Introduction to Task 47 and experiences from exemplary renovation projects

Fritjof Salvesen

Asplan Viak AS – Norway

Operating Agent SHC task 47

Seminar Sydney 5. April 2013

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

SOLAR HEATING & COOLING PROGRAMME

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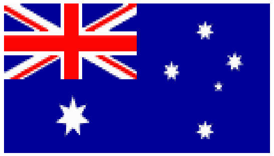
Australia


Austria


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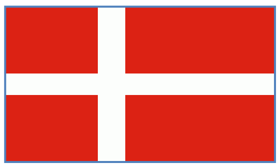
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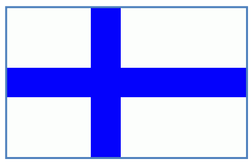
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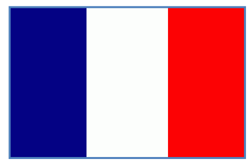
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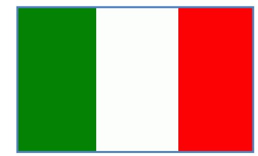
Germany


Italy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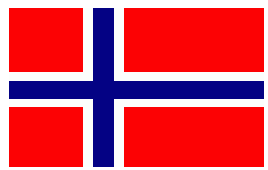
Norway


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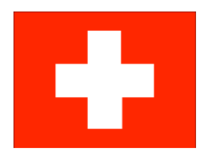
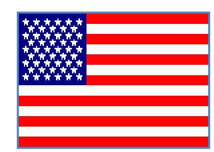
Singapore


South Africa


Spain


Sweden


Switzerland


United States

Organizational members: European Commission, ECREE

5 Year Strategic Plan 2009-2013

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- To **be the primary source** of high quality technical information and analysis on SHC technologies, designs and applications
- To contribute to a significant **increase in the performance** of SHC technologies and designs.
- To **enhance cooperation** with industry and government on increasing the market share of SHC technologies and designs
- To **increase the awareness and understanding** of the potential and value of SHC systems by providing information to decision-makers and the public

- Task 49 - Solar Heat Integration in Industrial Processes
- Task 48 - Quality Assurance and Support Measures for Solar Cooling Systems
- 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 32 - Advanced Storage Concepts for Solar Thermal Systems in Low Ener
- 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 25 - Solar Assisted Air Conditioning
- Task 24 - Active Solar Procurement
- Task 23 - Optimization of Solar Energy U
- Task 22 - Building Energy Analysis Tools
- Task 21 - Daylight in Buildings
- Task 20 - Solar Energy in Building Renov
- Task 19 - Solar Air Systems
- Task 18 - Advanced Glazing Materials for
- Task 17 - Measuring and Modeling Spect
- Task 16 - Photovoltaics in Buildings
- Task 15 - Advanced Central Solar Heatin
- Task 14 - Advance Active Solar Energy S
- Task 13 - Advance Solar Low Energy Bui
- Task 12 - Building Energy Analysis and D
- Task 11 - Passive and Hybrid Solar Com
- Task 10 - Solar Materials R&D
- Task 9 - Solar Radiation and Pyranometr
- Task 8 - Passive and Hybrid Solar Low E
- Task 7 - Central Solar Heating Plants wit
- Task 6 - Performance of Solar Systems U
- Task 5 - Use of Existing Meteorological In
- Task 4 - Development of an Insolation Ha
- Task 3 - Performance Testing of Solar Co
- Task 2 - Coordination of Solar Heating ar
- Task 1 - Investigation of the Performance

Task 47:

Renovation of Non-Residential Buildings towards Sustainable Standards

Duration: January 2011 - June 2014

Objectives

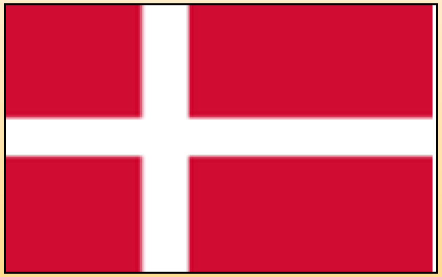
- Develop a solid knowledge base on how to renovate non-residential buildings towards the NZEB standards (Net-Zero Energy Buildings) in a sustainable and cost efficient way.
- Identify the most important market and policy issues as well as marketing strategies for such renovations.

Participating countries

Australia

Austria

Belgium



Denmark

Germany

Italy

Norway

Task 47 web-site: http://task47.iea-shc.org/

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Solar Renovation of Non-Residential Buildings Settings Edit

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.

