

• Ruukki energy panel is an airtight solution for commercial and industrial buildings, logistics centres and warehouses

• Solution is based on extensive expertise in airtightness with testing of tens of buildings, and long experience from design to installation

• Whole building air-tightness level $q_{50} < 1,0 \text{ m}^3/\text{(h,m}^2) \text{ can be guaranteed}$

• $q_{50} = 0,76 \text{ m}^3/\text{(h,m}^2) \text{ measured in this building}$
Day-lighting utilisation
Energy efficiency and good lighting comfort

- Large day-lighting windows on S-W facades (prefab units)
- Window panes with opal polycarbonate sheets
- Diffuse day-lighting without glare & cut extra heat gains
- Good thermal properties, total U-value ~ 0,84 W/m²K
- Reduces artificial lighting need together with lighting control (55% in the spaces adjacent to large windows)
Energy piles

Renewable energy use, seasonal energy storage

- Steel piles enable utilization of demanding soil conditions for renewable energy collection
- Ground energy is utilized for heating through heat pumps in winter and as free cooling during summer
- Totally of 60 energy piles with length of 11m were used in HAMK OLK building
- In addition, two traditional heat wells of 200m were used
Integrated solar heat collectors

Renewable energy use, recharging the energy pile field

- Fully integrated solar heat collector to fit in steel roofing system
- 24m² Ruukki Classic® solar heat roof is used on the roof of the technical room
- Heat energy is directed to the soil through energy piles = ”Thermal battery”
- Due to utilisation of low temperatures, the efficiency of the system is very high
Solar heat and energy piles

Summer

Solar heat collectors

Energy pile

Soil +3°C - +15°C

+10°C

+45°C

Winter - no solar

To space heating

Heat pump

Energy pile

Soil +15°C →+3°C

+3°C

+0°C

Sunny winter day

Energy pile

Soil +3°C

+13°C

+25°C

+8°C
Integrated radiant heating & cooling
Energy efficiency and good indoor comfort

- New type of radiant heating and cooling units integrated into the roof element
- Enables low temperature system
  - better COP for heat pump
  - free ground cooling through heat wells
- Reduced air-flows in ventilation, because needed only for fresh air
- Reduced temperature gradient in hall and more comfortable indoor climate in occupied zone
  => Energy savings
Total solution for nZEB
Optimisation and energy efficiency
determined with building simulation by IDA-ICE tool
Comparison of purchased energies

- Heating
- Cooling
- Lighting
- HVAC

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Reference</th>
<th>nZEB</th>
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<tbody>
<tr>
<td>Electricity</td>
<td>12400€/a</td>
<td>5200€/a</td>
</tr>
<tr>
<td>District Heating</td>
<td>6200€/a</td>
<td>4000€/a</td>
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</tbody>
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w/o solar PV
Building integrated solar PV-panels

• High performance Building Integrated PV-solution for building facades
• Full system with PV-panel modules, structural components and all electrical equipments
• Totally 61 m² are used in S-W facade in HAMK, yearly electricity production 6900 kWh
• Reduces primary energy use from 70 kWh/m² to 63 kWh/m²
Follow-up and sensoring

- Building has been equipped with extensive measuring system for energy systems and indoor conditions
Conclusions

- nZEB hall needs both reduction in energy demand as well as renewable energy production
- Building has to be designed as a whole
- nZEB hall is possible to execute in Nordic conditions in a cost-efficient way
Thank you!
Ruukki’s project delivery contained

• Steel frame, part design, installation
• Roof elements, element design, installation
• Energy panels incl. air tightness measurement, installation
  – Modular flashings
  – Ruukki expression prints
• Ruukki Add-on solar PV solution, dimensioning, installation
• Ruukki Classic Solar heat panels for seasonal heat-energy charging, dimensioning, installation
• One-off Cor-Ten claddings, part design, installation
• Ceiling integrated Radiant heat/cold distribution system, dimensioning, installation

Component deliveries contained:
• Energy piles seasonal heat storage, dimensioning
• Sandwich panels for interior walls
Building your tomorrow.