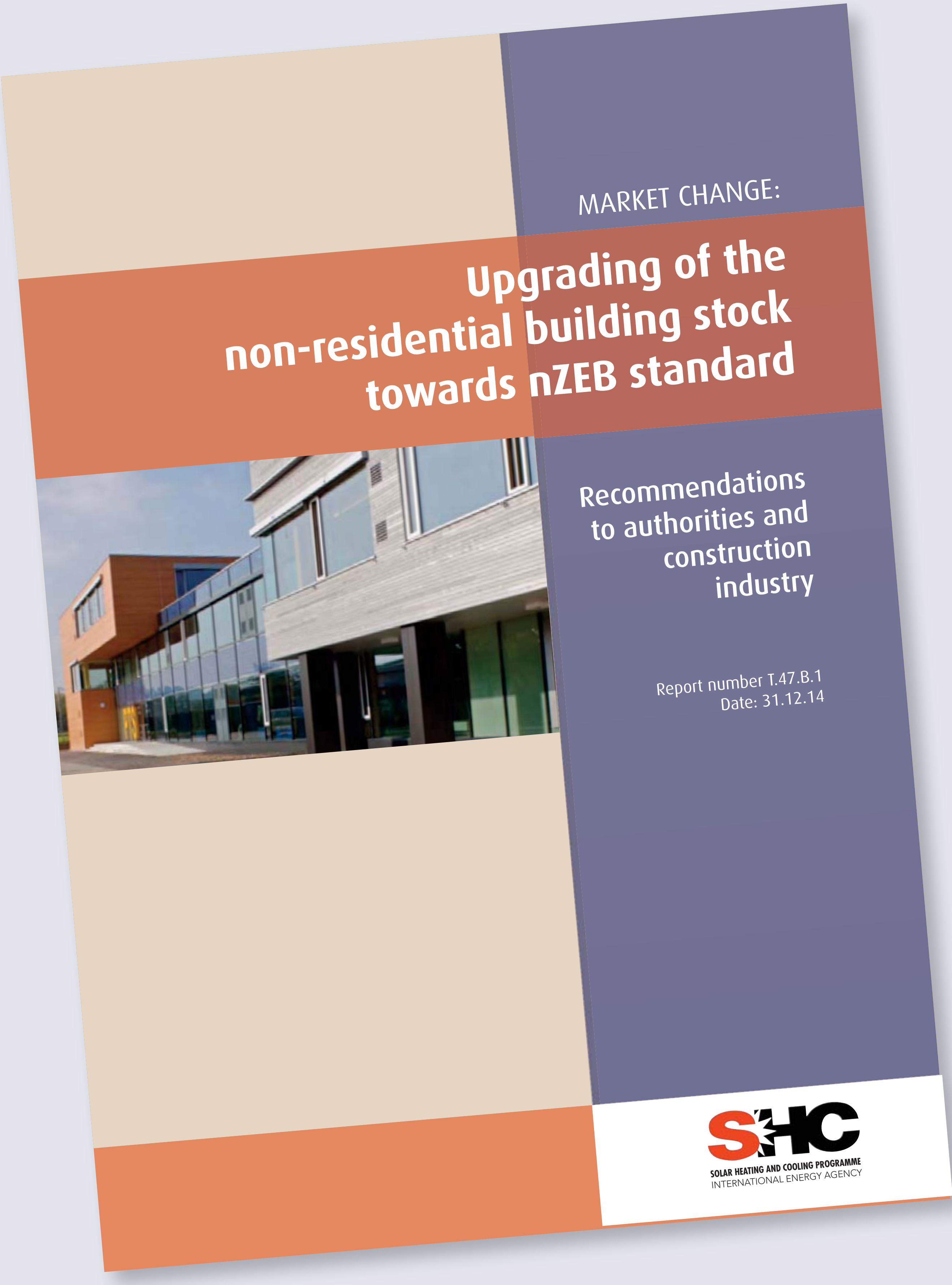
ANNEXES TO THE REPORT:


MARKET CHANGE:

Upgrading of the non-residential building stock towards nZEB standard

Recommendations to authorities and construction industry

Report number T.47.B.1
Date: 31.12.14

SHC
SOLAR HEATING AND COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Contents

Annex 1: Danish non-residential building stock

DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

Building stock analysis –

Danish non-residential buildings

Internal summary report made for IEA SHC Task 47 "Sustainable Renovation of Non-Residential Buildings"

The full report in Danish is available at: www.sbi.dk

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2 Introduction

The purpose of this analysis is to estimate the energy savings that can be expected until 2050 from renovating non-residential buildings in Denmark. It is assumed that energy upgrading will be carried out at those points in time when renovation or replacement would normally occur, i.e. when different parts of the building are worn out and in need of maintenance.

This is an internal summary report prepared for IEA SHC Task 47 “Sustainable Renovation of Non-Residential Buildings”. The full report is available in Danish at www.sbi.dk.

The calculation model uses two main characteristics for dividing the total building stock; one related to construction period and one related to building use. Table 1 shows the 9 construction periods characterised by either typical architecture (the early periods) or tightening of the Danish Building Regulations (- recent periods). Table 2 shows the division of the building stock by use code according to the BBR (Building and Housing Register) for the categories included in the analysis (non-residential buildings).

Please note that BBR Code 160 “Residential institution” and BBR Code 430 “Hospitals” are considered residential buildings in Denmark (with respect to Building Regulation requirements). However, they have been included in this analysis since they can be considered non-residential in other contexts.

Table 1. Construction periods.

Nr.	Period
p1	Before 1890
p2	1890 - 1930
p3	1931 - 1950
p4	1951 - 1960
p5	1961 - 1972
p6	1973 - 1978
p7	1979 - 1998
p8	1999 - 2006
p9	2007 - 2012

Table 2. Use codes according to BBR (non-residential).

Code	Description
160	Residential institution
320	Office, commerce, storage, public administration
330	Hotel, restaurant, hairdressers
410	Libraries, churches, museums
420	Education and research
430	Hospitals
440	Daycares

3 Data from BBR and EMO

The following describes a number of ratios used in the development of the calculation model for the total building stock's net heat consumption. The model is mainly based on records from the Energy-Certification Scheme database (EMO). Table 3 shows the extent of the EMO database coverage of the total building stock, both by number of buildings and heated area.

Table 3. Total heated area. Buildings without heating plant and listed buildings are not included.

		Number of buildings			Heated area		
	BBR Code	BBR [-]	EMO [-]	Labelled share [%]	BBR [m²]	EMO [m²]	Labelled share [%]
Residential institution	160	4,192	1,697	40	4,266,434	2,506,076	59
Office and commerce	320	56,304	7,533	13	57,230,749	17,876,342	31
Hotel and service	330	11,561	889	8	6,058,006	1,187,392	20
Cultural buildings	410	8,585	1,574	18	4,197,662	1,428,209	34
Education and research	420	17,050	5,751	34	21,680,224	14,336,129	66
Hospitals	430	2,199	913	42	4,393,353	3,059,133	70
Daycares	440	7,728	4,173	54	3,372,557	2,237,136	66

3.1 Heated area as a function of construction period and building use

Table 4 shows the total heated area excluding buildings that are categorised as protected or conservation-worthy and buildings without heating. Table 4 therefore shows the potential heated area, which will allow for heat savings in connection with energy-upgrading measures.

Table 4. Heated area [m²] excluding areas from buildings catagorised as protected or conservation-worthy and buildings without heating system (data from BBR 2012).

BBR Code		Before 1890	1890-1930	1931-1950	1951-1960	1961-1972	1973-1978	1979-1998	1999-2006	After 2006	Total
Residential institution	160	126,511	413,100	254,058	354,833	815,948	646,509	842,702	549,895	262,878	4,266,434
Office and commerce	320	2,882,306	6,642,212	3,029,752	2,866,171	10,511,374	5,732,085	14,132,042	6,625,526	4,809,281	57,230,749
Hotel and service	330	742,549	1,288,002	436,902	425,228	966,811	397,163	1,123,268	421,999	256,084	6,058,006
Cultural buildings	410	886,101	896,886	262,585	218,758	411,370	309,294	804,126	291,443	117,099	4,197,662
Education and research	420	651,790	2,349,593	1,540,402	2,725,945	6,008,478	2,961,339	3,549,766	1,387,119	505,792	21,680,224
Hospitals	430	144,143	611,484	412,817	378,625	936,151	795,224	721,180	263,829	129,900	4,393,353
Daycares	440	117,079	337,523	210,396	237,114	720,075	303,894	995,863	318,218	132,395	3,372,557
Total	All	5,550,479	12,538,800	6,146,912	7,206,674	20,370,207	11,145,508	22,168,947	9,858,029	6,213,429	101,198,985

3.2 Area factors for calculation model

The model for calculating the heating requirement of the building stock is based on a number of ratios. One of these ratios is area factors that describe the area of ceiling, exterior wall, floor and windows per m² heated area. Figure 1 - Figure 4 show the calculated area factors based on retrievals from the EMO database. Area factors are calculated for each type of building use and for each construction period.

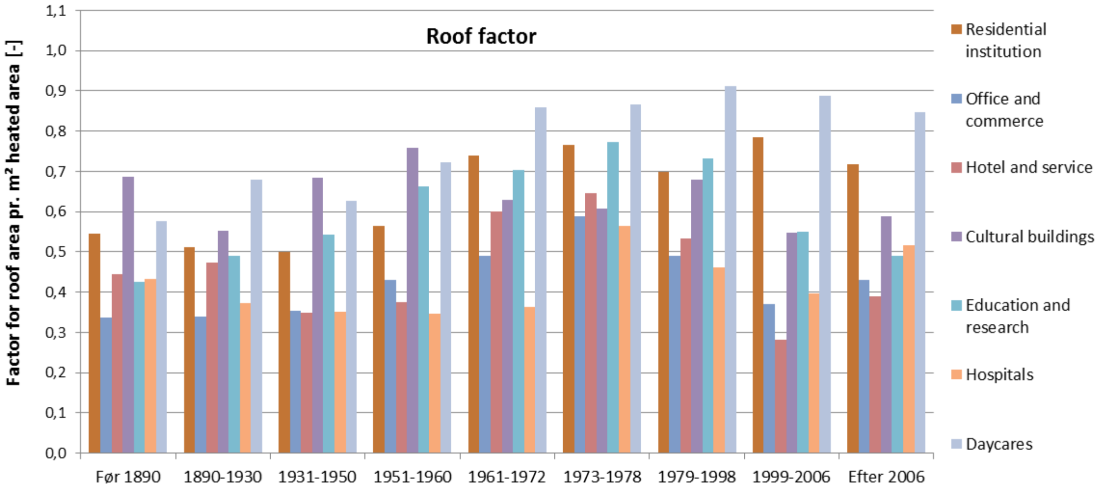

Figure 1. Calculated mean area factor for roofs per m² heated area based on data from EMO.

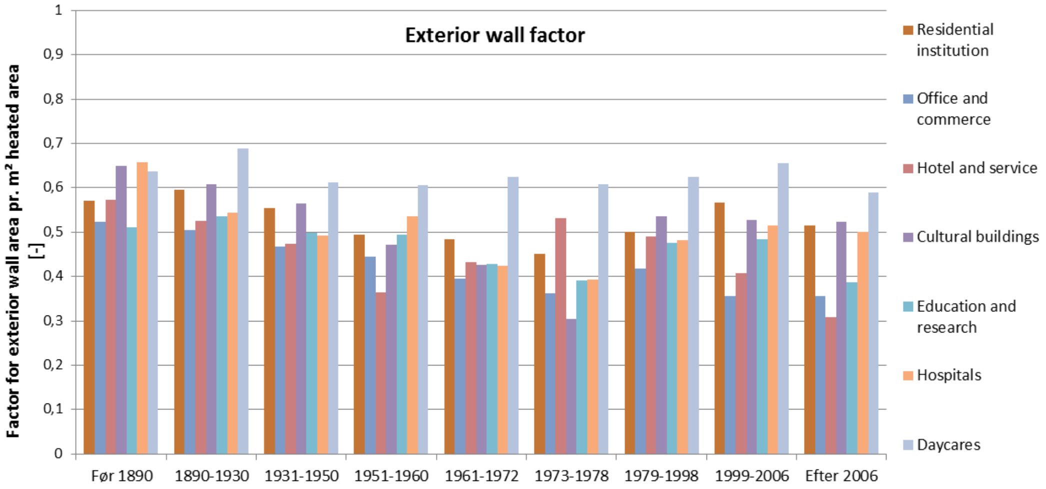

Figure 2. Calculated mean area factor for exterior walls per m² heated area based on data from EMO.

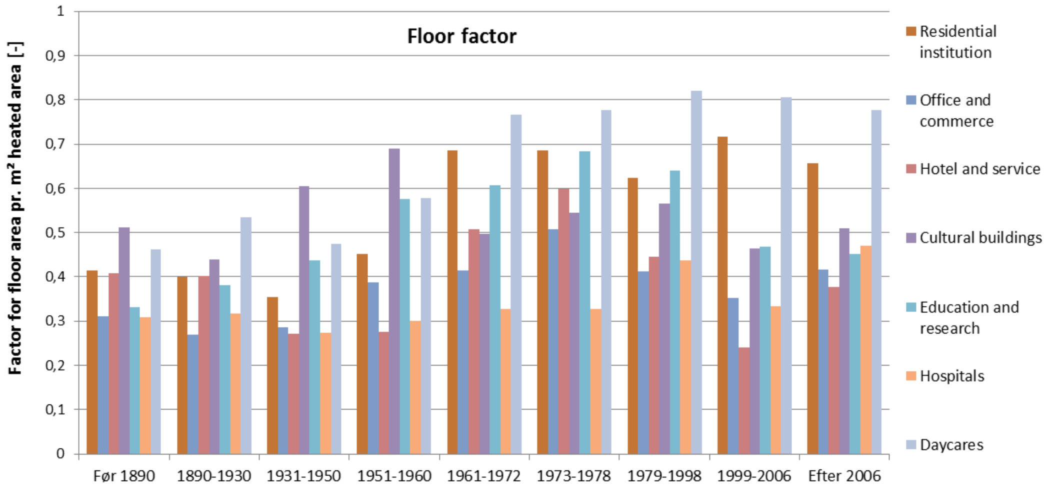

Figure 3. Calculated mean area factor for floors per m² heated area based on data from EMO.