Settings

Task Information

DURATION
januar 2011 — juni 2014

OPERATING AGENT
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fritjof.salvesen@asplanviak.no

What's New

NEWS | MEETINGS | PUBLICATIONS

SHC Solar Award 2013 - Call for Nomination - For over 30 years, the International Energy Agency's Solar Heating & Cooling (SHC) Programme has worked to expand the use of solar energy for heating and cooling.

Task 47 Highlights 2012 Now Online

SHC 2013 Abstract Submission and SHC 2012 Conference Proceedings - January 8, 2013

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

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From the public web site:

SHC Home › Task Home ›

Workshop IEA SHC Task 47: Retrofit of Non-Residential Buildings

SEPTEMBER 7, 2012 - BRUSSELS, BELGIUM

Exemplary renovation projects have demonstrated that total primary energy consumption can be drastically reduced while also improving buildingâ€™s the indoor climate. However, the experiences gained from these projects have not been systematically analyzed to make them a reliable resource for planners. Because most property owners are not even aware that such savings are possible, they set energy targets that are too conservative. And, buildings renovated to mediocre performance can be a lost opportunity for decades. It is essential that building owners be aware of the successes and set ambitious targets. The aim of this symposium is to show some exemplary renovation projects in the participating countries of task 47.

- Workshop Flyer

PRELIMINARY AGENDA & PRESENTATIONS

10:00	Welcome and Introduction by OA Fritjof Salvesen
10:10	School of Schwanenstadt, Austria
10:20	Kindergarten in HÃ¸je-Taastrup, Denmark
10:40	Norwegian Tax Directorate
11:10	Office in Vorst, Belgium
11:30	Coffee Break
11:50	High Rise Commercial Building, Australia
12:10	Printing Workshop, Germany
12:30	Franciscan Monastery in Graz - Historic Building
12:50	Discussion and Summary

Renovation Examples

Kampen School, Norway
mars 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 Schwanenstadt - Austria
januar 2013 - PDF 1,1MB - Posted: 2.10.2013
By: Claudia Dankl, Thomas Steffi and Susanne Supper
School building from 1960s with numerous expansions. Renovated in 2006/07 to meet the passive house standards.

Osram Culture Centre – Denmark
januar 2013 - PDF 1,6MB - Posted: 2.10.2013
By: Jørgen Rose and Kirsten Engelund Thomsen
Built in 1953 as an industrial building and renovated in 2009. The first prefabricated building in Copenhagen.

Kindergarten Vejtoften - Denmark
oktober 2012 - PDF 1,3MB - Posted: 10.19.2012
By: Jørgen Rose and Kirsten Engelund Thomsen
Built in 1971 with minimal insulation standard. One of 27 kidergartens in the municipality that will undergo and extensive energy renovation. The method developed in this project will be applied in all the other kindergartens.

NVE Building - Norway
oktober 2012 - PDF 1,23MB - Posted: 10.19.2012
By: Anders Johan Almas, Michael Klinski, Niels Lassen
The office building was constructed through 1962 -64 fir the Norwegian Water Resources and Energy Directorate. Protected elements both internal and external. The first protected buiilding in Norway to be renovated to energy level B or better.

School Renovation - Cesena, Italy
juni 2012 - PDF 0,79MB - 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
juni 2012 - PDF 1,17MB - 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

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Powerhouse Kjørbo – Norway

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

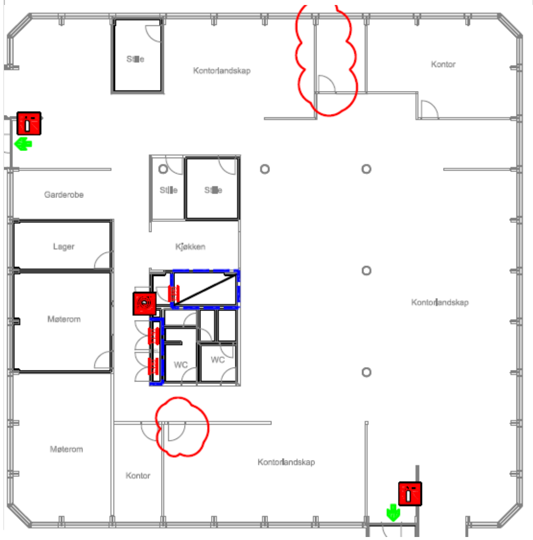
BACKGROUND

- *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 m^2 (internal area without outer walls)*
- *The buildings are programmed for approximately 280 person, which makes an average area of 19 m^2 pr. person.*

