Introduction to Task 47 and experiences from exemplary renovation projects

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Operating Agent SHC task 47

Seminar Sydney  5. April 2013
SOLAR HEATING & COOLING PROGRAMME

Established in 1977

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- Task 19 - Solar Air Systems
- Task 18 - Advanced Glazing Materials for Solar Energy
- Task 17 - Measuring and Modeling Spectral Parameters
- Task 16 - Photovoltaics in Buildings
- Task 15 - Advanced Central Solar Heating Systems
- Task 14 - Advanced Active Solar Energy Systems
- Task 13 - Advance Active Solar Energy Systems
- Task 12 - Building Energy Analysis and Design
- Task 11 - Passive and Hybrid Solar Combiner Systems
- Task 10 - Solar Materials R&D
- Task 9 - Solar Radiation and Pyranometers
- Task 8 - Solar and Heat Pump Systems
- Task 7 - Ventilation, Thermal Comfort, and Indoor Air Quality
- Task 6 - Performance of Solar Systems under Real Conditions
- Task 5 - Use of Existing Meteorological Information
- Task 4 - Development of an Insolation Hardware
- Task 3 - Performance Testing of Solar Collectors
- Task 2 - Coordination of Solar Heating and Cooling
- Task 1 - Investigation of the Performance of Solar Collectors
- Task 49 - Solar Heat Integration in Industrial Processes
- Task 47 - Solar Renovation of Non-Residential Buildings
- Task 46 - Solar Resource Assessment and Forecasting
- Task 45 - Large Scale Solar Heating and Cooling Systems
- Task 44 - Solar and Heat Pump Systems
- Task 43 - Solar Rating & Certification Procedures
- Task 42 - Compact Thermal Energy Storage
- Task 41 - Solar Energy and Architecture
- Task 40 - Net Zero Energy Solar Buildings
- Task 39 - Polymeric Materials for Solar Thermal Applications
- Task 38 - Solar Air-Conditioning and Refrigeration
- Task 37 - Advanced Housing Renovation with Solar & Conservation
- Task 36 - Solar Resource Knowledge Management
- Task 35 - PV/Thermal Systems
- Task 34 - Testing and Validation of Building Energy Simulation Tools
- Task 33 - Solar Heat for Industrial Process
- Task 31 - Daylighting Buildings in the 21st Century
- Task 29 - Solar Crop Drying
- Task 28 - Solar Sustainable Housing
- Task 27 - Performance of Solar Facade Components
- Task 26 - Solar Combisystems
Task 47:

Renovation of Non-Residential Buildings towards Sustainable Standards

Duration: January 2011 - June 2014

Objectives

• Develop a solid knowledge base on how to renovate non-residential buildings towards the NZEB standards (Net-Zero Energy Buildings) in a sustainable and cost efficient way.

• Identify the most important market and policy issues as well as marketing strategies for such renovations.
Task 47: Renovation of Non-Residential Buildings towards Sustainable Standards

Participating countries

Australia
Austria
Belgium
Denmark
Germany
Italy
Norway

Task 47 web-site: http://task47.iea-shc.org/
Solar Renovation of Non-Residential Buildings

Overview

Buildings are responsible for up to 35% of the total energy consumption in many of the IEA participating countries. The EU Parliament approved in April 2009 a recommendation that member states have to set intermediate goals for existing buildings to fix minimum percentage of buildings to be net zero energy by 2015 and 2020.

A few exemplary non-residential renovation projects have demonstrated that total primary energy consumption can be drastically reduced together with improvements of the indoor climate. Because most property owners are not even aware that such savings are possible, they set energy targets too conservative. Buildings renovated to mediocre performance can be a lost opportunity for decades.

The objectives of this new Task are to develop a solid knowledge base on how to renovate non-residential buildings towards the NZEB standards (Net-Zero Energy Buildings) in a sustainable and cost efficient way and to identify the most important market and policy issues as well as marketing strategies for such renovations.
Task 47: Renovation of Non-Residential Buildings towards Sustainable Standards

Task 47 have four subtasks:

Subt. A: Advanced Exemplary Projects
• Documentation of the design, performance, process and motivations of exemplary building renovations

Subt. B: Market and Policy issues and Marketing Strategies
• Building stock analysis
• Decision making processes - barriers and driving forces

Subt. C: Assessment of Technical Solutions and Operational Management
• Detailed description of two best case buildings (school and office building)
• A technical report with recommendations

Subt. D: Environmental and Health Impact Assessment
• A booklet on sustainable and advanced renovation of schools.
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From the public web site:

Renovation Examples

Kampen School, Norway
March 2013 - PDF, 1.4MB - Posted: 3.12.2013
By: Mads Mysen and Anna Svensson
A demonstration project where new concepts for energy efficient ventilation and lighting are integrated, using the existing ducts and demand control sensors.