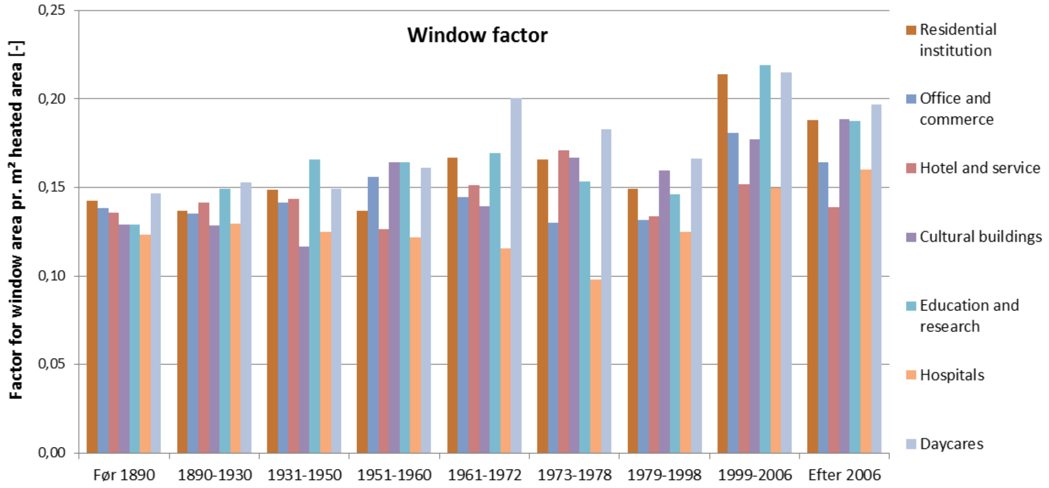

Figure 4. Calculated mean area factor for windows per m² heated area based on data from EMO.

3.3 Area-weighted U-values for the calculation model

As for the area factors, calculations have been performed for the area-weighted transmission heat loss coefficient (U-value) for all constructions. Figure 5 - Figure 8 show the calculated U-values for each of the 9 construction periods.

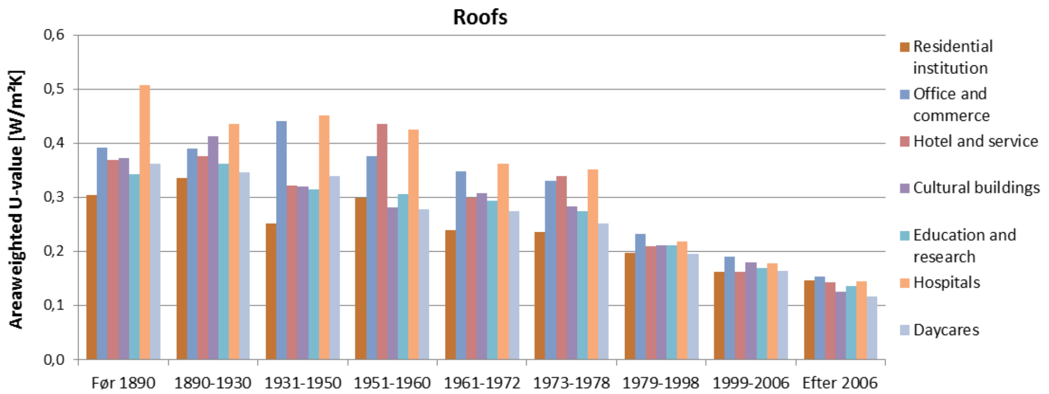

Figure 5. Calculated area-weighted U-values for roof constructions based on data from EMO.

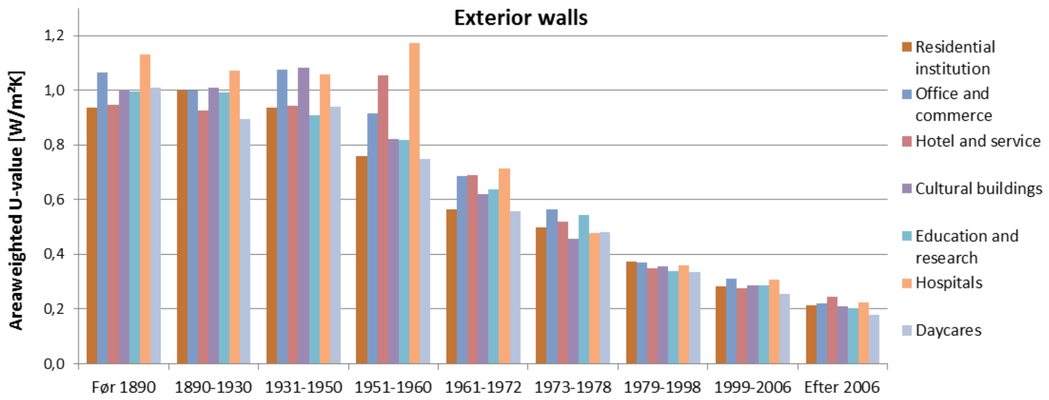

Figure 6. Calculated area-weighted U-values for exterior wall constructions based on data from EMO.

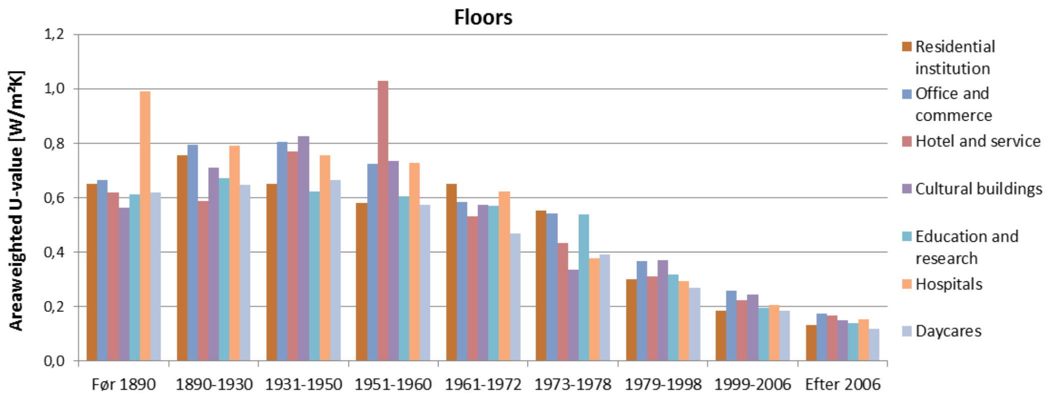

Figure 7. Calculated area-weighted U-values for floor constructions based on data from EMO.

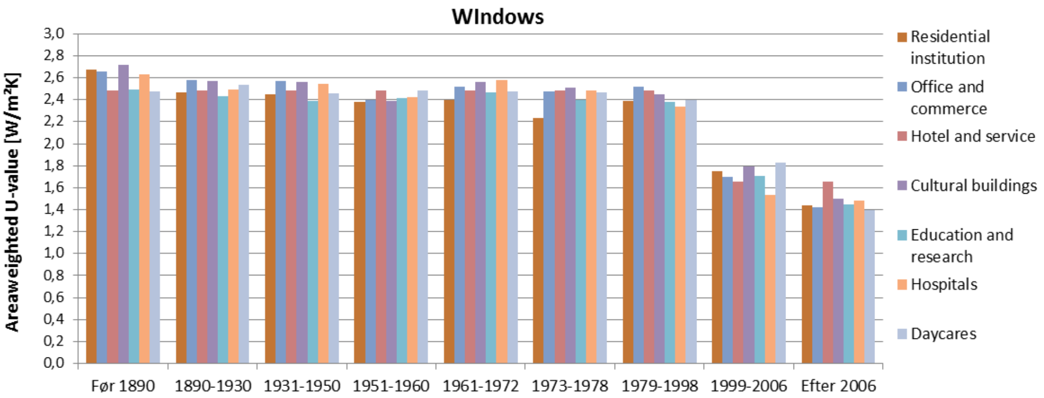

Figure 8. Calculated area-weighted U-values for windows based on data from EMO.

3.4 Insulation level and ownership

The following figures show the area-weighted U-values for roofs, exterior walls, floors and windows specifically for buildings used as offices/commerce (BBR Code 320) and for education (BBR Code 420), since the share of publicly owned buildings are most pronounced for these uses.

The following definition of ownership has been used (cf. owner codes given in BBR):

Privately owned:	Private, I/S, A/S, ApS, Social housing, Non-profit institutional investors, Cooperative and Other
Publicly owned:	Municipality, Other municipality, County, State

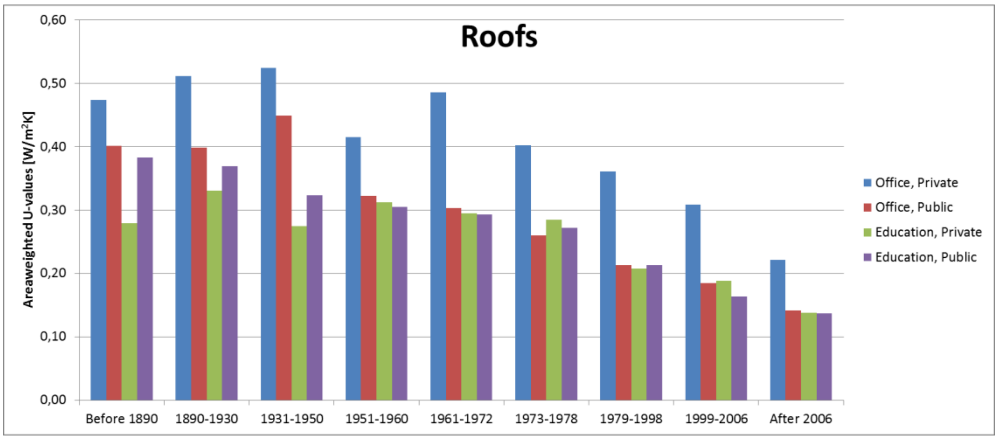

Figure 9. Area-weighted U-values for roofs calculated by ownership.

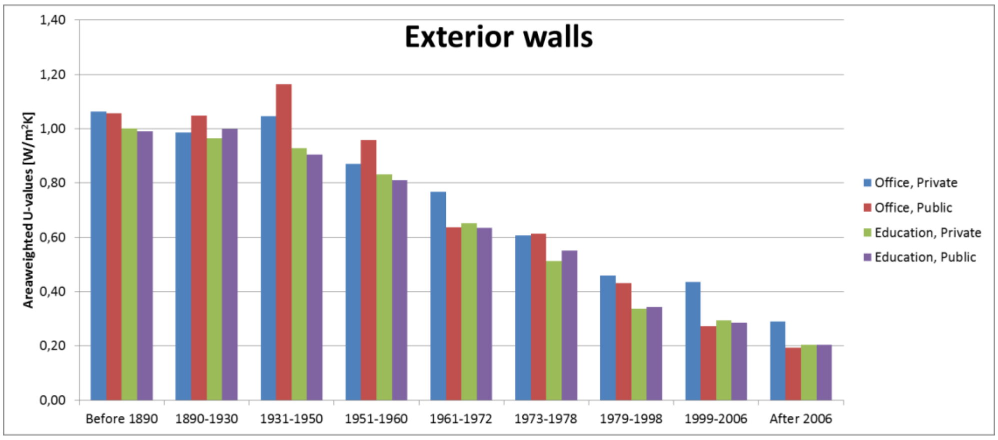

Figure 10. Area-weighted U-values for exterior walls calculated by ownership.

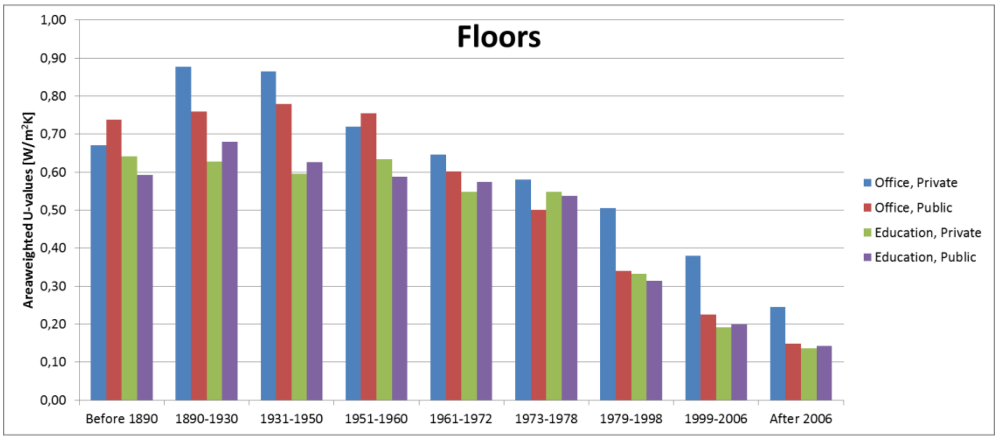

Figure 11. Area-weighted U-values for floors calculated by ownership.

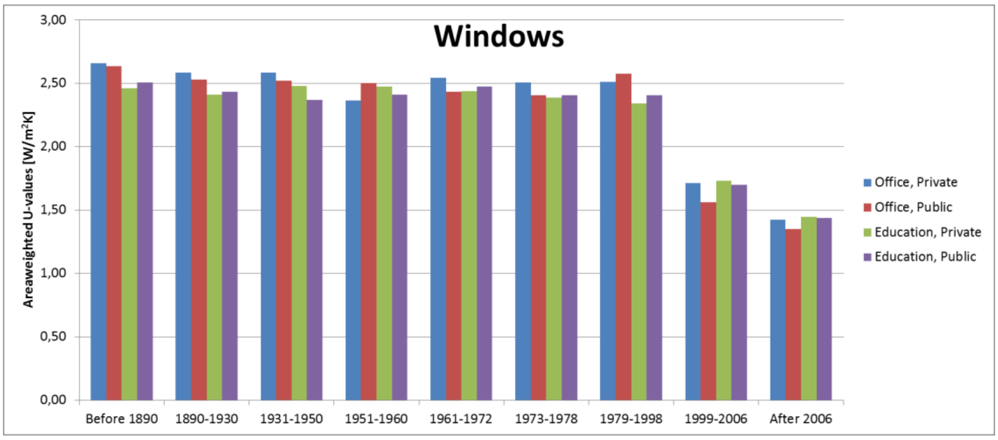

Figure 12. Area-weighted U-values for windows calculated by ownership.

The comparison shows no significant difference between the two types of ownership; however, privately owned office/commercial buildings apparently have a slightly lower insulation level of roofs than corresponding publicly owned buildings.

4 Calculation results

The original analysis calculates several different scenarios. In this shortened version of the report, only one scenario is presented.

4.1 Scenario A – Business-as-usual

The scenario is based on the component requirements stipulated in BR2010 (Danish Building Regulations 2010) for renovation of buildings and replacement of building components. Energy-saving measures are implemented at the pace that building components face renovation/replacement due to their age. The total savings calculated from scenario A will be 10,544 TJ per year in 2050.

Table 5. Overview: energy-saving measures and implementation percentage.

Basic actions	BR10 requirements	Implementation (%)
Insulation of roofs according to BR10 requirements	U ≤ 0,15 W/m²K	80 (present rate)[1)]
Insulation of exterior walls according to BR10 requirements	U ≤ 0,20 W/m²K	80 (estimate)
Replacing windows according to BR10 requirements	2015: $E_{ref} \geq -17$ kWh/m² pr year 2020: $E_{ref} \geq 0$ kWh/m² pr year	100 (estimate)

1) Christensen T.H., Jensen J.O. & Gram-Hanssen K. (2013).

