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Background for Nearly Zero-Energy Building Renovation

The building sector accounts for 40% of the energy use within EU. There is a great potential to reduce energy use and thereby greenhouse gas emissions and to make the building stock future-proof.

With a more energy efficient building sector a country becomes less dependent on imported energy

Why renovate into Nearly Zero-Energy level (instead of a traditional renovation)?

- To significantly reduce the conventional energy consumption and lifecycle greenhouse gas emissions of buildings.

- To increase the property value and the life time of the building and to ensure the affordability of the living costs on the long term.

- To improve the comfort level.
NeZeR Design competition – Objectives and organisation

Objective:
To improve knowledge in the building chain and among institutional housing owners with respect to Near Zero Energy Building Renovation (NZEBR)

Method:
• A series of national design competitions to prepare innovative concepts for renovation of existing buildings
• Focus on multifamily buildings;
• A common set of evaluation criteria, considering not only energy performance, but also environmental quality, user aspects and market appeal,

Organisation:
• National competitions in 5 countries (Sweden, Finland, Netherlands, Spain, Romania)
• Participating teams: students (SE, FI, ES, RO) or professionals (NL)
• Execution: Nov 2015 – Sept 2016
ZERO! Student Idea & Design Competition for Nearly Zero Energy Building Renovation

Hyvinkää, Finland

Design by: Student team UPS (Caroline Mellberg, Jesse Myers, Kristaps Sveisbergs & Yana Arkhangelskaya) from Aalto University and Metropolia University of Applied Sciences

1. Challenge /present situation
   • Multi-apartment residential dwelling with floor area of 2907 m²
   • Built on 1972
   • Heating consumption 2014: 386 MWh (133 kWh/m²)
   • Improvement required in indoor environment quality
   • Improvement required in energy usage

2. Proposed solutions for renovation
   • Renovation concept based on Social Integration, Sustainable Materials and Renewable Energy
   • New building envelope placed over the old structure
   • HVAC: Decentralised supply units with heat recovery unit and centralised extraction system
   • Renewable energy technologies: Solar PV panels and thermal collectors
   • Total energy consumption after renovation 39.5 kWh/m² (heating 33.5 kWh/m², electricity 6 kWh/m²)
3. **User aspects**
   - Daylighting, proper ventilation and green space ensures maximum comfort level
   - Change in apartment sizes makes the building available for different family group creating diversity between residents
   - Common space and renovated sauna ensure social integration among the residents

4. **Aesthetical and environmental aspects**
   - Glazed facade with wooden frame, angular walls including PV panels on the wings of the building, extended window strips on the back facade
   - Re-use of old structure without demolishing it
   - New construction materials with high recyclable quality and CO₂ emissions storing capacity (hempcrete, Cross Laminated Timber)
   - Green roofs for enhancing air quality

3. **Market appeal**
   - High replication potential from the perspective of main renovation concept and utilization of proven technologies
   - Feasible and financially reasonable engineering solution
   - Sensible business plan supporting renovation-construction process
Energy Efficiency Renovation of Multifamilyhouses from the 1950’s
Uppsala, Sweden

Design by: Sara Magnusson and Anna Lundgren, University of Uppsala,

Challenge / present situation
- Apartment block, multifamily building with 22 apartments, 3 floors, 1691 m²
- Constructed in 1950-53
- Space heating and DHW 150 kWh/m²/year (appr 120 heat + 30 DHW)
- Property electricity 3 kWh/m²
- Last renovation in 2008 (change of HVAC system)
- Owned by Stockholmshem (largest property owner in Stockholm)
- Cultural important buildings, not allowed to change the appearance of the facade

2. Proposed solutions for renovation
- Principles used for renovation: a mix of different measures
- Ambition – energy performance before and after renovation:
  - Energy consumption before renovation: 150 kWh/m² Atemp
  - Energy consumption after renovation: 41 kWh/m² Atemp
- Building envelope improvements: insulation, new windows
- Changes in HVAC installation: Ventilation with heat recovery
- Renewable energy technologies: geothermal energy (through heat pump)