School in Schwabenstadt - Austria
January 2013 - PDF, 1.1MB - Posted: 2.10.2013
By: Claudia Dörfler, Thomas Steffen and Susanne Supper
School building from 1960s with numerous expansions. Renovated in 2005/07 to meet the passive house standards.

Osram Culture Centre – Denmark
January 2013 - PDF, 1.6MB - Posted: 2.10.2013
By: Jørgen Rose and Kirsten Engelland Thomson
Built in 1953 as an industrial building and renovated in 2009. The first prefabricated building in Copenhagen.

Kindergarten Vejtonen - Denmark
October 2012 - PDF, 1.2MB - Posted: 10.10.2012
By: Jørgen Rose and Kirsten Engelland Thomson
Built in 1971 with minimal insulation standard. One of 27 kindergartens in the municipality that will undergo and extensive energy renovation. The method developed in this project will be applied in all the other kindergartens.

NYE Building - Norway
October 2012 - PDF, 1.2MB - Posted: 10.10.2012
By: Anders Johan Almas, Michael Kinski, Niels Lassen
The office building was constructed through 1962-64 for the Norwegian Water Resources and Energy Directorate. Protected elements both internal and external. The first protected building in Norway to be renovated to energy level B or better.

School Renovation - Casena, Italy
June 2012 - PDF, 0.7MB - Posted: 7.2.2012
By: Task 47
Presentation that outlines a major renovation of a primary school built in the 1960s. Includes building envelope, heating system, renewable energy system and lighting.

Norwegian Tax Authority Building Renovation - Oslo, Norway
June 2012 - PDF, 1.1MB - Posted: 7.2.2012
By: Task 47
Presentation that outlines the renovation of the high-rise Norwegian Tax Authority building in Oslo, Norway. The renovation includes high insulated building facade, increased air tightness, energy recovery, and high efficiency technical systems.
Task 47: Renovation of Non-Residential Buildings towards Sustainable Standards

1. INTRODUCTION

PROJECT SUMMARY
Year of construction: 1962
Past energy renovations:
- Minor improvements
- New windows

SPECIAL FEATURES
- Insulation of the building envelope
- Energy-efficient lighting and control systems
- Automated ventilation systems

MAIN CONSULTANT
Stenbock Architects

ARCHITECT
Stenbock Architects

ELECTRICAL CONSULTANT
Mikael Björklund

PARTNERS
- Electrolux Lighting
- Skanor AH
- Wylex

OWNER
City of Copenhagen

Brochure
Contact

Osram Culture Centre – Copenhagen, Denmark
Vilhelmenga 4, 2200 Copenhagen N

IEA – SHC Task 47
Renovation of Non-Residential Buildings towards Sustainable Standards

NVE building – Middelthuns gate 29, Oslo
Norwegian Water Resources and Energy Directorate

Norwegian Tax Authority - Oslo Norway

School in Schwanenstadt, Austria

School “Tito Maccio Plauto” – Cesena (IT)

Kampen School, Norway

1. INTRODUCTION

PROJECT SUMMARY
Year of construction: 1888
Past energy renovations:
- Minor improvements
- New windows

SPECIAL FEATURES
- Demonstration project
- New concepts for energy-efficient ventilation and lighting
- Insulation of the building envelope

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1. INTRODUCTION

PROJECT SUMMARY
Year of construction: 1980
Past energy renovations:
- Minor improvements
- New windows

SPECIAL FEATURES
- High insulated pre-fabricated façades
- Antiproto
- Reduced energy consumption
- High efficiency
- COP coil recovery

ARCHITECT
LPO Architects

Consultant
Svenske Bygg

ARCHITECT
Erik Veeger

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1. INTRODUCTION

PROJECT SUMMARY
- Year of construction - 1980
- None past energy renovations

MAIN RENOVATION TOPICS
- High insulated facades
- Airtightness 0.6 h-1
- High efficiency technical systems, ground coupled heat pump, COP = 15 for cooling, COP = 3.5 for heating, efficient heat recovery, and low SFP.
- PV electricity production on site.