Table 6. Unit consumption in scenario A in 2050 in various building types and construction periods.

kWh/m² per year	Before 1890	1890-1930	1931-1950	1951-1960	1961-1972	1973-1978	1979-1998	1999-2006	After 2006
Res. Institution	118.1	115.9	109.8	106.2	112.1	110.5	92.2	75.4	52.7
Office/commerce	86.3	85.5	88.1	92.3	90.2	97.7	84.0	77.5	75.3
Hotel/service	131.1	127.7	117.6	129.8	129.0	143.2	122.5	112.0	112.3
Cultural buildings	117.8	110.8	112.7	104.3	99.3	95.8	108.6	92.2	89.0
Edu./research	87.9	94.9	102.9	97.8	105.7	122.0	95.5	87.1	78.7
Hospitals	143.5	135.9	133.7	135.3	128.2	139.6	133.0	128.3	122.6
Daycares	123.7	134.8	129.8	133.2	137.6	136.2	120.7	118.7	110.5

Table 7. Percentage of savings in 2050 for scenario A for each building category and construction period. The table's last column and row shows the area-weighted average percentage of savings for each building category and construction period respectively, and the lower right corner shows the total area-weighted savings.

%	Before 1890	1890-1930	1931-1950	1951-1960	1961-1972	1973-1978	1979-1998	1999-2006	After 2006	Total
Res. institution	28.6	28.9	28.5	24.8	22.5	20.0	21.4	20.9	18.0	22.8
Office/commerce	34.1	32.4	32.3	27.9	24.0	19.3	19.6	14.5	9.9	22.5
Hotel/service	24.3	23.8	23.4	19.9	18.5	17.5	14.3	9.3	7.8	19.0
Cultural buildings	29.6	29.5	28.5	25.7	21.8	20.0	18.1	13.2	8.8	24.5
Edu./research	30.9	31.0	27.6	27.7	22.6	16.9	17.9	14.0	9.7	22.5
Hospitals	26.9	24.3	23.3	24.2	17.2	11.2	11.7	7.9	6.0	17.0
Daycares	28.1	26.4	25.8	23.0	21.1	18.7	16.7	12.2	5.4	19.4
All	31.3	30.4	29.3	26.8	22.8	18.1	18.7	14.3	9.9	**21.8**

The total cost of upgrading the building components as required by BR10 in scenario A is estimated at 9.5 billion EUR (2013 level, excl. VAT and the cost of construction sites and scaffolding) by 2050, of which 7.5 billion EUR are for the replacement of windows and 2.0 billion EUR for insulation of the building envelope. One reason for the high cost of replacing windows is that they need to be replaced 1.41 times during the period leading up to 2050.
The total cost of 9.5 billion EUR corresponds to an average of 257 million EUR per year.

4.1.1 Publicly owned buildings

As a special focus area, the difference between publicly owned buildings are studied (BBR Code Municipality, Other municipality, County or State) and privately owned (Private, I/S, A/S, ApS, Social housing, Non-profit institutional investors, Cooperative and Other).

Table 8. Percentage of savings potential through the implementation of scenario A in the public share of the building stock within the 6 building categories where a significant part of the heated area is owned by public building owners.

%	Before 1890	1890-1930	1931-1950	1951-1960	1961-1972	1973-1978	1979-1998	1999-2006	After 2006
Res. Institution	20.6	16.9	14.3	21.7	21.2	14.3	12.2	5.6	0.4
Office/commerce	20.4	22.3	23.6	23.7	24.1	21.6	23.6	2.2	1.1
Cultural buildings	25.2	21.1	25.6	19.2	22.5	20.8	17.3	2.0	3.0
Edu./research	32.7	26.5	24.5	28.4	30.5	20.4	17.4	5.8	1.3
Hospitals	20.7	20.5	21.1	17.2	20.5	18.7	13.3	2.7	2.0
Daycares	22.4	22.9	22.1	23.7	27.6	21.8	18.6	9.9	0.4

Table 9. Savings potential in kWh/m² per year through the implementation of scenario A in the public share of the building stock within the 6 building categories where a significant part of the heated area is owned by public building owners.

kWh/m² per year	Before 1890	1890-1930	1931-1950	1951-1960	1961-1972	197-1978	1979-1998	1999-2006	After 2006
Res. Institution	34.5	30.4	24.6	25.4	34.3	28.2	22.9	9.0	0.9
Office/commerce	30.0	31.9	34.8	32.2	29.7	29.1	30.1	2.5	1.1
Cultural buildings	37.2	30.9	35.5	25.6	29.1	31.6	22.2	2.1	3.0
Edu./research	28.4	32.0	31.5	33.5	38.0	31.2	25.3	7.4	1.5
Hospitals	38.2	36.3	38.5	28.6	28.6	27.7	21.7	3.8	2.6
Daycares	32.1	35.5	33.7	35.2	38.5	32.5	25.9	12.4	0.4

For comparison, Table 10 shows the potential savings within the privately owned share of the same building categories.

Table 10. Percentage of savings potential through the implementation of scenario A in the private share of the building stock within the 6 building categories where a significant part of the heated area is owned by public building owners.

%	Before 1890	1890-1930	1931-1950	1951-1960	1961-1972	1973-1978	1979-1998	1999-2006	After 2006
Res. institution	20.8	18.6	15.1	14.9	24.1	22.8	22.3	10.9	1.5
Office/commerce	19.9	19.5	20.5	18.2	20.2	22.5	27.9	3.1	1.8
Cultural buildings	25.4	19.5	23.0	15.5	21.8	24.8	21.9	2.6	4.9
Edu./research	19.3	20.8	20.0	23.1	30.4	27.7	27.0	9.8	2.9
Hospitals	29.2	24.5	29.3	19.9	23.7	21.5	17.3	5.1	5.4
Daycares	21.3	23.5	23.9	28.0	29.2	27.5	26.6	14.2	0.8

The total savings potential in the publicly owned buildings within the 6 categories is 10,625 TJ per year in the public sector and 9,845 TJ per year in the private sector.

Annex 2: Norwegian non-residential building stock

IEA SHC Task 47

Building stock analysis Norway

Non-residential buildings

VERSJON	DATO
V3	2014-11-20

FORFATTER(E)
Anna Svensson
Trond Haavik

OPPDRAGSGIVER(E)	OPPDRAGSGIVERS REF.
IEA SHC Task 47	Oppdragsgivers referanse

PROSJEKTNR	ANTALL SIDER OG VEDLEGG:
102000162	

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Sammendragstekst

UTARBEIDET AV	SIGNATUR
Anna Svensson	

GODKJENT AV	SIGNATUR
Sofie Mellegård	

PROSJEKTNOTAT NR	GRADERING
Prosjektnotatnummer	

Historikk

VERSJON	DATO	VERSJONSBESKRIVELSE
V1	2014-07-07	
V2	2014-11-17	
V3	2014-11-17	Språkkorrigering

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1 Introduction

Around 80 % of the existing Norwegian building stock will still be standing in year 2050[1], hence renovation of buildings has a high potential of energy efficiency.

This report describes an analysis of the Norwegian building stock for non-residential buildings. The report is a contribution to Subtask B of IEA SHC Task 47 "Solar Renovation of Non-Residential Buildings". The aim of the analysis is to reveal the potential for reducing the energy demand within the non-residential sector related to building category and building year.

- Building category; is there a category within the non-residential buildings which has a higher potential for energy savings?
- Building year; is there a particular building year with a higher energy saving potential?

The report is mainly based on available statistics and analysis and to a lesser extent on new work carried out specifically for this project. Based on these assumptions and the lack of data of non residential buildings in the Norwegian building stock, there is also a chapter included where to find data, shortages and suggestions for ways of attaining a better database.

2 Regulations for retrofitting in Norway

The original European Performance Building Directive (EPBD) required cost-effective energy measures for major renovations of existing buildings exceeding 1000 m². In the revised directive the requirement for floor area limitation is removed, thus all major renovations are covered regardless the size of the building. Amajor renovation include buildings renovating more than 25 percent of the building envelope, or at a total cost of 25 percent of the value of the building, excluding land value. [2]

In Norway, the current regulation is applicable for existing buildings when it is a change of use or when the renovation, assessed by the municipality, is so extensive that the building is substantially renewed. This is applied for all buildings, regardless of size, but the municipalities have practiced a spacious limit when new regulatory requirements will apply. The Ministry of Local Government and Modernization published a circular letter[3] clarifying the requirements when upgrading, to "Requirements () is generally limited to () those parts of the structure to which the measure applies". Hence, most small renovation projects falls outside the concept of applying the current regulation on the whole building but only, according to the guidelines, to the building elements where measures are applied.

The Norwegian building code was introduced in 1949 and energy efficiency was among the criteria. Since then the regulations for energy efficiency has been strengthened for every new revision. The building code is named after the year it was introduced, from TEK49, 69, 87, 97, 07 to TEK10. Minimum requirements in the Norwegian regulations are stricter than in most other European countries, and also stricter than e.g. insulation standard for frame requirement in many countries[4]. Therefore, the minimum requirements for current regulations, comply with the EU directive, apart from the weak requirement of U-values for windows. These minimum requirements, as only binding guideline for retrofitting, will not lead to an ambitious renovation, moderate component

[1] [1] Flæte O. et al, 2012.
[2] EU, 2010
[3] KRD, 2010
[4] Schild et al., 2010

requirements would on the contrary, in many cases, result in an unambitious renovation level, which consequently will lead to unprofitable additional energy renovations later.[5]

3 Building stock statistics

The estimated existing building stock in Norway consists of 3,8 millions buildings, 1,4 million residential buildings and 2,4 million other buildings. The total gross floor area (GFA) of the building stock amounts to 389 million m², of which 129 mill m² are non residential buildings[6].

The Norwegian non residential building stock has such owner structure[7]:

Private sector	61%
State bodies	10%
Regional authorities	8%
Municipalities	21%

There is a need of an extensive work on studying the present Norwegian building stock. This has been improved for the residential building stock over the last years. As for the non-residential buildings, this work is still to be executed. Detailed statistics of new buildings are relatively up to date, compared with information of existing buildings. Neither renovated nor demolished buildings have been registered in Norway in a larger scale[8].

3.1 Collection of building stock data in Norway

There are several institutes which have started to collect more detailed data of the existing building stock. Table 1 shows the floor area and energy use in different Norwegian databases.

Table 1.Floor area and energy useee different Norwegian databases.

	Floor area			Energy use		
	SSB Mill. m² GFA	Enova Mill. m² GFA	EPBD Mill. m² GIA	SSB GWh	Enova GWh	EPC GWh
Kindergarten	1,3	0,1	0,3	402	16	63
Office buildings	26,8	3,2	16,7	7,687	697	3,212
School buildings	13,9	3,0	6,0	3,747	473	1,089
University	2,4	0,1	2,2	732	24	502
Hospitals	4,8	1,0	1,4	2,075	318	528
Nursing home	5,2	0,8	2,0	1,909	183	572
Hotell and restaurants	5,7	0,6	1,9	2,168	162	515
Leisure centre	2,3	0,2	1,1	927	63	254
Commercial buildings	30,4	3,3	8,3	10,855	4	1,949
Cultural buildings	2,9	0,1	0,8	910	18	193
Other industry/ building	29,3	1,1	7,2	4,000	267	1,811
Total	**125,0**	**13,4**	**47,8**	**35,412**	**2,226**	**10,688**

[5] Hovin Kjølle K., 2013
[6] KRD. 2012
[7] Thue. 2003
[8] SSB and Prognossenteret, 2011

3.1 Enova

Enova is a public enterprise which is owned by the Ministry of Petroleum and Energy. It has programs and support schemes to motivate for more environmentally friendly consumption and generation of energy.

Building owners who receive financial support from Enova are obliged to report their annual energy use and other building information to Enova. These incentives started in 1997. By the end of 2012 Enova had registered 2119 non-residential buildings with a total energy use of 2226 GWh/year divided on 13,4 mill m^2.These buildings count for approximately 10 % of the total building stock of non residential buildings[9]. This is a useful source for more detailed information of buildings in different building categories, although the buildings are not directly representative of the building stock. Compared with other building stock analysis it seems that the buildings in the Enova program, with an average net heated floor area of 6300 m^2, has an over representation of larger buildings.[10] The database also only includes buildings participating in ambitious programs or support schemes with measures carried out.

3.2 EPC

The Energy Performance Building Directive, 2002/91/EC has been fully implemented in Norway since 2010. The scheme for the certification of buildings (EPC) is under the responsibility of the Ministry of Petroleum and Energy. The Water Resources and Energy Directorate (NVE) is the managing body for certification and inspection schemes. The EPC are set with regard to 13 different building categories, as also the Norwegian energy requirements.

Between the years 2010-2013 nearly 360 000 EPCs have been issued, whereas only 17 000 concern non residential buildings. The energy performance is a fictive thermal performancecalculation of the building, with standardized input of internal load, operating time and set point temperatures for heating and cooling. The certificate is therefore suitable for comparing the actual building with other buildings, disregarding the actual use of the building but not comparing with the actual energy consumption of the building. For existing buildings, you are required to inform of the total energy use the last three years.[11]

4 Typical buildings and building year

Dividing the non-residential buildings into building categories, the largest building area with almost ¼ each, is the industry and commercial buildings, followed by office buildings (figure 1). Though the industry buildings have the largest floorarea, they havea comparatively low energy use, disregarding the industry processes (figure 2).

[9] Enova, 2012
[10] Igor Sartori (21032014)
[11] Energimerking.no and Implementing the EPBD 2012

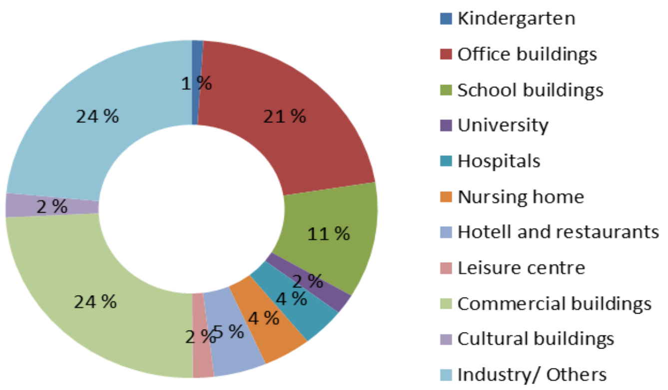

Figure 1 Distribution of floor area between different building categories in Norway.[12]

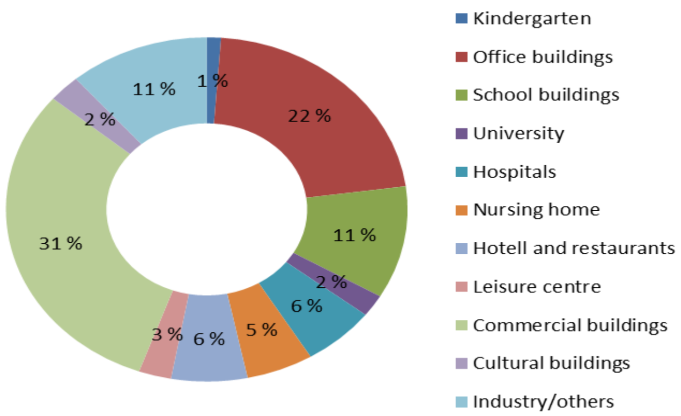

Figure 2 Energy use in Norwegian non-residential buildings per year, 1998-2010[13].