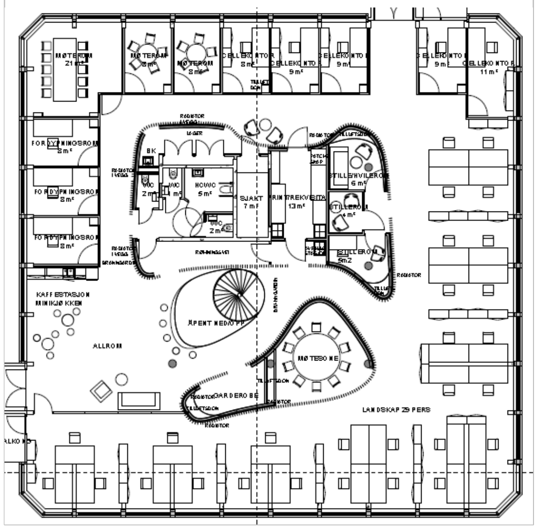
OBJECTIVES OF THE RENOVATION

- *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*

Facade and typical floor plan before refurbishment



Facade and typical floor plan after refurbishment



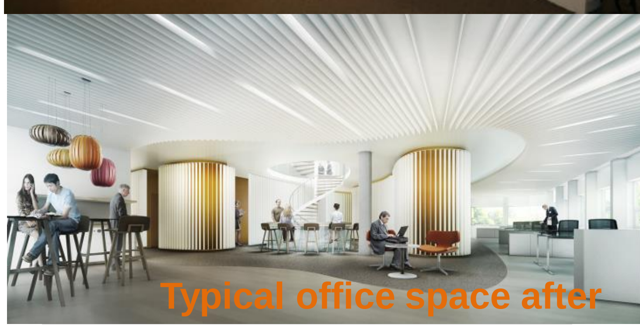
3. DECISION MAKING PROCESSES

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

Idea was born
2011

First brief project description completed
01.07.2012

Detailed project description completed
01.11.2012

Tendering process started
01.11.2012

Signing of contract with main contractor
18.03.2013

Start renovation (demolishing)
01.02.2013

Renovation completed
Q1.2014

Evaluation among occupants
TBD

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 meets 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/m² k

Window / to wall ratio: 40 / 60

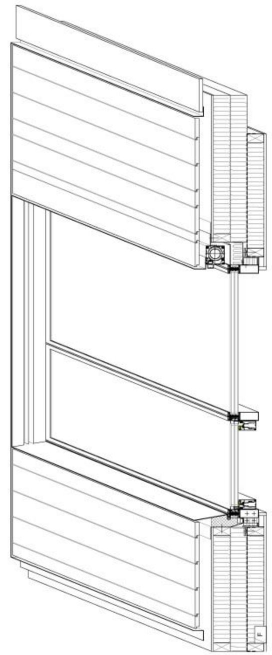
Light transmitting factor for windows: *68 %*

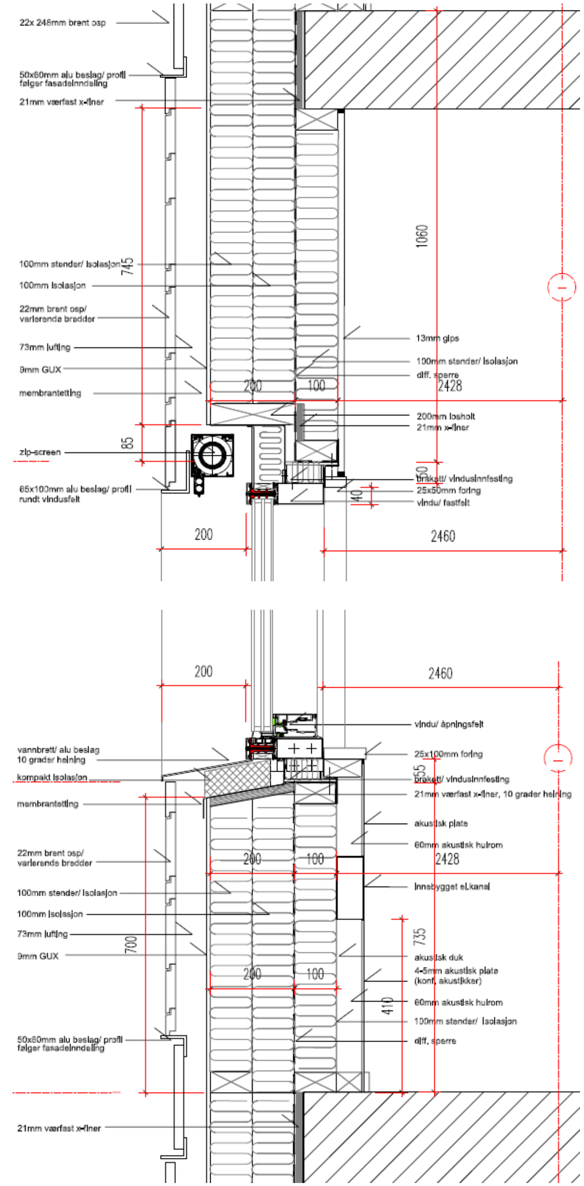
Daylight factor, average on working areas *2,1*