Architect
Snøhetta Architects AS, Oslo

Consultants
Skanska Norway, Hydro, Zero, ZEB and Asplan Viak

Owner
Entra Eiendom AS

Brochure: Arne Førland-Larsen
Contact:
Arne.forlandlarsen@asplanviak.no

IEA SHC Task 47
Renovation of Non-Residential Buildings towards Sustainable Standards

2. CONTEXT AND BACKGROUND

BACKGROUND

• The building situated in Sandvika, close to the Oslofjord from the northeast to the southeast side, with a highway with heavy traffic on the north west.

• The renovation includes two blocks out of a total of 9 of the entire site. (Map next page)

• The refurbish buildings have an area of 5.180 m² (internal area without outer walls)

• The buildings are programmed for approximately 280 person, which makes an average area of 19 m² pr. person.

OBJECTIVES OF THE RENOVATION

• Powerhouse is defined as a building that during its lifecycle produces more renewable energy than it consumes for the production of building materials, construction, operation and demolition of the building.

• The building shall be built within commercial marketable conditions

• The energy production must be based on energy sources on site or nearby with access from the site

• Energy use for electrical appliances shall not be included in the energy balance account.

• BREEAM classification score: Excellent
3. DECISION MAKING PROCESSES

The Powerhouse Alliance
The Powerhouse alliance includes the companies: Snøhetta Architects, Skanska, Hydro, Entra Eiendom and the NGO Zero. The Powerhouse concept was first launched in 2011. The proposal for the first Powerhouse project, a new office building in Trondheim, was presented in 2012. The Powerhouse Kjørbo is the first renovation project of the Alliance.

Powerhouse, criteria of the energy goal
In order to fulfill the declared goal of the PowerHouse (given in a press release from the Alliance): The Powerhouse alliance will:
• challenge existing building conventions
• develop cutting-edge concepts
• promote new national and international standards for energy efficiency and energy positive buildings
• be technological path-breaking

The main definition of PowerHouse: Powerhouse shall during its lifetime produce more energy than it uses for materials, production, operation, renovation and demolition

Timeline for the decision making process

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea was born</td>
<td>2011</td>
</tr>
<tr>
<td>First brief project description completed</td>
<td>01.07.2012</td>
</tr>
<tr>
<td>Detailed project description completed</td>
<td>01.11.2012</td>
</tr>
<tr>
<td>Tendering process started</td>
<td>01.11.2012</td>
</tr>
<tr>
<td>Signing of contract with main contractor</td>
<td>18.03.2013</td>
</tr>
<tr>
<td>Start renovation (demolishing)</td>
<td>01.02.2013</td>
</tr>
<tr>
<td>Renovation completed</td>
<td>Q1.2014</td>
</tr>
<tr>
<td>Evaluation among occupants</td>
<td>TBD</td>
</tr>
</tbody>
</table>
4. BUILDING ENVELOPE

Roof construction:
U-value: 0.08 W/m²K (average value)

Wall construction:
U-value: 0.15 W/m²K (average value above and below ground)

Floor facing ground (basement) equivalent value in average:
U-value: 0.16 W/m²K

Windows:
U-value: < 0.8 W/m²K (average value)

Floor on ground
U-value: 0.12 W/m²K

Floor in basement
U-value: 0.16 W/m²K

Thermal bridge avoidance:
Focus on thermal bridges in:
- Mounting of windows
- Insulation thickness where concrete slabs meet the façade
- Wood facade construction with few thermal bridges, and 200 mm insualtion in front of slabs.

Overall demand to thermal bridges are:
< 0.03 W/m²k

Window / to wall ratio: 40 / 60

Light transmitting factor for windows: 68 %

Daylight factor, average on working areas 2,1

Sun shading
External sun shading integrated in facade

---

Summary of U-values [W/m²K]

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof/attic</td>
<td>~0,2</td>
<td>0,08</td>
</tr>
<tr>
<td>Floor/slab</td>
<td>-</td>
<td>0,12 – 0,16</td>
</tr>
<tr>
<td>Walls</td>
<td>~0,3</td>
<td>0,08</td>
</tr>
<tr>
<td>Ceilings</td>
<td>~0,3</td>
<td>~0,3</td>
</tr>
<tr>
<td>Windows</td>
<td>~1,8</td>
<td>0,8</td>
</tr>
</tbody>
</table>
5. BUILDING SERVICES SYSTEM

OVERALL DESIGN STRATEGY
The overall design strategy based on:
• Optimizing the building envelope
• Optimizing technical system
• Utilizing renewable energy

LIGHTING SYSTEM
New lighting system have planned LENI number ~9 kWh/m² year

HEATING SYSTEM
Before – Water based heating system
After – Air heating delivered from ventilation system combined with radiators in the wave wall in the center of the building

COOLING SYSTEM
Before:
• central cooling of inlet air for mechanical ventilation in combination with cooled beams.