Most non-residential buildings in Norway are post-war buildings, built between 1945 and 1986 (figure 3). The theoretical statistics (SSB) shows that in the category commercial buildings and office buildings, 75% and 81 %, respectively of the total category is built before 1986. Many of these buildings, 20-65 years old, are in need of renovation, though the SSB do not have information about already renovated or demolished buildings. The commercial buildings and office buildings in the EPC database on the other hand shows that 53% and 77%, respectively of the total category of commercial building and office building have an energy certificate lower than label C (corresponding to present building code)[14], and have therefore a potential for energy saving.

[12] Enova, 2011, SSB and Prognossenteret,2011
[13] Enova, 2011, SSB and Prognossenteret,2011
[14] www.Energimerking.no, 2014

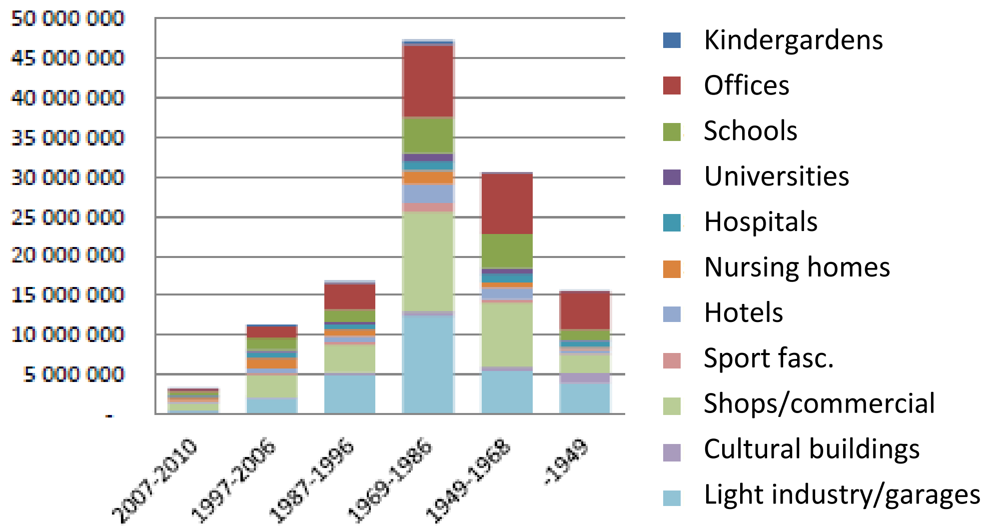

Figure 3 Floor area per building year and building category in Norway.[15]

5 Potential of existing non-residential buildings

There is no overview over renovated or demolished buildings in Norway today, thus the theoretical building stock, showed in figure 3, only provide information of which year the building was built, not building code it is actually achieving today, as some of the buildings have been renovated and other demolished.

The theoretical total energy use in 2010 was 35 TWh/year.[16] The report "*Potential og barrierestudie*", estimate an demolishing rate of 0, 5% and a new building rate of 1,5%. The theoretical potential for energy efficiency in the report is derived from the gap between the calculated delivered energy for the different building years and what the buildings would have performed if they were renovated according to current building codes (TEK10). The technical potential is the theoretical potential combined with an estimated part of 15% of the buildings stock that is unable to make a major renovation, including historical buildings. The technical potential reduces the energy potential from 21 to 19 TWh (figure 4).

The greatest potential lies in commercial buildings followed by office buildings, industry and school buildings, due to the total floor area. The greatest specific energy potential for a building (kWh/m^2) lies is industry, leisure centers and kinder gartens, which have the highest relatively rate, within the category, of older buildings and consequently high energy use (kWh/m^2).

[15] Enova, 2011
[16] Enova, 2012

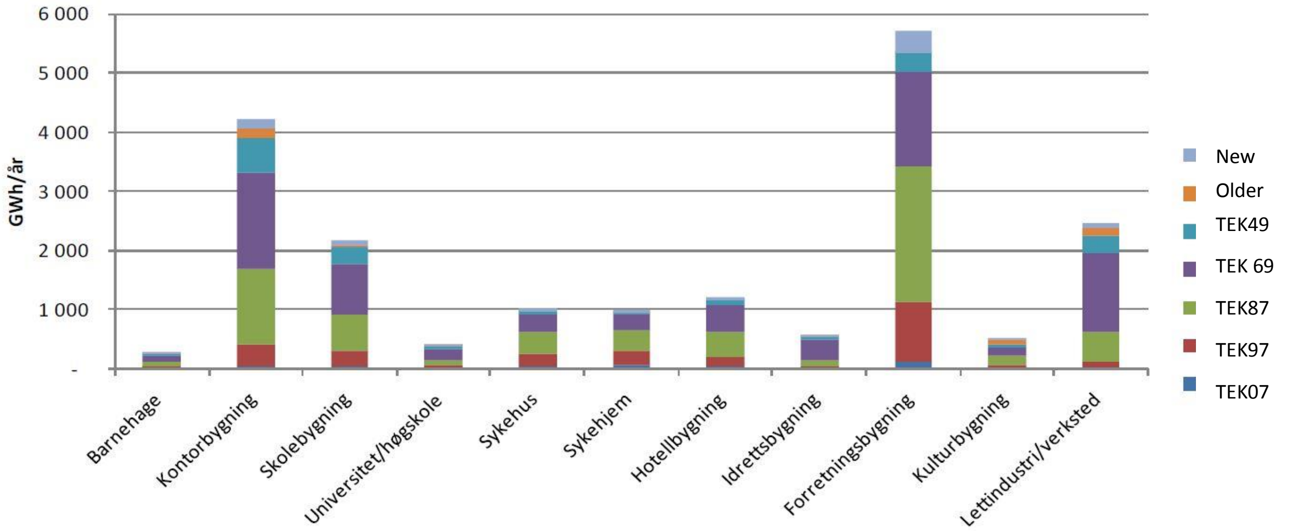

Figure 4 Technical potential for energy efficiency in 2020 in GWh, per building category in Norway.[17]

6 Building measures and economical potential

With an energy price of 0,8 NOK/kWh (approximately 0,1 Euro) the energy saving potential can be reduced from 19 TWh to 9 TWh. The main potential is still within commercial and office buildings. The highest technical potential lies in measures for the building envelope, but the economical potential is much lower due to the high investment cost. The biggest economical potential lies in measures in the ventilation/air conditioning followed by operating measures.

7 Real potential and barriers

The real potential for energy efficiency is the part of an economical potential, not naturally initiated, due to different barriers. The real potential also neglects the already triggered potential, with an estimation of an yearly upgrade rate of 1,5% and a refurbishing rate of 2%, towards 2020.
The concluded real potential for buildings up to 2020 is 5,6 TWh

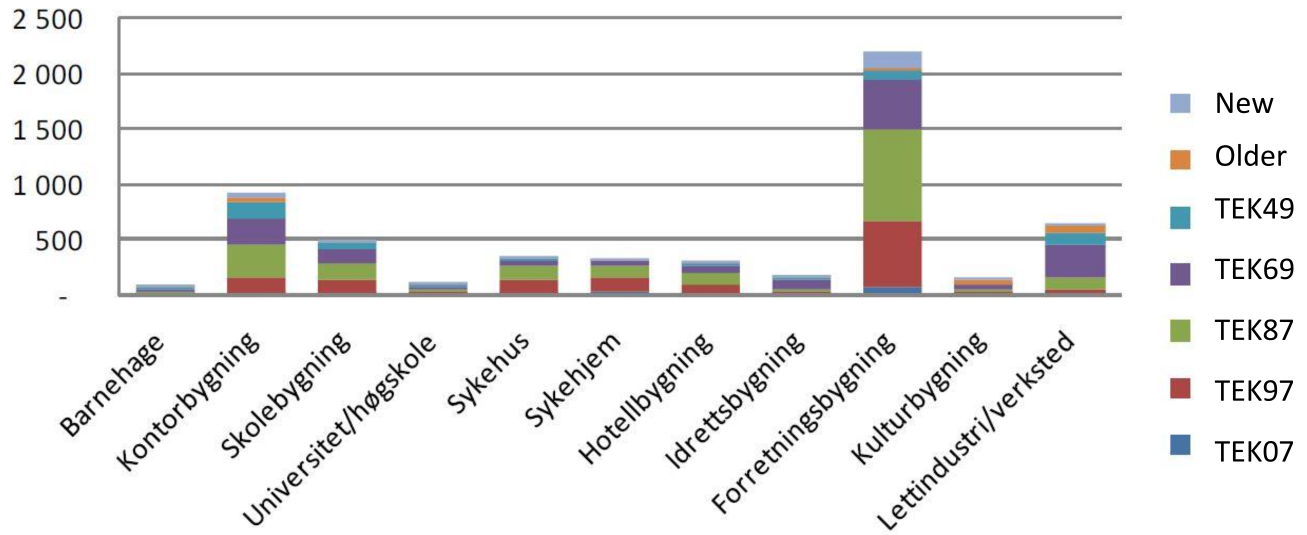

Figure 5 Economical potential for energy efficiency in GWh, per building category in Norway.[18]

[17] Enova, 2011

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[18] Enova, 2011

Annex 3: Italian non-residential building stock

Author: Ezilda Costanzo; ENEA

Introduction

There are about 13.6 million buildings in Italy, 13% for non-residential use.
Nearly 60% of the non-residential building-stock needs to be retrofitted, implying energy and functional renovation as well. Within the existing building-stock, a large share is built before 1960s where there were no requirements for energy efficiency. These buildings have low insulation levels and the technical systems are old and inefficient.
Most of them have undergone no renovation and only a small part of them went through minor renovation in the last 20 years.
Knowledge of the non-residential building-stock still presents several uncertainties on data quantity and quality, use patterns, changes occurred. Moreover the sector is affected by a consistent investment decrease due to the financial crisis (annual investments lowered by 20% from 2008).
Measures implemented according to the Italian NEEAP (National Energy Efficiency Action Plan 2007) produced 2,220 GWh/y savings at 2012, not achieving the expected halfway target and resulting only in 9% the fixed 2016 target 24,590 GWh/y (table 1).

Table 1– Energy savings at 2012 and 2016 targets (GWh/year) in the Italian NEEAP

Measures and savings	MEPS EPBD (GWh/y)	EET – White certificates (GWh/y)	55% Fiscal deduction scheme for Renovation	Savings at 2012 (GWh/y)	Target achievement 2012 (%)	Target 2016 (GWh/y)
Residential buildings	24,450	15,237	8.246	44,109	73,5%	60,027
Non residential	728	1,278	214	2,220	9,0%	24,590

Yet non-residential buildings constructed or even renovated according to current energy efficiency standards consume 70% less than a typical existing building. Hence, the sector, and notably renovation of the significant public non-residential existing stock subset, represents a priority at national and regional level.
At present, strengthened targeted measures are being developed in the context of EPBD and EED implementation (Energy Performance Contracts, Financial measures, Audit campaigns, Demonstration and exemplary renovation cases for public buildings, etc.)[19]
Better knowledge of the building stock and consumptions data availability in the public sector has led us to restrict the following analysis to this subset, with a focus on **public schools and offices.**

Non residential building stock features

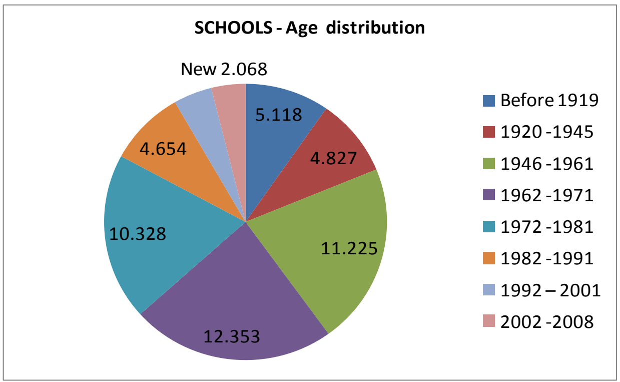
In Italy there are nearly 1,770,000 non-residential buildings and about 400,000 host recreational and sports activities, schools, hospitals and churches.
Nationwide, there are 51,904 **school buildings** - 42,000 are public schools. 30% of school buildings are concentrated in the 10 largest provinces (the top three are Rome, Milan and Naples). The total surface of school buildings is 73.2 million m^2 and their total volume is 256.4 million m^3.

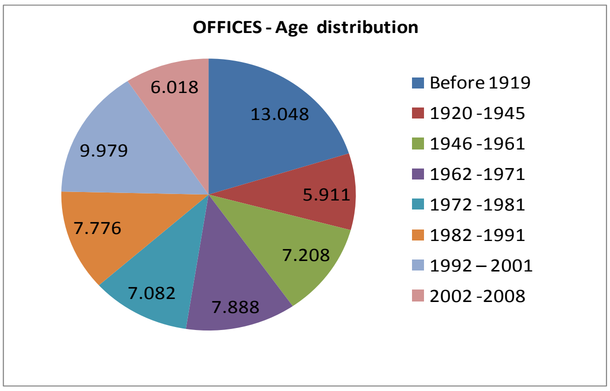
[19] Energy efficiency of buildings is a top national priority. The National Energy Strategy (NES), where Energy Efficiency is the first of seven priorities, targets 20 Mtoe savings of primary energy per year by 2020 and 15 Mtoe of final energy, reaching a consumption level about 24% lower than the levels projected at European level under the “business as usual” scenario (Primes model 2008). This will result in some 55 million tonnes of CO2 emissions saved per year.

The school building stock is obsolete: 10% were built before 1919, 67% before first Energy Law (1976), and only 4% comply with EPBD energy performance standards. More than 50% volumes (about 130 million m^3) are big-medium buildings (1.000 - 3.000 m^2), and 27% (69.5 million m^3) are huge surfaces (> 3.000 m^2).
The school building stock is characterized by low maintenance: its renovation is a key focus and a to solve insufficient safety together with functional and comfort obsolescence.
The structural typology is 67% mixed (reinforced concrete and masonry), 15% stone masonry, 14% stone and brick masonry. Schools in Italy have traditional heating systems (97%, fed by natural gas (73%), fuel oil (24%), electricity (1%), and biomass (0,8 %).