Sun shading
External sun shading integrated in facade

Summary of U-values [W/m²K]

	Before	After
Roof/attic	~0,2	0,08
Floor/slab	-	0,12 – 0,16
Walls	~0,3	0,08
Ceilings	~0,3	¨0,3
Windows	~1,8	0,8





5. BUILDING SERVICES SYSTEM

OVERALL DESIGN STRATEGY

The overall design strategy based on:

- *Optimizing the building envelope*
- *Optimizing technical system*
- *Utilization renewable energy*

LIGHTING SYSTEM

New lighting system have planned LENI number ~9 kWh/m^2 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*

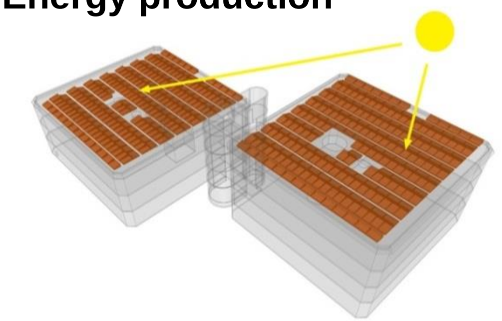
HOT WATER PRODUCTION

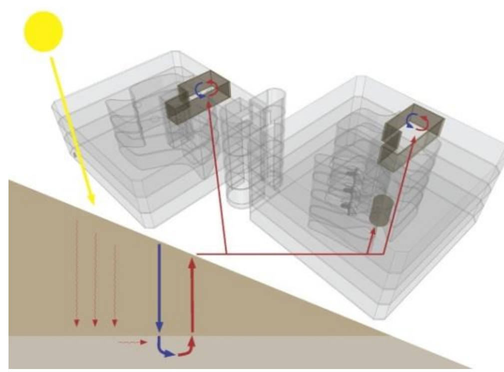
- *Heat pump and district heating*

RENEWABLE ENERGY SYSTEMS

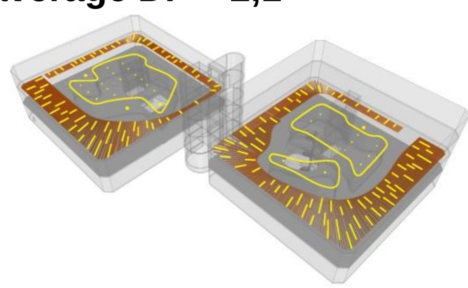
- *Before - District heating*
- *After – preliminary ground based heat pump*
- *PV system for electric generation should produce 230.000 kWh/year*