After:
• Central air cooling – mechanical and displacement ventilation

HOT WATER PRODUCTION
• Heat pump and district heating

RENEWABLE ENERGY SYSTEMS
• Before - District heating
• After – preliminary ground based heat pump
• PV system for electric generation should produce 230.000 kWh/year
6. ENERGY PERFORMANCES

ENERGY PERFORMANCE
Annual delivered before
~ 240 kWh/m² (including data facilities.)

Annual delivered after:
~20,4 kWh/m² (without data facilities)
~50 kWh/m² year (including data facilities)

RENEWABLE ENERGY USE
Annual delivered before:
Electricity ~ 125 kWh/m²
District heating ~ 75 kWh/m²
District cooling ~ 40 kWh/m²

Annual delivered after:
Electricity ~ 18,4 kWh/m²
District heating ~ 2 kWh/m²

PRIMARY ENERGY CONSUMPTION
Primary energy consumption is defined as delivered energy multiplied with primary energy factors, as primary factor for conversion of electrical consumption calculated for a 60 year life time /Source ZEB and Powerhouse project report – 2012/

<table>
<thead>
<tr>
<th>Energy budget - net energy/ space deliverable</th>
<th>Netto energy</th>
<th>Deliver energy</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space heating</td>
<td>15,4</td>
<td>4,6 0,9 5,5 kWh/m² year</td>
<td>Ground couples heatpump</td>
</tr>
<tr>
<td>Mechanical ventilation - heating</td>
<td>2,4</td>
<td>0,8 0,1 0,9 kWh/m² year</td>
<td>Ground couples heatpump</td>
</tr>
<tr>
<td>Hot Water</td>
<td>4,3</td>
<td>1,1 1 2,1 kWh/m² year</td>
<td>Ground couples heatpump</td>
</tr>
<tr>
<td>Energy fans for mechanical ventilation</td>
<td>2,1</td>
<td>2,1 2,1 kWh/m² year</td>
<td></td>
</tr>
<tr>
<td>Energy pumps for heating, ventilation, cooling</td>
<td>0,8</td>
<td>0,8 0,8 kWh/m² year</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>7,7</td>
<td>7,7 7,7 kWh/m² year</td>
<td></td>
</tr>
<tr>
<td>Technical equipment, PC, copymachines etc.</td>
<td>12</td>
<td>12 12 kWh/m² year</td>
<td></td>
</tr>
<tr>
<td>Central data facilities - servers</td>
<td>16,9</td>
<td>16,9 16,9 kWh/m² year</td>
<td></td>
</tr>
<tr>
<td>Cooling, cooled beams in office areas</td>
<td>0</td>
<td>0 0 kWh/m² year</td>
<td></td>
</tr>
<tr>
<td>Cooling, central servers</td>
<td>16,9</td>
<td>1,1 1,1 kWh/m² year</td>
<td>Free cooling from ground</td>
</tr>
<tr>
<td>Cooling, central mechanical ventilation</td>
<td>3,5</td>
<td>0,2 0,2 kWh/m² year</td>
<td>Free cooling from ground</td>
</tr>
<tr>
<td>Sum energy demand</td>
<td>82</td>
<td>47,3 2 49,3 kWh/m² year</td>
<td></td>
</tr>
<tr>
<td>Sum exclusive central data facilities</td>
<td>65</td>
<td>30,4 2 32,4 kWh/m² year</td>
<td></td>
</tr>
<tr>
<td>and technical equipment</td>
<td>53</td>
<td>18,4 2 20,4 kWh/m² year</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy demand / production</th>
<th>Delivered/produced energy</th>
<th>Primary energy factor</th>
<th>Primary energy demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV - production, first 30 years</td>
<td>40,7</td>
<td>1,98</td>
<td>80,6 kWh/m²</td>
</tr>
<tr>
<td>PV - production, last 30 years</td>
<td>60,1</td>
<td>0,93</td>
<td>55,9 kWh/m²</td>
</tr>
<tr>
<td>PV - production, average 60 years</td>
<td></td>
<td></td>
<td>68,7 kWh/m²</td>
</tr>
<tr>
<td>Operational energy use</td>
<td>-20,4</td>
<td>1,46</td>
<td>-29,8 kWh/m²</td>
</tr>
<tr>
<td>Embodied energy</td>
<td></td>
<td></td>
<td>-22,1 kWh/m²</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td>16,8 kWh/m²</td>
</tr>
</tbody>
</table>