<table>
<thead>
<tr>
<th></th>
<th>Original building</th>
<th>After NEBFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basement floor</td>
<td>Thin insulation</td>
<td>15 cm added insulation</td>
</tr>
<tr>
<td>Roof</td>
<td>10 cm mineral wool insulation</td>
<td>50 cm mineral wool insulation</td>
</tr>
<tr>
<td>Windows and doors</td>
<td>U value approximately 3 W/(m² K)</td>
<td>U value 1.4 W/(m² K)</td>
</tr>
<tr>
<td>HVAC</td>
<td>Mechanical ventilation without heat recovery</td>
<td>Ventilation with heat recovery</td>
</tr>
<tr>
<td>RES</td>
<td>District heating (partly recycled and renewable energy)</td>
<td>Geothermal heat pump (renewable energy contribution from geothermal energy and part of the electricity) (Solar heating and solar PVs)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Lowered temperature especially in the basement (to 18°C) but also in the apartments (to 21°C)</td>
</tr>
</tbody>
</table>
3. User aspects
- Ventilation with heat recovery gives better indoor comfort
- Indoor climate improvement by controlled ventilation, better windows (reduced draught from windows)
- The proposed solution require evacuation of the tenants during renovations

4. Aesthetical and environmental aspects
- Cultural classified building → not allowed to change the appearance of the facades
- A way to overcome the obstacle above was proposed in another solution; new entrance halls (air locks) to reduce the draft into the stairwell. Interesting option to reduce energy use without changing the appearance to a great extent

5. Market appeal
- High replicability of measures
- Well-known technical solutions
- Chosen package solution has relatively low life cycle cost
- Mainstream solutions → low technical risk
- Geothermal heat pump will require more maintenance compared to the original heating system (district heating)
Zero on the meter renovation
Groningen, The Netherlands

*Design by: Dura Vermeer, info@duravermeer.nl*

1. **Challenge / present situation**
   - Post-war housing expansion district
   - 7 identical apartment buildings, 168 units, dating from 1966
   - First renovation phase contains 2 blocks, 48 units, each 77 m²
   - Poor insulation, ventilation and indoor air quality
   - Energy consumption 265 kWh/m²/year
   - Small apartments, large loggia’s

2. **Proposed solutions for renovation**
   - User satisfaction is key in renovation process
   - All-electric technology
   - Energy performance after renovation: 0 kWh/m²/year
   - Added building skin, roof, HVAC and solar panels
   - Apartments enlarged by incorporating loggia’s
   - 40 years lifetime extension + performance guarantee
   - New financing instrument: Energy Performance Fee (EPV)
   - Affordable for tenants and housing association
3. **User aspects**
   - Intensive 1-to-1 tenant guidance
   - Safety first and customer-friendly contact during process
   - Larger apartments, better indoor air quality, higher comfort level
   - Minimal building activities on site
   - Short time period: renovation 1 block, = 24 units, in 6 weeks
   - Demo apartments renovated first
   - 100% tenant participation!

4. **Aesthetical and environmental aspects**
   - Fresh, modern look and feel, yellow brick strips
   - Visible, clean solar panels instead of smoky chimneys
   - Re-use of existing building skin and roof where possible
   - Existing glazing, frames, doors and chimneys removed

3. **Market appeal**
   - Replication potential in NL: ca. 379,000 units, of which 250,000 owned by social housing associations
   - Performance of energy use and user satisfaction needs proving
1. **Challenge / present situation**
   - Multifamily block, 20 dwellings, 1362.15 m²
   - Building year: 1967
   - No renovation
   - Ownership type: private/ Elder users
   - 5 floors, 1 basement, brick walls and gabled ceramic roof
   - Energy consumption. Individual boilers
   - Space heating 113,8 kWh/m²
   - Domestic hot water 17,1 kWh/m²
   - Deficient indoor environment quality
   - Neglected facades, electric cables unprotected
   - Architectural barriers (no lift)

2. **Proposed solutions for renovation**
   - Envelope improvement, use of renewable energy sources, accessibility and efficient illumination improvement.
   - Ambition – energy performance after renovation:
     - Energy consumption:
     - Space heating (48.88 kWh/m²)
     - Domestic hot water (13.65 kWh/m²)
     - Energy performance leap from label E to A
     - Building envelope improvements: Ventilated façade with wood fibre insulation
     - Changes in HVAC installation: Centralized installation with individual energy efficient monitoring
     - Renewable energy technologies: biomass boiler, solar panels
     - Accessibility: lift installation, change the central core of the building
Climbing toward nearly zero energy building renovation
Sestao, Basque Country - Spain

3. User aspects
- Improvements in user comfort levels
  - Significant improvement acoustic insulation (effect on sound transmission from exterior) 45→64dBA
  - Monitoring of indoor climate and decrease air leakage
- Health aspects
  - No condensations, no mould risk (breathing problems), no smells, minor air pollution sources
  - Noise reduction
- Robustness for incorrect or unexpected user behaviour
  - Regulation and control of thermal installations
- Duration of renovation process - Industrialized construction: time reduction
- Communication with residents
  - Meetings (advisory council, healthy technicians), opinion surveys, user involvement (decision making), good practices (use of energy)