Energy production

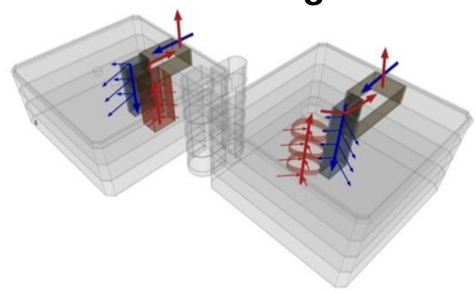




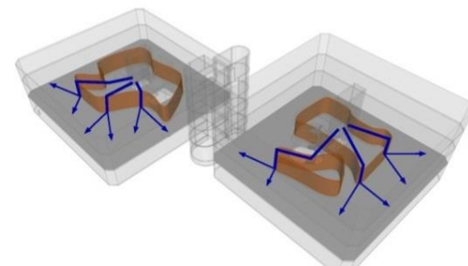
Daylight strategy – average DF > 2,1



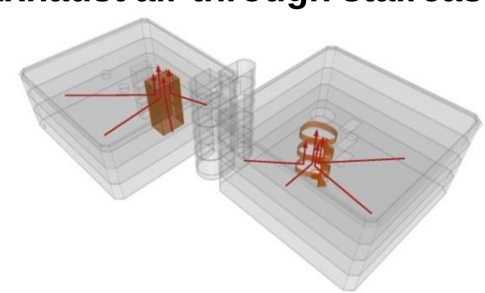
Ventilation and cooling
Reduced duct length



Displacement ventilation



Exhaust air through staircase



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

PRIMAY 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/

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

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

7 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 se /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*

Building table element	kWh/m^2 per year	kg CO_2-eq/m^2 per year
22 Superstructure	0,07	0,04
23 Outer walls	3,81	1,75
24 Inner walls	1,50	1,49
25 Structural deck	6,09	1,27
26 Outer roof	2,20	0,78
28 Stairs, balconies etc.	0,03	0,01
36 Ventilation and aircondition	1,99	0,30
43 Low voltage supply	0,23	0,11
49 Other electric power installations (PV)	9,57	1,78
62 Person and product transport	0,08	0,02
69 Other technical installations	0,33	0,07
Energy consumption in construction phase	1,21	0,06
Total with reinforcing steel and concrete	**27,2**	**5,7**
Total without reinforcing steel and concrete	**22,1**	**4,5**

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.

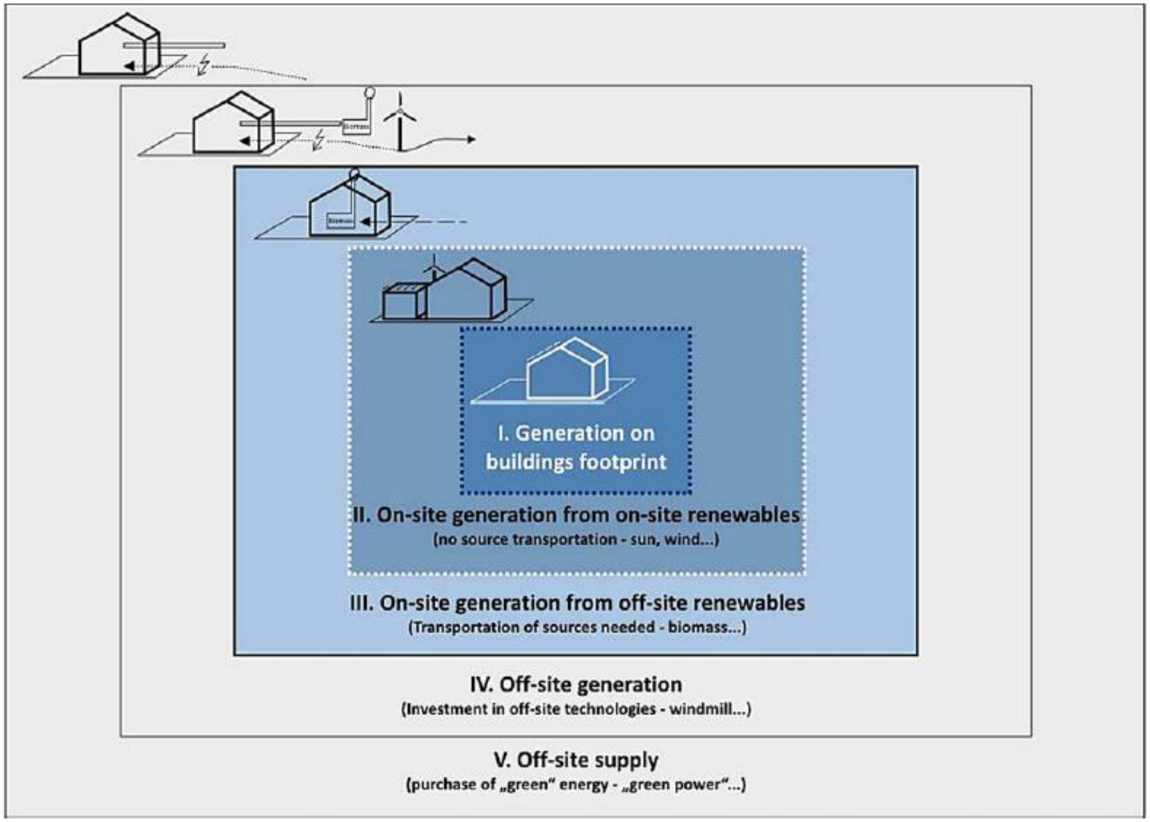
OTHER INTERESTING ASPECTS

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.