In Italy there are 64,911 **office buildings**, of which 13,581 are owned or occupied by public authorities (21%). The stock is not so modern: 20% were built before 1919, 50% before first Energy Law (1976), and only 9% were built after the 2005 EPBD reception.
Main structural typologies are reinforced concrete and masonry (85%) and glazed walls (6%). In 42 % buildings there is temperature control for each room.
The total surface is 56.7 million m^2 and total volume almost 200 million m^3. Most of office buildings are rather small (50.6% buidings'surface is smaller than 350 m^2).

Figure 1– Age distribution of school and office buildings in Italy





As regards **shopping centres,** according to estimates and interviews carried out on a representative sample, there are 1,114 commercial centres covering a gross area of slightly more than 16 million m^2.
Hotels account for 25,845 buildings. 30% are concentrated in the six top-ranking provinces of Rimini, Bolzano, Venice, Naples, Trento and Rome, and, in the last 8 years, their number has increased by 1.4%.
Italy has 76 **banking** groups, with 33,727 branches, scattered throughout the country and mostly occupying portions of buildings on the ground floor. Buildings wholly or largely used for banking operations are 1,469, with a total surface of 5.5 million m2.

Regulatory framework

EPBD derived criteria, calculation methods and minimum requirements for energy performance of buildings, heating and hot water systems, air conditioning and artificial lighting apply both to new buildings and to refurbishment of existing buildings.
The current minimum energy parameter values and thermal characteristics (transmittance and conversion performance values) will become more demanding on the basis of the results of the comparative methodology framework within Directive 2010/31/EU.
The minimum transmittance **U** required for building elements will be lowered by 15% compared to their current value starting from January 2016, and by another 15% from January 2021. A similar improvement will apply to the minimum performance of heating and conditioning systems.
For public buildings, the minimum requirements will be made 10% more demanding.
RES reception decree 28/2011 call for integration of renewable energy sources in buildings undergoing major renovation and having a useful floor area exceeding 1,000 m^2 undergoing.
The decree establishes, for major renovation, the obligation of using an annually increasing share of renewables to cover energy consumption for heating and cooling equal to 50% of the expected consumption for hot water and to 20% of total consumption for heating, cooling and hot water. This share will be increased to 35% starting from 2014 and to 50% from 2017.
As concerns electricity it is compulsory to install power from renewables which varies according to the area of the building multiplied by a coefficient which increases from now to 2017: 1 kW every 80 m^2 by 31 December 2013, 1 kW every 65 m^2 up to the end of 2016, and 1 kW every 50 m^2 from 2017.

Energy features of non-residential stock:

- Non residential buildings are responsible for 1/3 energy consumptions of the building sector
- Consumption is continuously increasing and rose from 9,5 Mtoe or 110.5 GWh/year (2005) to 18,9 Mtoe or 219.8 GWh/year (2011)
- Electricity consumptions have doubled compared to 1990, mainly due to cooling and appliances use
- Main energy sources are almost exclusively gas (50.4%) and electricity (45.4%).
- Understanding energy use is complex, as end-uses such as lighting, ventilation, heating, cooling, refrigeration, IT equipment and appliances vary greatly from one building category to another
- Building typologies are quite different in the different geographic and climatic zones.
- Obsolete existing buildings consume 70%-80% more than new buildings

Italian climate is Mediterranean subtropical in the South and temperate continental in the North. Given the diversity in climatic conditions, minimum performance standards for buildings (EP) and U value requirements for components vary in according to 6 climatic zones (A-F).

Table 2 - Consumption weighted by climatic zones

Use	Electric consumption kWh_{el}/m^2 a	Thermic consumption kWh/m^2 a	Measured consumptions kWh/m^2 a
Schools	50	130	220
Offices	95	170	320
Commercial Centers	330	45	-
Hotels	110	150	-
Commerciali Builings	185	80	-

Saving potential of non-residential buildings: focus on public schools and offices

Renovation of public buildings is a priority in the short perspective of EU EPBD and EED reception and due to the relevance of surface and volumes.

Better knowledge of the building stock, audit and consumptions data availability has led us to focus the analysis to public schools and offices.

Analysis of saving potential was performed considering:

- Building typologies
- EP (kWh/m2 a) related to climatic zone and the most obsolete/low energy performing buildings
- An aggregation model for buildings

Table 3 - Reference school and office building type assumed for the analysis

Reference Type		School Buildings	Office Buildings
Volume	m^3	11,700	6,000
Ground floor surface	m^2	900	500
Envelope	m^2	3,490	-
Opaque surface	m^2	1,183	-
Transparent surface	m^2	507	-
Floor height	m	4.25	4
Total Height	m	13	-
S/V (shape factor)	$(1/m^2)$	0.3	0.35

The following renovation measures have been taken into account, and prediction based on MEPS 2010 and results of current incentivizing schemes:

- Envelope insulation
- Windows replacement
- Retrofit of the Heating System (thermostatic valves)
- Boilers replacement
- Solar Panels for DHW
- Solar shadings and protections
- BEMS
- Lighting systems (High Efficiency Lamps)
- Renewable integration

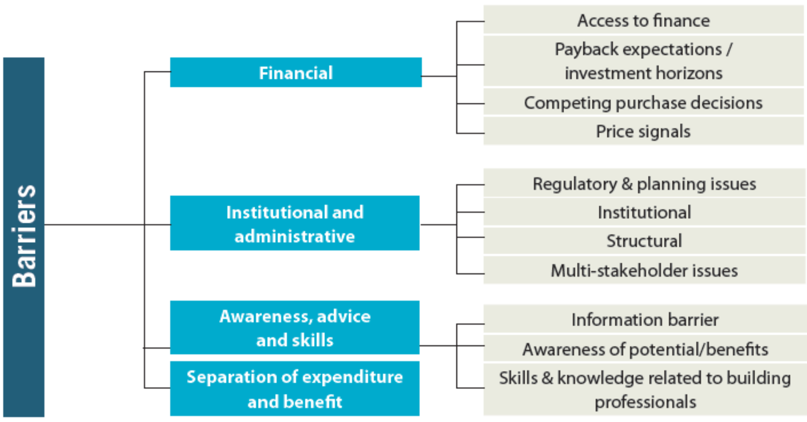
Potential annual savings for public schools and offices are shown in table 4:

Table 4 - Savings estimated by renovating public schools and office buildings

SCHOOLS (Annual savings at 2020)	OFFICES
0.39 Mtoe (4,53 GWh/year)	0.16 Mtoe (1,86 GWh/year)
33,36% public schools consumptions	23,27% public offices consumptions

The specific annual average saving of a non-residential buildings (considering less performing buildings that are nearly 22,000 public schools, 6,000 public offices, 10,500 hotels) has been estimated as 0.35 GWh/year.
For the total non-residential building stock, hypothesising renovation of 1% buildings raised by upcoming promotion and financial measures, the estimation is 1100 GWh/annual savings at 2020 and cumulated 28,000 GWh

Most important barriers to retrofit in Italy (to be developed if required)



Financial barriers:
The most ambitious retrofits will undoubtedly require considerable upfront funding. For older buildings this considerable investment can have positive impact on the asset value, especially where energy efficiency retrofits also other building performances (aesthetics, comfort, safety, functional). A set of measures including PPP is at study to overcome the crisis of the sector.

Institutional and Administrative barriers:
Fragmentation, delay and gaps in the regulatory action of public planning have not allowed the public sector to be the driver for improved energy efficiency in buildings as it should be. Programs responding to the NES, opportunities in EPBD and EED implementation as well as the new Cohesion Policy 2014-2020 are imminent opportunities for improvement. Regions, being delegated to energy policies in Italy drive innovation and change.

Awareness advice and skills – Separation of expenditure and benefit
Low centralization, different effectiveness at regional level, capacity building (within EC initiatives Build-up skill and following), stakeholder engagement and communication/awareness of consumers.

References:
1. Data provided by ENEA to BPIE EUROPE’S BUILDINGS UNDER THE MICROSCOPE
2. Consolidated information from the Member States on Nearly Zero Energy Buildings: Italy

Annex 4: Questionnaire decision-making processes

SUBTASK B

TEMPLATE QUESTIONNAIRE FOR

- *DECISSION MAKING PROCESSES IN CASE STUDIES*

Start all interviews with an open question:

How would you sum up as the most interesting learning from this project?

1. Technicalities in short

(more detailed technical descriptions will be made in Subtask A and/or C)

- Type of building (eg commercial, retail, school, etc)
- Year Built
- Renovation completed (if multiple renovations, list dates of major or significant renovations)?
- Total cost of the renovation project (in local currency and Euro).
- Energy use in kWh/m2 before and after the renovation – please specify what is included in the numbers (if not completed what is the target?)
- Function of building, before and after
- Who uses the building, before and after
- Does the project include any EPC (EnergyPerformanceContract) elements?

2. Project Stakeholders and Participants

List the project participants/stakeholders, their role and the degree of influence they had in the project.

Participant (Name and organisation)	Role (project title)	Influence (decision maker, influencer, technical, advisor, delivery)

2.1 Building-owner

- Name
- Type of organization (government organization, publicly listed company, private company, utility, etc)
- Key financial figures (applicable only for companies)
  - Total annual revenues for the 2 last years
  - Profit before tax for the 2 last years
  - Equity ratio (net equity/total assets x 100)
    - Net equity in Euros for the last year
    - Total assets for the last year
- Key persons in this project representing the owner
  - Qualifications
  - Type of professional experience
  - How many years employed in the company
  - Relevant networks related to this project
  - What was the motivation for the person(s) to be involved in the project
- At what level was the decision to launch the project made?
  - Technical department or workgroup level eg Division or Facility Manager
  - Administrative/Operational or business unit level eg General Manager
  - Board Level
  - Ministerial (political)
  - Other, please specify
- At what level was/is the decision made regarding the desired outcomes
  - Technical department or workgroup level eg Division or Facility Manager
  - Administrative/Operational or business unit level eg General Manager
  - Board Level
  - Ministerial (political)
  - Other, please specify
- What is the general mission of the company / what is the general policy of the public authority
- Does the organization have an overall strategy with respect to energy efficiency in their building(s)?
  - If yes, please specify?
- Does the organization have an overall strategy regarding sustainability standards (such as BREEAM, LEED…)?
- Does the organization have previous experience with low energy buildings?
  - New buildings
    - Passive House standard
    - Low energy standard,
    - Other standards – please specify.
  - Existing buildings
    - How many renovation-projects, which include a strong focus on energy efficiency, has the organization undertaken?
    - What is the documented energy performance in KWh/m2 before and after renovation for the projects?

2.2 Main contractor/builder

- Name
- Main owners (part of bigger group or independent)
- Key financial figures
  - Total annual revenues for the 2 last years
  - Profit before tax for the 2 last years
  - Equity ratio (net equity/total assets x 100)
    - Net equity in Euros for the last year
    - Total assets in Euros for the last year
- Key persons in this project representing the builder
  - Qualifications
  - Type of professional experience
  - How many years employed in the company
  - Relevant networks related to this project
  - What was the motivation for the person(s) to be involved in the project
- What is the general mission of the company
- Does the company have an overall strategy saying something about the quality with respect to energy efficiency in the projects they offer their customers?
  - If yes, please specify?
- Does the enterprise have an overall strategy regarding sustainability standards as:
  - BREEAM, LEED…?
  - QA procedures/ISO standards?
- Does the company have previous experience with low energy buildings?
  - New buildings
    - Passive House standard
    - Low energy standard, but other level – please specify.
  - Existing buildings
    - How many renovation-projects, which include a strong focus on energy efficiency, has the organization undertaken?
    - What is the documented energy performance in KWh/m2 before and after renovation for the projects?

2.3 Design team (architect/technical consultant)

- Name
- Main owners (owned by employees or bigger company)
- Key numbers illustrating the size (# employees or total turnover)
- Number of advanced renovation projects
- Key person(s) in this project
  - Qualifications
  - Type of professional experience
  - How many years employed in the company
  - Relevant networks related to this project
  - What was the motivation for the person(s) to be involved in the project
- Experience with sustainability standards and energy efficiency?
- QA procedures/ISO standards?

2.4 Other key stakeholders/participants in this project

- Please describe the other participants playing an important role in this project:
  - Occupants (if other than owner)
  - Subcontractors (please specify)
  - Public authorities (please specify)
  - Suppliers of energy efficient components, systems, materials, labels as ECO-label, etc
  - Do these have any sustainable labels/ratings?
  - Other (please specify)
- Checklist for description of each other important particpant:
  - Pick relevant questions from 2.1 - 2.3 above

2.5 Other stakeholders (than the most important ones) in this project

- Please describe other stakeholders which influenced the decision for realizing the project, the target outcomes, or during the renovation process:
  - Occupants (if other than owner)
  - Architect/Technical Advisor (company or person)
  - Subcontractors (please specify)
  - Public authorities (please specify)
  - Other (please specify)
- Checklist for description of other actors:
  - Brief description of the participant and how/why it influenced the project

3. Decision making process

The questions below are to be addressed respectively to the key person in the owner organization and the key person on the supplier side (main contractor) and/or architect. This has to be done independently, in order to check if the different stakeholders have experienced this differently.

- Why renovation instead of demolition?
- Who initiated this project?
  - The owner (specify who in the organization)? or
  - The main contractor? Or
  - Other (please specify)?
- Why was it initiated?
- Was the intention from the beginning to focus that strongly on energy efficiency?
  - Yes/No
  - Please provide more detail
- Were alternative solutions/strategies analysed? If Yes:
  - Describe the alternatives
  - What were the reasons for choosing the final solution over the alternatives?
  - If not, why not?
- Were there other reasons than energy efficiency matters for starting the project? Such as:
  - Poor façade
  - Poor occupant comfort due to:
    - Indoor temperature (low/high)
    - Air quality
    - Moisture problems

        - Noise from outside/internal
        - Other (specify)
    - Existing tenant(s) need extension and/or change of building use due to operational changes
    - New tenant with different needs for the building
    - To create a positive image for the organization
    - Other reasons (please specify)
- How would the owner's decision maker weight the relative importance of each reason for initiating the project?

	Very important	Important	Some importance	No importance
High energy costs				
Poor façade (performance, aesthetic, comfort, glare etc)				
Indoor comfort				
Availability of subsidies				
Request by tenant				
Organization objectives/policy				
Other, please specify: .				

Mark with X

- During the planning process, the building owner gained new knowledge and experience. Based on this experience, would they rate the importance of reasons for initiating the project differently today? If yes, please quantify as above. (Mark with a circle)
- What type of formal research/analysis/calculation was undertaken and presented as the foundation for the final decision making?
- What type of informal information influenced the decision?
- If not already answered, please describe the importance of
    - public information campaigns (very important/important/some importance/no importance)
    - financial incentives - incl tax deductions (very important/important/some importance/no importance)
        - If financial incentives were received, how much in Euros and in percentage of total renovation costs. Please also describe how the grant was calculated (for example; as a fixed percentage of the investments related to ventilation, insulation and windows?).