4. Aesthetical and environmental aspects
- Visual quality of new facades and materials Zero Toxicy (Wood fibre insulation and Anodized aluminium)

5. Market appeal
- Replication potential (buildings from 1951 to 1980) : 702 buildings in Sestao (60%) and 3.410.771 buildings in Spain (35%)
- Proven technologies - Case study: Residential building in Urduliz (Spain)
- Engineering solutions – ease of implementation
  - Use of common retrofitting solution (ventilated façade)
  - Easy external cladding assembly
  - No scaffolding
- Technical risks
  - Material cost fluctuation (aluminium)
  - Proven technology without technical risks
- Prospects for scale of volume effects
  - Higher demand implies lower material price
- Financial aspects – life cycle costs
  - Less maintenance and energetic costs (less demand 60%)
  - Grants: Energy efficiency and accessibility
  - Revalorization of housing (use of basement, lifts, aesthetic improvement)
Zero Energy Romanian Passive House Retrofit - ZeRoPHit
Bucharest, Romania

Design by: Norana Petre - norana.petre@atelier1.ro, Aurelia Axente-Stan - axente4s@yahoo.com, Varga Szabolcs - vvprojekt@gmail.com, Vlad Petean - vlad.petean@airconstruct.ro, Andrei Damian - adamian7@yahoo.com.

1. Challenge / present situation
   • Multifamily building, 1322.17 sq m, 20 dwellings, dating from 1969
   • A four storey building with an unheated basement
   • It was never renovated
   • The residents are the owners of dwellings
   • Poor insulation, ventilation and indoor air quality
   • Energy consumption 290,22 kWh/m² year
   • It is connected to the district heating system

2. Proposed solutions for renovation
   • Ambition – energy performance after renovation:
     ▪ space heating: 17,4 kWh/m² year
     ▪ domestic hot water: 21,02 kWh/m² year
     ▪ Other: 4,32 kWh/m² year
   • Building envelope improvements:
     ▪ High thermal performance of the envelope;
     ▪ Balconies with independent structure;
     ▪ A new storey;
   • Changes in HVAC installation
     ▪ Ventilation unit with heat recovery for each apartment
   • Renewable energy technologies: thermal solar and PVs panels;
3. User aspects

- High thermal performance of the envelope and reduction of the thermal bridge influence
- The mechanical ventilation system with heat recovery offers fresh air, filtered from dust, pollen, pre-heated, using the waste energy;
- Duration of renovation process: 1 year and half, including the design;
- It is necessary to be scheduled a lot of communication sessions with owners

4. Aesthetical and environmental aspects

- Unitary volume, same architectural style for the existing building and the 5th floor, asymmetric arrangement of the balconies, vertical elements suggested through a different material, neutral colors, different textures.

5. Market appeal

- Applicable to all 4-storey residential unrefurbished buildings existing in Romania
- All the technologies used in this project were proved on the Romanian construction market / The scenario for the partial demolition of walls in the living room can be with risk
- The fifth level was proposed to be made from prefabricated wood panels-CLT; in this way, the execution will be quicker; due to the quicker execution, the price for the execution will be lower
Final remarks about design competition

- Energy reductions (without Renewable Energy) of 47-88% predicted
- With Renewable Energy production accounted, some concepts come (close) to zero energy
- One NZE building renovation already executed, others to follow

- Design competition has created enthusiasm and creative energy
- Good instrument to involve (future) professionals in NZEBR innovation
- More than 100 (young) professionals have been studying on NZEBR designs
- Plans for continuation of competition in some countries
Biggest challenges in NZEBR

- **Making residents happy !!**
- Short renovation time
- High investments – cost reductions necessary
- Split incentive in rental situation – new regulation may be needed
- Existing district heating may make NZE renovation less attractive
- Multiple owners: difficult decision making process

- Lack of roof space for PV installation in case of multifamily buildings
- Other measures to improve building may be necessary too (e.g. lifts)
NeZeR – Near Zero Energy Renovation

Partners

- VTT Technical Research Centre of Finland Ltd., FI
- Sestao Berri 2010, ES
- Tecnalia Research and Innovation Foundation, ES
- City of Rotterdam, NL
- Municipality of Amersfoort, NL
- Portaal, NL
- W/E Consultants Sustainable Building, NL
- ISPE Institute for Studies and Power Engineering, RO
- Municipality of Timisoara, RO
- City of Stockholm, SE
- IVL Swedish Environmental Institute, SE
- Stadshus AB, SE
- Stockholmshem, SE

More information: www.nezer-project.eu