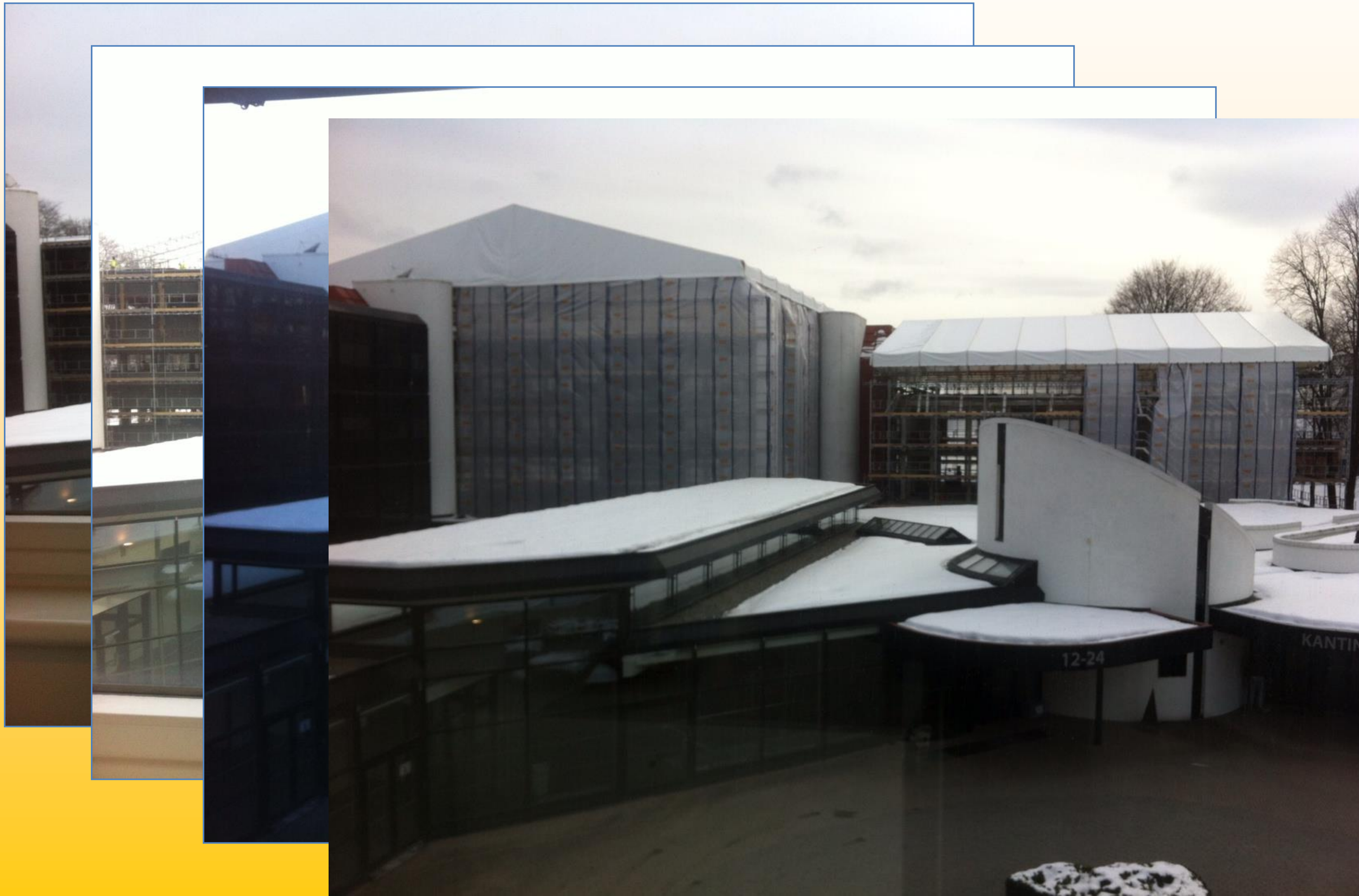
The energy goal must not be reached at the sacrifice of good architecture and indoor climate, or other central environmental qualities.