4. Renovation process

- Was the building occupied during the renovation process?
    - No/Yes
    - Partly (please describe)
    - If no:
        - Did the previous tenant end the contract and move elsewhere.
        - Did the owner of the building end the contract so the tenant(s) had to move.
        - Did the tenant(s) move to temporary accommodation organized by the owner.
            - If yes, please describe how this was dealt with.
                - Other reasons, please specify
- If the building was occupied during the renovation period, please answer these questions:

  - How were the occupants involved in the planning of the renovation process?
  - What type of communication activities were undertaken with the occupants during the renovation period/process?
  - Did the occupants have to move internally within the building during the process?
  - What were the challenges during the renovation phase with respect to the occupants?
  - How were these challenges overcome?
  - What were the positive experiences from the renovation phase? List
  - What were the benefits of these positive experiences
  - How was the renovation phase perceived by the occupants? (This question should be addressed also directly to representative(s) for the occupant(s), in addition to the building-owner and the main contractor (in order to get different perspectives).
- What were the unexpected challenges during the renovation phase?
  - Did such issues result in major changes to the planning and delivery process?
  - How was this dealt with in respect to:
    - Change in renovation strategies?
    - Communication with the key stakeholders (and did it bring in other influencers/participants in the process)?
    - Financially?

5. Summary of experiences

- What would the owner of the building highlight as:
  - The biggest challenge in the decision making phase of this project?
  - The most challenging during the renovation delivery phase?
  - Do they consider the project a success?
  - What were the main reasons (driving forces) for it being a success or failure?
  - Will they start a new/similar project in the future based on the basis of their previous experience?
  - Would they recommend such projects to others?
    - Why/why not?
  - Do you have any recommendations/suggestions to national and local authorities based on your experiences from this innovative project?
- What would the main contractor/builder point out as:
  - The biggest challenge in the decision making phase of this project?
  - The most challenging during the renovation delivery phase?
  - Do they consider the project a success?
  - What were the main reasons (driving forces) for it being a success or failure?
  - Will they start a new/similar project in the future based on the basis of their previous experience?
  - Would they recommend such projects to others?
    - Why/why not?
  - Do you have any recommendations/suggestions to national and local authorities based on your experiences from this innovative project?

Comment: the same list of questions should be addressed to other key participants involved in the project (this could also be tenant(s)).

Finally, please summarize the milestones of the project:

1. Initial idea launched: date
2. First version of the project plan: date
3. Final version of the project plan date
4. Decision to start the project date
5. Start up renovation date
6. Renovation project completed date

Follow up questions to the timeline above:

1. Did the decision making process take longer than they expected?
2. Did the renovation process last longer than expected?
3. Were there initial resistance (or skepticism) from any of the participants (persons), and did the attitude to the target outcomes change during the process?

Annex 5: IAG House, Sydney, Australia Decision-Making Process

1. Introduction

The following case of study analyses the retrofitting building, IAG House, located at, 388 George Street, Sydney CBD, Australia.

The case consisted in the upgrade of services for an existing commercial building, aiming to increase the energy and water performance under the two schemes existing in Australia, namely Green Star and NABERS.
The renovated property is a 35-storey building built in 1976 and renovated in 1996. All the services at the moment of the last renovation in 2008-2009 dated from the renovation in the mid 1990s. The services replaced were mainly located in the plant room, such as: chillers, pumps, fans, cooling towers and also the Building Management System. The renovation achieved the desired goal set for the renovation of 4.5 Stars, reducing its energy consumption in more than 50% going from 159,44kWh/m^2/year to 72/m^2/year. The rating also considered GHG emissions as an integral part of it, which were also decreased around 50%.

The analysis of the decision making process was carried out through literature review and public information available about the involved companies. An interview to the consultant´s Industry director; Lester Partridge under the Task 47 subtask-B was the main resource to elaborate this report. Additional information from interviews was not feasible due to

privacy policies of the other companies involved in this case of study.
All information and benchmarks are shown as per NABERS rating.

2. Milestones

These are the milestones for the project:

- Initial idea launched: 2006 (18 months project)
- Final version of the project plan: 03/2008
- Decision to start the project (as class A/PH): 03/2008 (straight away)
- Start up renovation: 2008 (12 months)
- Renovation project completed: 2009
- Monitoring for NABERS rating: 2010

3. Technicalities in short

Facts about the project:

- Originally built: 1976
- First Renovation: 1998
- Last Renovation: 2009 (only services)
- Original architect:
- Renovation consultant: AECOM
- Employees in the building before renovation:
- Type of building: A grade commercial office building
- Space before: 38,743m^2
- Space after: 38,743m^2
- Measured before: 159,44kWh/m^2/year
  2.5 stars NABERS
  GHG emissions 141kgCO_2/m^2/year
- First planned: 100kWh/m^2/year
  4.5 stars NABERS
  GHG emissions 95kgCO_2/m^2/year
- Final plan: 72kWh/m^2/year
  4.5 stars NABERS
  GHG emissions 73kgCO_2/m^2/year
  (5.0 stars GHG emissions benchmark = <70kgCO_2/m^2/year)
- Total cost: yy Mill (€zz m)
  - No grants nor subsidies considered

	Current	Post Upgrade	Savings
Base Building CO_2	4,900 tonnes	2,500 tonnes	2,400 tonnes
Tenancy CO_2	4,700 tonnes	2,400 tonnes	2,300 tonnes
Water	52ML	40ML	12ML

Table 01: Calculated CO_2 emissions

The renovation aimed to upgrade the building services of the building to increase its NABERS rating, from 2.5 stars to 4.5 stars from a maximum of 6. The following list of service improvements where simulated separately, assessing the impact of each one of them in energy and water consumption.

Chillers

- Variable speed compressors
- High COP (extended evaporator vessels to enhance heat exchange)

Water pumps

- Replace either chilled and condenser water
- Variable speed circuits
- Variable speed drives (VSD)
- High efficiency motor

Fans

- Provide VSDs
- High Efficiency motor
- Lower Static Pressure
- Low air flow

Cooling Towers

- Install VSDs
- High efficiency motors
- Depressed wet-bulb return water temperature to chiller
- Control to run in parallel

Lighting

- Reduce power in common areas from 15W/m^2 to 10W/m^2, replacing tungsten to compact fluorescent
- Reduce power consumption in tenancy areas from 12W/m^2 to 7W/m^2 by means of a PIR (intelligent control system)
- Occupancy sensors
- Perimeter daylighting harvesting, (no changes in façade)
- Evaluate Combined Heat and Power (CHP) decision to increase energy consumption with trigeneration in order

to reduce GHG, as electricity in Australia comes from Coal, therefore gas has less emissions.

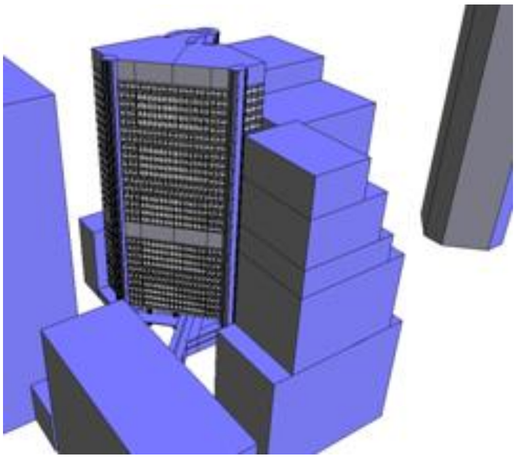


figure 01 : 3D model

4. The main actors

The following case of study actors are companies operating across the globe, dedicated to large scale business and with defined objectives, strategies and commitment to sustainable practices.
In regards of energy efficiency and sustainability, the rating systems become a relevant part of the strategy used for the case of study, as it represents at what level is the company positioning in the market. Considering the explicit commitment to climate change and the importance of delivering and offering services related to sustainability, the decision making process can be tracked-down to the highest levels of administration, and then assessed in detail at local instances.

4.1 Name of the tenant: IAG and NRMA Insurance Companies

Ownership

The Insurance Australia Group is the parent company which under operates several insurance companies in the Australasia region, China and India. The company has around 13,500 employees and a GWP of 10 billions per year.

Business Concept

In Australia the company distributes insurance either for personal and commercial customers through a structure of two different models, as direct products and also as an intermediator.

Company's strategies/goals related to sustainability

On their website the company states a commitment to sustainable business and it is also defined as one of their principles, considering the interests of their clients, the community and the environment.
Their approach to sustainability is to recognize the effect of changing natural perils and also to deliver sustainable outcomes for their claims. In regards of the natural environment there is an explicit commitment on reducing CO2 emissions per full time equivalent employee and also carbon neutrality on their operations. (Insurance Australia Group, 2014)
The company publishes in a yearly basis a Sustainability Report.

4.2 Name of Landlord: Brookfield Office Properties

Ownership

The owner of the studied premises is Brookfield Office Properties, a subsidiary company of Brookfield Asset Management. The real estate corporation owns, manages, and develops premier assets mainly at downtown locations across many cities, in different countries, such as: U.S.A., Canada, U.K. and Australia. In terms of space Brookfield owns worldwide more than 7mill. sqm of lettable office space, from where a ±10% represents the Australian market (743,000sqm). In addition and in regards of the size and its human resources, the company reports around 2,250 employees for the office properties branch. (Brookfield Office Properties, 2014) (Wikimedia, 2014)

Member of green networks
Brookfield defines three principles towards environment protection and sustainable growth, which are:

- develop, operate, design and retrofit to achieve optimal energy efficiency, reduce carbon emissions and deliver high standars of IEQ (indoor environmental quality)
- incorporate innovation in environmental strategies to achieve best performance in the industry
- pursue best-class certification and actively participate in green industry organisations

Brookfield is part of the following organisations in Syndey and most of its portfolio includes high ratings in sustainable rating tools:

- Better Buildings Partnership, is a partnership of public and private entities, including investment corporations, contractors, the City of Syndey Council and also Univeristies. Their Objectives are: collaborative work to improve sustainability of Sydney; improve the energy, water and waste efficiency of buildings within LGA; facilitate connection to green infrastructure, such as trigeneration and recycled water networks; to engage with environmental policies and regulations; promote aims of Sustainable Sydney 2030. (Better Buildings Partnership, 2014)

LEED – 37 properties in USA.
BOMA Best – 100% properties in Canada.
Energy Star – 85% of USA properties.
NABERS – 80% in Australia ≥ 4.0 stars.

Business concept
Environmental initiatives are stated in their website to be major component of Brookfield's Strategic business plan, and defined as high priority key business objectives.
Decision making by the company is said to be pursue a balance in fiscal and environmental responsibilities.

Company's strategies/goals related to sustainability
Brookfield Commercial defines a commitment to sustainability which aims to deliver services that are: environmentally friendly responsible, that prevents pollution and also promote sustainable practices.
The particular case consider the following sustainability initiatives:

Services
- CO_2 monitoring linked to the Building Management System (BMS) ensuring fresha air provision.
- Installation of a BMS to improve efficiency in HVAC operations
- Upgraded and updated fire services

Energy
- SMART metering with online monitoring
- Major uses of energy have been separately metered for management purposes
- Boiler system with centralised heating disable local VAV electric heating
- Lighting programmed control system

• Variable Speed Drives (VSD's) to operate on-demand in base building.

Water
• Rain water harvesting system for cooling tower water top-up
• Water saving fittings in toilets
• Water meters have been designed to monitor and manage water consumption. (Brookfield, 2014)

4.4 Name of Contractor: Brookfield-Multiplex

Ownership
Brookfield-Multiplex is an international development and contracting company specialized in large scale complex buildings. Their operations started in Australia in 1962 and have spread to the Middle East, Asia, Europe and Canada. Financial support comes from its parenting corporation: Brookfield Asset Management.
In the Australasia region the company has 1,221 employees in 5 offices. (Brookfield-Multiplex, 2014)

Member of green networks
GBCA Green Building Council Australia
Green Building Companies Australia
Better Buildings Partnership

Business concept
The approach of Brookfield Multiplex is through integrated services, collaborative work and innovation.

Company's strategies/goals related to sustainability
Brookfield-Multiplex base their sustainability strategies in a holistic approach, and covering a triple bottom line defined as: financial, environment and community. As part of their engagement with this idea of the triple bottom line, they have joined the Salvation Army Employment Plus to ensure socially responsible employment practices. Their management systems complies either with Australian Standards as well as other international standards like ISO. Research has also been stated as an important component in the collaborative work of this company. (Brookfield-Multiplex, 2014)

Key persons for this project:
Owen Grace
Position
Sustainability Coordinator at Brookfield Multiplex Australasia
Role in this project
Project Manager

4.5 Engineering Consultant: AECOM

Ownership and business concept
AECOM is an international company providing services in engineering, design, construction, consulting, environmental, planning and government services. It has built a reputation as to be a leading company worldwide.
AECOM was created in 1990 by Richard G. Newman by merging a series of other enterprises from Ashland Inc. and the onwards has incorporated more than 40 companies becoming one of the largest in the world.
AECOM´s approach to work is multidisciplinary, defining their mission as to create, enhance and sustain. The firm has approximately 45,000 employees and is located in more than 140 countries in the world.

Member of green networks in Australia

- Australian Green Infrastructure Council (AGIC), Foundation Members
- Australian Water Association (AWA) (Aecom, 2014)
- Green Building Council of Australia (GBCA)
- Water Services Association of Australia (WSAA)

Company's strategies/goals related to sustainability
AECOM explicitly states a commitment to sustainability on its website. Their mission is defined as to help, clients and society to manage natural, financial and human capital, with the aim of minimizing risk while advancing gin progress. AECOM regularly publishes a sustainability report and has partnered with the Carbon Disclosure Project working in collaboration to reduce GHG. (Aecom, 2014)

Key persons for this project:
EOIN LOUGHNANE
Position
Technical Director at AECOM, career has focused on sustainable building design, He provides nationwide support for AECOM's energy modelling professionals.
Role in this project
Design team leader
Education
National University of Ireland, Galway B.E., Mechanical Engineering, Chartered Mechanical Engineer, National Australian Built Environment Rating Scheme (NABERS) accredited assessor.
Experience
Design management, commercial building design, energy auditing, building upgrades, contract negotiations, operations management.
Previously ARUP Engineers 2001 – 2003 (Linkedin, 2014)

LESTER PARTRIDGE (interviewed)
Position
- Industry Director of AECOM Buildings
- Global Director of the Applied Research and Sustainability group

Education
- Mechanical Engineering Degree BE(Hons), University of Sydney
- Adjunct Associate Professor - University of New South Wales

Affiliations
- Institute of Engineers, Australia,
- Fellow IEAust, CPEng, NPER, National Australian Built Environmental Rating System, (NABERS) Accredited Assessor,
- Green Star Accredited Assessor,
- Committee Member of the NSW Chapter of CIBSE-2003 -2005,
- Member of the NSW PCA Sustainability Committee 2002-2004,
- Member of the Editorial Board of the Council of Tall Buildings and Urban Habitat (CTBUH),
- Committee Member of the Research Working Group for the Council of Tall Buildings and Urban Habitat (CTBUH),
- Technical Advisor for the CTBUH 2012 World Congress, Shanghai,
  Research Funding Peer Review Panel for the inaugural CTBUH research seed funding program,
- Board Member of the Cooperative Research Centre (CRC) for Low Carbon Living UNSW.(Linkedin, 2014)

5. The decision making process

Motivation
The motivation for the studied retrofitting case started from the tenant, an insurance company which at the time was recognising the effect of climate change in their business, therefore were looking to make a statement on the way they operate their business. The aim of the company is to link their operations with sustainability, which can explain the desired target of 5.0 stars under the performance rating skill as the main driver of the renovation, although a project rating was also assessed (green star). By achieving a given score in the NABERS scheme, the company´s premises can then be easily compared to other similar office spaces, and at the same time denotes commitment from the company with sustainable development.
Decisions were made at board level, after analysing a business case. The way works were carried out evidence that tenant was not aiming to vacate the place while retrofitted, thus works carried out mainly in plant room and in off-working hours caused minimum disturbance.
In regards of the time the renovation was carried out as soon as the technical decisions and definitions were made. This decision can be explained from the policies on sustainability of the tenant and owner of the premises. (Partridge, 2014)

Stakeholders Sustainability Approach
All firms involved promotes sustainability and their initiatives consider:

- Certifications
- Commitments
- Research

This condition stated by all the companies involved relates to the fact that the building was aimed to be certified on both of the major and existing rating systems in the Australian Market.