**CLARIFICATION:** the energy calculations and given energy numbers will be according to the national standards which might vary between countries, i.e. numbers are not always comparable.
ENVIRONMENTAL PERFORMANCE

Waste management
- More than 90% of waste from construction phase is recycled and/or reused

Ecological materials/indoor AQ
- Building materials with lowest possible embodied energy
- Burned wood for façade cladding
- Labeling materials or materials with low polluting according to EN 15251
- All product categories listed in BREEAM have been tested against and documented to meet the relevant standards Volatile Organic Compound (VOC) emissions.
- The climate gas emissions from new materials in the building comprise 50% of the emissions in a new reference building. (Ref definition see /Klimagassutslipp.no/
- EPDs (Environmental Product Declarations according to ISO 14025/EN-NS15804) have been procured for at least 10 different building products used to a large extent

Certification/Labels
- BREEAM-NOR, planned for certification label excellent

<table>
<thead>
<tr>
<th>Building table element</th>
<th>kWh/m² per year</th>
<th>kg CO₂-eq/m² per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 Superstructure</td>
<td>0,07</td>
<td>0,04</td>
</tr>
<tr>
<td>23 Outer walls</td>
<td>3,81</td>
<td>1,75</td>
</tr>
<tr>
<td>24 Inner walls</td>
<td>1,50</td>
<td>1,49</td>
</tr>
<tr>
<td>25 Structural deck</td>
<td>6,09</td>
<td>1,27</td>
</tr>
<tr>
<td>26 Outer roof</td>
<td>2,20</td>
<td>0,78</td>
</tr>
<tr>
<td>28 Stairs, balconies etc.</td>
<td>0,03</td>
<td>0,01</td>
</tr>
<tr>
<td>36 Ventilation and aircondition</td>
<td>1,99</td>
<td>0,30</td>
</tr>
<tr>
<td>43 Low voltage supply</td>
<td>0,23</td>
<td>0,11</td>
</tr>
<tr>
<td>49 Other electric power installations (PV)</td>
<td>9,57</td>
<td>1,78</td>
</tr>
<tr>
<td>62 Person and product transport</td>
<td>0,08</td>
<td>0,02</td>
</tr>
<tr>
<td>69 Other technical installations</td>
<td>0,33</td>
<td>0,07</td>
</tr>
<tr>
<td>Energy consumption in construction phase</td>
<td>1,21</td>
<td>0,06</td>
</tr>
<tr>
<td><strong>Total with reinforcing steel and concrete</strong></td>
<td><strong>27,2</strong></td>
<td><strong>5,7</strong></td>
</tr>
<tr>
<td><strong>Total without reinforcing steel and concrete</strong></td>
<td><strong>22,1</strong></td>
<td><strong>4,5</strong></td>
</tr>
</tbody>
</table>
8. MORE INFORMATIONS

RENOVATION COSTS
The building shall be renovated within commercial market conditions.

The specific cost of the project are not public for the time being. The tenant Asplan Viak has signed a 10 year renting contract. The rent is higher than for a similar office building with an average energy standard. However, when the reduced energy costs are included, the total cost for the tenant is at the same level as for a standard office building.

OTHER INTERESTING ASPECTS
Measured/delivered energy shall in net be counted to zero or be negative, and shall be calculated according to method/principles given in the Norwegian Standard 3031. Real operation conditions shall be used in the calculations, and technical equipment shall not be included.

The boundary of the plus energy building/Powerhouse is the site on which the building is located.

The energy goal must not be reached at the sacrifice of good architecture and indoor climate, or other central environmental qualities.

Task 47: Renovation of Non-Residential Buildings towards Sustainable Standards

Present status of Powerhouse Kjørbo
Preliminary conclusions from 8 projects

Average U-values before and after

Energy demand after renovation

Renewable energy systems

- PV: 38%
- Solar Thermal: 37%
- Bio: 13%
- None: 12%
More information to be available

- More exemplary brochures to be uploaded on the public web-site
  + 4 in May
  + 8-10 before end of year

- Overview of national renovation guidelines
  - 21 listed in a draft report,
More information:

http://task47.iea-shc.org/