The Powerhouse boundary is similar to the Boundary II *(On site generation from on-site renewable)* as illustrated below

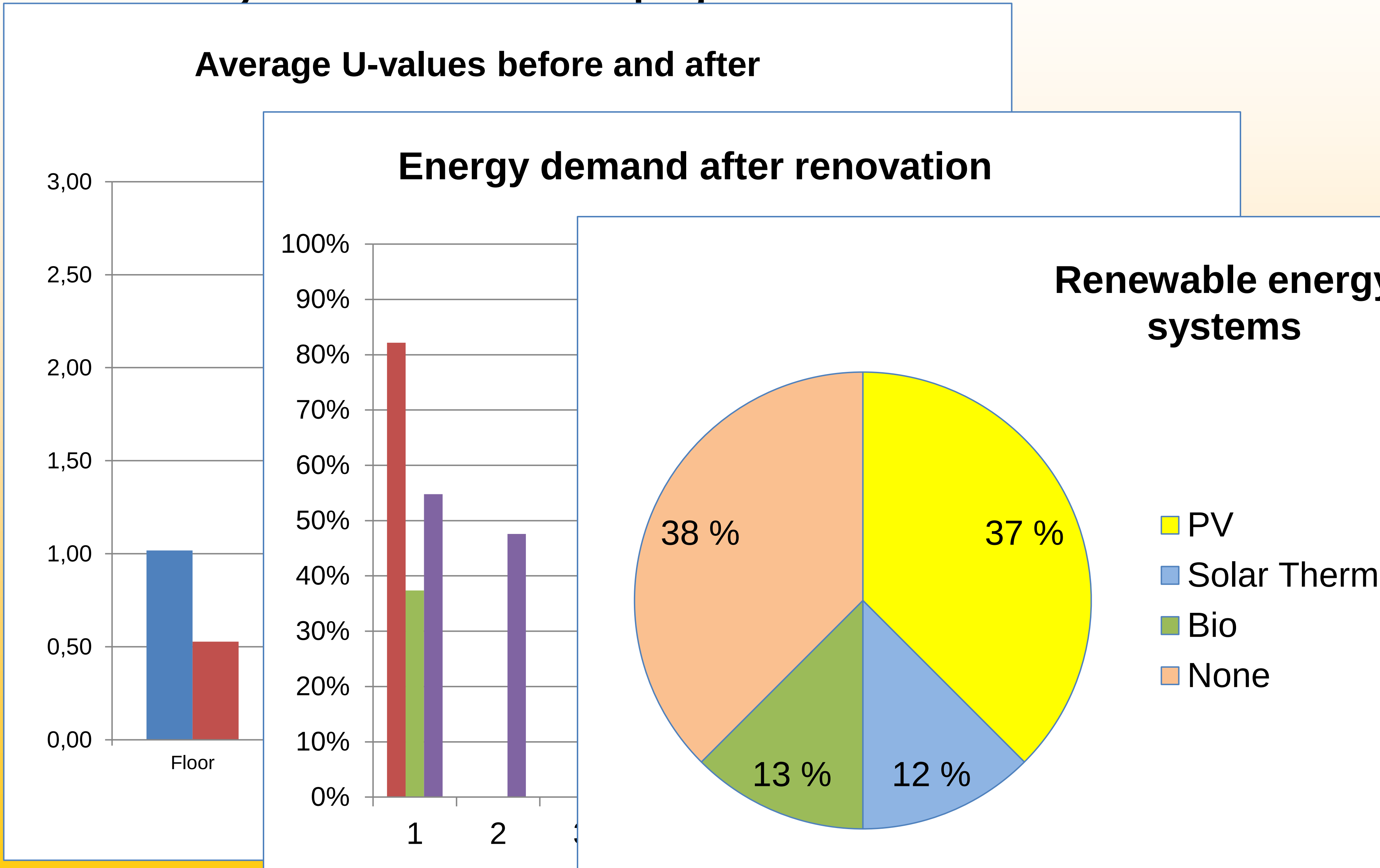


Source: A.J. Marszala,∗, P. Heiselberga, J.S. Bourrelleb, E. Musallc, K. Vossc, I. Sartori d, A. Napolitanoe. "Zero Energy Building – A review of definitions and calculation methodologies", Energy and Buildings 43 (2011) 971–979

Present status of Powerhouse Kjørbo



Preliminary conclusions from 8 projects



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/