Previous Experiences
Clients and consultants have had previous experiences on working together, the key engineer in the design of the services was requested by the client. This fact can be considered as a clue on decision making process in a level when the aim is to define work teams, acknowledging a human factor component and considering desirable to extend and replicate positive experiences. (Partridge, 2014)

Costs and economic decisions
From table 02, it can be observed that from the various levels of refurbishment studied by the consultant the most cost effective solutions was Level 3, related to obtaining 4.5 stars. Although the IRR was at the highest level if compared to the other levels evaluated. On the other hand it represented the best relationship between costs, property increase in value and GHG emissions offset at a level of complexity that would not consider major works on the building as altering facades or incorporating equipment such as tri-generation. (Partridge, 2014)

	Do nothing	Level 1	Level 2	Level 3	Level 4	Level 5
Capital upgrade (per m2)	$0	$35	$226	$980	$2040	$3000
NABERS Star Rating	2.5 star	3.0 star	4.0 star	4.5 star	5.0 star	5.0 star +20%
$kgCO_2/m^2$	150	130	100	85	70	55
IRR (10 yr DCF)	3.9%	4.2%	5.1%	10%	9,1%	10%
Increase in Building Value	0.0%	1.5%	6.5%	10.3 %	8,2%	15.0%
Cost per $kgCO_2$	$0.0	$1.75	$4.52	$15.1	$25.5	$31.58

Methodology
The methodology used by the consultant was able to deliver accurate results for the performance of it, previous to the renovations. Assessment of enhanced performance potential without any modification and also assessment of a series of possible alternative solutions to achieve the desired goal of the 5.0 stars rating.

The methodology used by AECOM can also be considered reliable and consistent as have been used for many years at the practice and also the head of the project stated that the approach nowadays would be exactly the same. (Partridge, 2014)

The methodology also considered evaluating all the listed services in point 3 as separate strategies, therefore assess the impact of each one of the systems against the desired outcome. This method made possible to define different set of solutions that reached the desired rating, then to be evaluated against costs and also determine complexity in terms of installation. As an example, the CHP (combined heat and power) proposed with the incorporation of a tri-generation system, although it was evaluated, it did comply with the benchmarks established by NABERS as the better solution in regards of GHG emissions, finally it was decided not to install it due to other issues, mainly economical derived from the complexity of installing a system like that.

Rating Tool targets
Consultants targeted the desired Energy rating score with a 0.5 increase to the level desired, in order to allow for any issue that might appear during operation of the new system, either related to the equipment or management.

Technical decisions
Technical decisions were informed from the monitoring of the existing building and also the simulation of it. Once decided which services should be updated according to where the greater potential was feasible, consultants provided specifications in terms of the desired performance required for the new equipment. Afterwards, equipment was decided according to specifications and availability on the market. (Partridge, 2014)

6. Lessons learned

6.1 Introduction

Highlights in the decision making process for this case of study is related to the straight- forward process followed in the renovation projects. Virtually no important barriers were found for this specific case. Both of these factors can be related to the alignment of the companies having an understanding and clear goals in what was desired to obtain when retrofitting. This process is heavily supported by both rating tools in the Australian case, especially NABERS rating as it measures performance from the actual building.

6.2 Important drivers

There are two factors that can be identified as the main drivers for the decision making process. One of these can be considered an explicit response to the tenant request, and also an implicit component can be observed in the fact that all companies involved in primary decisions were aligned in terms of awareness and responsibility of their practices on climate change.

	Very important	Important	Some importance	No importance
High energy costs		X		
Poor façade				X
Indoor comfort			X	
Availability of subsidies				X
Request by tenant	X			
Organization objectives/policy		X		
Other, please specify: RATINGS reduce energy and water consumption	X			

Table 03 : 3D model of the case of study

6.4 Main conclusions

The case of study analysed the decision making process for a renovation of an existing building exclusively on their services.

Clear defined commitment and approach towards sustainability of each of the actors allowed for a continuous process when deciding to study and carry out the renovations. Additionally computer simulation allowed for an informed decision process, being able to analyse different levels of intervention and also array of solutions to be implemented.

Finally, available energy and performance rating systems made possible to have clear target when deciding to what extent renovation should be carried out, which also delivered outcomes related to emissions measuring performance not only from an economical point of view but also from how less the building would contaminate after retrofitting it.

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Figures References

Cover:

http://brookfieldofficeproperties.com/au/sydney/sydney-cbd/iag-House

Lester Partridge, AECOM

Figure 01: Lester Partridge, AECOM

Annex 6: Science-Montoyer, Brussels, Belgium Decision-Making Process

1. Introduction

There exist very few outstanding examples of ambitious renovation projects in the non-residential sector in the world. The IEA SHC Task 47 studies the best demonstration projects in the seven participating countries. In subtask B the decision-making processes are studied in particular.

The studied building lies in the heart of the European quarter in Brussels, on the crossroad between the Science Street and the Montoyer Street. The building consisted of around 6,700m² spread over 8 floors and with 2 parking floors below ground. It is owned by Befimmo, one of the largest fixed-capital real estate investment trusts in Belgium. It was occupied by part of the Belgian Government administration through a long-term lease contract. The building had never been renovated before, except for standard maintenance, so there was no insulation, no ventilation strategy, and no energy efficient glazing. To quote the architect Aldo Sanguinetti from Arte Polis: “in other words, it really was an old building.”

Most interesting about this project is the fact that the upgrade towards a sustainable and energy efficient standard (BREEAM excellent) was part of a company-wide strategy based on a pure economic long term rationale.

In order to study the decision-making process, we used the information from the Brussels Capital Region on this building, and interviewed the architect as well as chief technical officer Rikkert Leeman, in charge of the renovation dossier and the technical team for Befimmo.

2. Milestones

These are the milestones for the project:

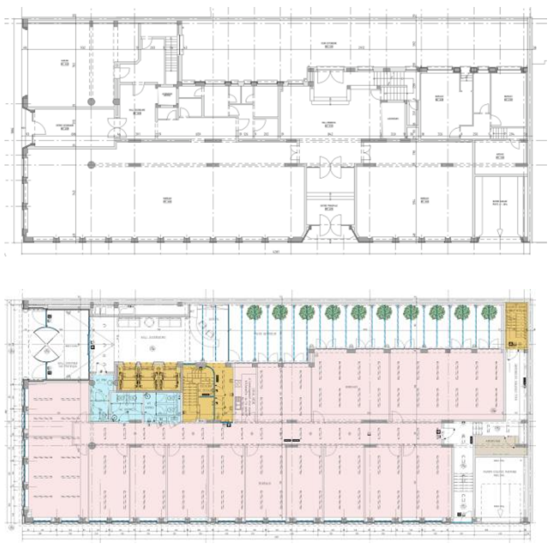
- News that the lease would not be renewed: 2006
- Start of study phase: beginning of 2007
- Application for the Brussels exemplary buildings competition (BatEx) and building permit: September 2007
- Rejection of the BatEx candidacy: December 2007
- Decision to rework the plans and reapply: 2008
- Start of tendering process: May 2009
- New application for BatEX and a new application for a building permit: September 2009
- Selection of the BatEx candidacy: December 2009
- Signing of the contract with the main contractor: March 2010
- End of the lease contract: 31 March 2010
- Start of the renovation works: May 2010
- Completion of the renovation: October 2011
- New lease contract signed: May 2012

3. Technicalities in short

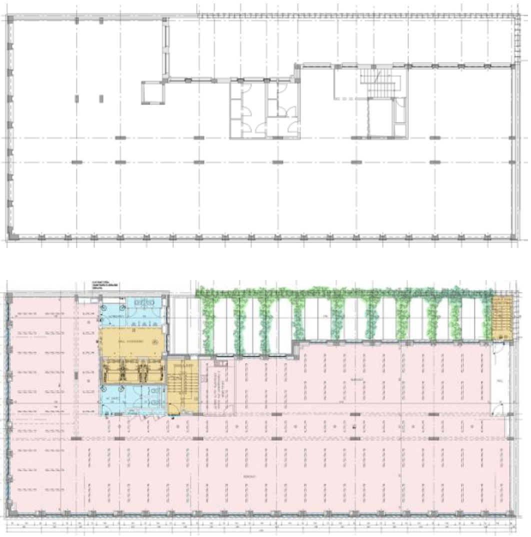
Facts about the project:

- Originally built: 1958
- Renovation architect: Arte Polis
- Type of building: office building
- Surface for offices: 6,879m²
- Planned net energy cons.: 20 kWh/m2 year
- Total cost: EUR 8.5 million
- Estimated to be 8% higher than building code
- Financial grant through BatEx: EUR 200,000

With a total floor height between slabs of around 2.7m, the existing concrete structure was fit to house the new office spaces, allowing for a heightened floor as well as a lowered ceiling. As such the old building was stripped down to its concrete skeleton. The circulation core (stairs and elevators) were situated in the middle of the old building, taking up almost the entire back façade. These were relocated to the side, in the corner of the L-shaped floor plans. Consequently, the entrance in the Science Street was removed, and a new entrance was made to the more up-market Montoyer Street, adding prestige, extra leasable surface and practicality to the building.



Ground floor before (top) and after (bottom)



Typical floor before (top) and after (bottom)

4. The main actors

4.1 Befimmo

Founded in December 1995, Befimmo is a real estate investment trust (REIT) specializing in investing in office buildings located mainly in city centres, notably in Brussels (>70%). Its portfolio currently consists of around a hundred office buildings, with a total area of around 850,000 m², a large part of which is let long-term to public institutions (>65%). The fair value of its portfolio amounts to EUR 2,044.5 million as at 30 June 2013.

The main focus of Befimmo is to offer a stable dividend to its shareholders. To realize this goal, Befimmo focuses specifically on long-term lease contracts, and on buildings with a prime location. Since long-term goals are key to maintaining stability, Befimmo became really focused on sustainable construction when the EPBD recast indicated to them that the newly introduced energy efficiency requirements would be part of a long transition path towards a sustainable built environment, rather than a one-time tightening of requirements. This prompted them to set ambitious goals, to review their entire portfolio and to implement an environment management system so sustainability would become an intrinsic part of their organization. In 2010, they became ISO 14001 certified.

typical floor before (top) and after (bottom)

Key persons in Befimmo for this project: Chief Technical Officer Rikkert Leeman and his team

The decision-making process within Befimmo was prepared by the technical team, led by Chief Technical Officer Rikkert Leeman. The final decision was taken by the board of directors.

The strength of this team lay in their technical knowledge and analysis of the different scenarios. For this reason, the team was composed of people with a broad range of expertise. They investigated all different scenarios, including demolition or selling the building, and analyzed costs as well as technical feasibility. The resulting report comparing all options was presented to the board of directors, who made the final decision.

Although Befimmo did successfully compete in a previous Brussels BatEx competition with the renovation of a listed modernist building, they lacked a detailed knowledge about energy efficiency and sustainability in normal office buildings. This resulted in the first designs consisting of a mainly glazed box with no accessible thermal mass inside except for the concrete columns.

However, though experience was still lacking, the company-wide decision to transform their portfolio towards sustainable construction made them eager to learn. For that reason, not being selected in the 2007 BatEx competition intrigued them, more than it discouraged them.

4.2 Arte Polis

Arte Polis is a medium sized architectural firm, with a fluctuating number of collaborators of between 8 to 15, and is led by founding architect Aldo Sanguinetti. It was a fusion of the different firms the architect had been leading since 1997 onwards. All projects of Arte Polis are situated in the Brussels Capital Region, and consist for a large part of office and commercial buildings, and for a smaller part of residential projects, from houses to big apartment complexes. While the latter are mostly new builds, the former mainly consist of renovation projects. This often concerned bigger and more complex renovation projects of office towers.

Key person in Arte Polis for this project: Architect Aldo Sanguinetti

The architect of the project had a lot of experience with renovation projects in Brussels, and had for a long time been interested in bio-climatic architecture. He has used a hands-on approach towards quality control for many years, vowing to spend at least one hour every morning on the building site, monitoring the execution and explaining to workers the importance of their work and the consequences towards the final goals.

Though very seasoned in renovation, the architect lacked specific experience with passive or close to passive construction. The more stringent goals towards air tightness for instance, were a first, as well as a more holistic approach towards sustainable design. The architect was convinced of the importance of insulation and had since long pushed for a good execution of details resulting in a thermal bridge free construction. However, other important principles like thermal mass or the glazing percentage of a façade were less well known. Until then, technical installations had tackled these challenges and provided a good indoor comfort. This lack of specific experience was easily overcome due to the eagerness of the architect to learn and the openness to the advice from third parties.

4.3 The BatEx call for projects and the facilitator eco-construction

Since 2007 the Brussels Capital Region has organized a yearly call for example projects to stimulate the construction of or renovation towards sustainable buildings. The goal is to prove that, even with limited financial means, it is possible to reach excellent energy and environmental performances.

The focus within the BatEx call for projects lay on four key factors: energy efficiency, eco construction (water, materials, comfort, health, waste management, etc.), cost efficiency and reproducibility, and architectural quality.

Between 2007 and 2012, 193 projects were selected, from small to large, with a total surface of 522,000m². To have these projects realized before 2016, a total of EUR 29 million has been granted. To put the impact in perspective: the BatEx reached about 20% of all construction in the Brussels Capital Region during that period.

An important aspect of the BatEx was the technical consultants, called 'facilitators', who were appointed by Brussels in different fields of expertise. Their task was to provide the professionals with adequate expertise during the transition towards more energy efficient construction. Within the framework of the BatEx competition, the facilitator eco-construction (the consultant for sustainable construction) gave input on the design decisions and provided adequate technical solutions if the design team lacked experience. Ceraa (the Center for Research, Information and Action in Architecture) took up this role. As a research non-profit founded in the shadow of the Brussels Saint-Luc school for architecture, they had a lot of experience in energy efficiency and sustainable construction.

5. The decision-making process

In this section we will have a look at each of the major decisions which were made by the different actors involved. The final result is a consequence of the sum of these decisions.

The 30-year lease contract with the Belgian Government was due to end at the beginning of 2010, and the chances were that this contract would not be extended, due to organizational changes in the housed administration. Therefore at the beginning of 2007, Befimmo started an internal study to prepare for a follow-up scenario. Together with the architect, they made a preliminary design study, where all different options were researched, including the demolishing and reconstruction.

These different scenarios were proposed to the Befimmo management board and the renovation solution was approved, based on costs and risks. Based on the renovation plans, they applied for a building permit and entered the BatEx building competition.

The study coincided with the in-company development of a strategy for sustainability. This was sparked by the communication on the EPBD recast, showing that the energy legislation that had just been implemented (the first version of the EPBD was implemented in 2006 in Flanders) would not be a one-time action, but rather the start of a whole transition. This culminated in Befimmo implementing an ISO 14001 certified Environmental Management System.

To realize a sustainable building design, the team aimed for the BREEAM Design & Preconstruction category "Excellent". The advantage of the BREEAM scheme was the flexibility for choosing measures.

In contrast to another project they applied with for the BatEx, the Science-Montoyer renovation was not selected. However instead of being discouraged, they were very intrigued by the reasons for not being selected. This feedback was provided by the Brussels facilitator, mainly concerning the issue of summer comfort. The building, designed from the view of a standard office building, had an almost entirely glazed façade, raised floors and lowered ceilings. This would have caused a lot of cooling demand in summer months.

Since there was a strong will to make this building a BatEx winner, with a good and rational energy performance, the plans were completely reworked, in collaboration with the facilitator. The new design was certified "Excellent" in the BREEAM Design & Preconstruction category. In January 2012, and the Science-Montoyer was rated "Excellent" in "Post Construction" phase in the "BREEAM Europe Offices" category.

At the beginning of 2009, the tenant confirmed that they would not extend the lease contract, so a new building application was introduced (even when the former application had been approved) and the new scheme was entered into the latest BatEx competition. This time the result was positive.

One month after the expiration of the old lease, the renovation works started. Seven months after they finished, a new lease contract for 21 years was signed by the European Parliament. To get this contract, an important element was the sustainability of the building. Having a BREEAM certification helped to prove this sustainability.

During construction, a last main hurdle was the lack of experience of all parties involved with realizing a very air-tight building. Here all parties involved decided it would be interesting to first build a mock-up of the proposed solution for the façade. This mock-up was then tested, in the presence of all involved parties. This allowed all parties to identify the weak spots in their first proposal, and to work out feasible solutions, with all parties involved.

6. Lessons learned

6.1 Introduction

The success of this project was built on the willingness and sincere interest of the building owner to develop a real sustainable renovation, and thus to overcome the setbacks they encountered along the way. The independent expertise of the facilitator eco-construction was a valuable asset to overcoming barriers, as was the good and constructive collaboration on-site between involved actors.

6.2 Important drivers

These were the most important drivers for increasing the ambition level of the project:

- clear strategy and goals from the start within the company
- emphasis on long term client retention and good quality of the buildings
- the will to learn and to be a frontrunner
- the impact on the image of the owner
- the support from the facilitators
- the experience of the architect in renovating office buildings
- the holistic and open approach of BREEAM

6.3 Important barriers

There were some barriers which could have altered this project:

- insufficient technical experience of all parties involved on specific topics like air-tightness
- the lack of widely spread technical solutions

6.4 Main conclusions

- In order to build up experience in the market, access to and concrete support from experts is important.
- If an entire company stands behind a target, it will reach it.
- From the start, the actors involved approached the project as a learning experience.

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More info about:

Befimmo, www.befimmo.be

Arte Polis, www.artepolis.be

Facilitator eco-construction, www.bruxellesenvironnement.be

IEA SHC Task 47:

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

Annex 7: Boligselskabet Sjælland, Roskilde, Denmark Decision-Making Process

1. Introduction

There exist very few outstanding examples of ambitious renovation projects in the non-residential sector in the world. The IEA SHC Task 47 analyzes the best demonstration projects in the seven participating countries. In subtask B the decision-making processes are studied in particular.

This paper describes the decision-making processes for a renovation project involving an office building in Roskilde, Denmark. The building is owned by the Danish housing association "Boligselskabet Sjælland" which is also the tenant of the building. The housing association took the initiative to carry out the extensive energy renovation of the building.

Built in 1968, the office building only had a very limited level of insulation to start with. An energy renovation of the building envelope was carried out in 1991. This previous renovation included adding insulation to the wall (175 mm) and windows were replaced with traditional double-glazed windows, but no improvements in terms of energy efficiency have been made since. The recent energy renovation was completed in 2010 and had a very strong focus on energy savings.

The building has a gross floor area of 2478 m^2 and houses approximately 84 employees spread over four floors.

The main objective of the renovation was to reduce the overall energy consumption of the building while also improving the indoor climate. This was achieved by adding insulation to the facade, replacing existing windows, improving air tightness of the building envelope, replacing the ventilation system and adding photovoltaic cells to the facade.

This paper is the result of an interview conducted during the autumn 2013 with Poul Martin Møller (project leader from Boligselskabet Sjælland) and Charlotte Jakobsen Szøts (now employed as an architect at Boligselskabet Sjælland but during the renovation she was the owner of the architectural company Jakobsen Szøts ApS).

The purpose of the interview was to learn how this project evolved from the initial idea to how it is now renovated.

2. Milestones

These are the milestones for the project:

- Initial idea launched: Dec 2008
- First version of the project plan: May 2009
- Final version of the project plan: Jul 2009
- Decision to start the project: Jan 2009
- Startup renovation: Dec 2009
- Renovation project completed: Dec 2010

3. Technicalities in short

Facts about the project:

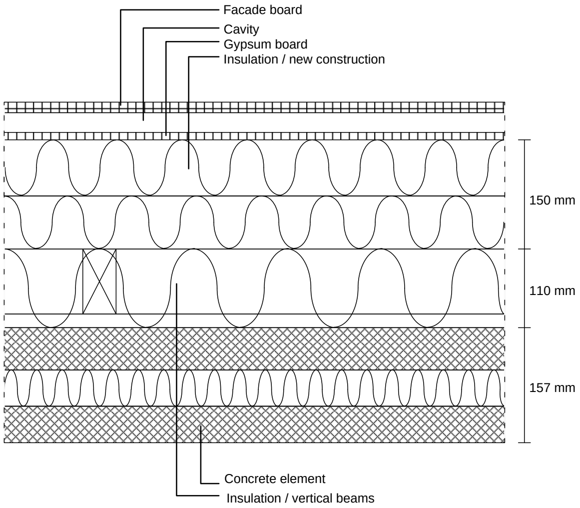
Built:	1968
Renovation architect:	Jakobsen Szøts ApS
Energy consultant:	DOMINIA A/S
Calculated after:	50 kWh/m^2/year
Measured after:	55 kWh/m^2/year
Total cost:	DKK 35.9 mill (EUR 4.8 mill)

The building housed both offices and shops before the energy renovation. The existing offices were used by Roskilde Boligselskab which was undergoing a merger with Andelsbolig-foreningen af 1899. After the merger the new housing association (Boligselskabet Sjælland) needed space for more employees, and therefore part of the renovation plan was to convert the entire building to offices to make room for the new and larger housing association.

There are no photographs of the original office building, but this picture (below) shows the back of a similar housing complex which was built at the same time and renovated in the same style as the office building in 1991.

The facade of the building was deteriorated and needed an upgrade and windows were worn down and energy inefficient.

The picture below shows a cross-section of the exterior wall. The original construction from 1968 is the concrete element and the additional 110 mm insulation was added in 1991.



The figure shows how the original 50 mm insulation was increased by 110 mm in 1991 and again by 150 mm in 2010, greatly improving the U-value of the exterior wall.

4. The main actors

4.1 Boligselskabet Sjælland

Boligselskabet Sjælland is the owner and tenant of the building.

Boligselskabet Sjælland is a non-profit housing association and is represented in numerous Zealand municipalities. The company has approximately 220 employees.

They offer a wide range of properties from one- and two-family houses of prefabricated buildings and multi-storey buildings to the close/low construction. The properties include family homes, youth homes and homes for the elderly. Boligselskabet Sjælland has its own building and construction department with responsibilities for project management, construction management and site supervision and construction consultancy and technical advice in relation to the managed companies.

Boligselskabet Sjælland manages approximately 13,000 homes.

Key persons in Boligselskabet Sjælland for this project:
Poul Martin Møller acted as the project leader for Boligselskabet Sjælland.

Poul Martin Møller has worked as an architect since 1976 and has been employed by Boligselskabet Sjælland for the last five years. He has an education as an architect and construction economist.

4.2 Jakobsen Szøts ApS

Jakobsen Szøts ApS was the architectural advisor in the renovation project.

The company was owned and managed by Charlotte Jakobsen Szøts, but closed after finishing the renovation project. Afterwards Charlotte Jakobsen Szøts was hired to work for Boligselskabet Sjælland.

Key persons in Jakobsen Szøts ApS for this project:
Charlotte Jakobsen Szøts has worked as an architect for 24 years; 14 years in Germany and 10 years in Denmark. She has been employed in Boligselskab Sjælland for two years.

4.3 B. Nygaard Sørensen A/S

B. Nygaard Sørensen A/S was the main contractor in the renovation project.
The company is a medium-sized construction company working mainly in the eastern part of Denmark (Zealand). They employ approximately 95 people.

Based on both public and invited tenders, B. Nygaard Sørensen A/S performs turnkey and general contracting in both new construction, renovation and remodeling. Tasks include housing for private companies as well as residential housing, commercial buildings and institutional buildings. Similarly, they have a substantial turnover within urban renewal, modification, balconies, and facade and roof renovation.

4.4 DOMINIA A/S

DOMINIA A/S was the energy consultant in the renovation project.

The company provides design, client consulting and construction management in both new construction and renovation projects. The company focuses strongly on sustainability and has a strong position relating to sustainable design, sustainable construction and energy optimization.

Their customers are typically large housing associations, municipalities, the state and private developers.

The company is an employee-owned consulting engineering firm with approximately 40 employees.

5. The decision-making process

In this section we will have a look at each of the major decisions which were made by the different actors involved. The final result is a consequence of the sum of these decisions.

- After a merger between Roskilde Boligselskab and Andelsboligfore-ningen af 1899, the new company needed a larger office building. Furthermore, the building was in need of regular maintenance (worn down facade, windows and building systems).

- The company had a strong focus on energy savings and presenting a green profile, and therefore these were the main focus areas of the project to begin with.

- The basic method for determining the overall plan for the renovation project was economic optimization within a frame based on maximum investment and taking into account the operating costs.

- The company generated a lot of presentation material for the project (programme, presentations, calculations, 3D-simulations and – presentations) in order to visualize and present the overall project idea to the representative board (a board elected among the residents of the buildings owned by the housing association).

- The representative board agreed to the plan developed by the housing association, and the renovation project was initiated.

6. Lessons learned

6.1 Introduction

The original plan for this project was to renovate an existing building, containing both offices and shops, and turn it into a new headquarters for the housing association. The company wanted to have a strong focus on energy efficiency and the green profile.

The most interesting point in the project is the fact that the company used a lot of effort on producing the material needed to convince the representative board that the project was a good idea and the right way to go.

6.2 Important drivers

These were the most important drivers for the ambition level of the project:

- The project had a strong focus on energy efficiency to start with. The company wanted a solution that would strengthen its green profile.
- Economic calculations on energy savings/investments were performed, and a lot of energy was put into producing material to present the project to the representative board.

6.3 Important barriers

There were some barriers which could have altered this project:

- The relocation of employees during the renovation of the building presented some problems, but these were overcome by the use of both other buildings and temporary pavilions placed in the parking lot in front of the building.
- During the renovation of the facade asbestos was found in the existing constructions. This delayed the renovation process and increased the costs.
- The removal of some of the interior walls made it clear that the floor needed levelling in these areas; this was not foreseen and would also add to the cost of the renovation.

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More info about:

Danish Building Research Institute, AAU

http://www.sbi.dk/en

Housing Association Zealand

http://www.bosj.dk/

B. Nygaard Sørensen A/S

http://www.bns.dk/

DOMINIA A/S

http://www.dominia.dk/

IEA SHC Task 47:

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

6.4 Main conclusions

The main conclusions from this project are:

- It is economically viable to perform deep energy renovation rather than settle for ordinary maintenance.
- Experience gained in this project will be utilized in other projects, when the buildings owned by the housing association will be energy renovated in the future. A project on a similar building (dwelling) is already initiated.

Annex 8: Solbråveien 23, Asker, Norway Decision-Making Process

Photo: Moderne Byggfornyelse

1. Introduction

There exist very few outstanding examples of ambitious renovation projects in the non-residential sector in the world. The IEA SHC Task 47 studies the best demonstration projects in the seven participating countries. In subtask B the decision-making processes are studied in particular.

One of the examples is a project located in Asker in Norway, situated about 20 km west of Oslo. It is an office building owned by the company Solbråveien Eiendom KS, which is a limited partner company. The mission of this company is solely to own and rent out this particular building. The owners of the company are real estate investors. The key owner is Mr Sverre Sejersted, who also owns and runs the real estate management company Banco Management that administers the lease, maintenance and renovation of the building, which has a total heated area of 10,386 m^2.

Calculated delivered energy before renovation was 244 kWh/m^2 and expected to be 80 kWh/m^2 after renovation. The project was granted NOK 4.67 million (~ EUR 580000) from the Norwegian energy efficiency body Enova due to the project objective of achieving the Norwegian low energy standard.

An important lesson from this project was that even though the company could market the building as energy efficient (96 kWh/m^2), it was difficult to find serious long term tenants. The façade, which originally was not planned to be upgraded, was not attractive enough. In the revised plan a new glass façade and more insulation was included.

The following individuals were interviewed in order to learn from the decision-making process of this project:

- Rolf Storstrøm, representing the owner;
- Knut Guldbrandsen, representing the main contractor;
- Espen Aronsen, representing the main technical contractor which also happened to be the first new tenant in the building.

2. Milestones

The milestones for the project are as follows:

- Initial idea launched: Sep 2009
- First version of the project plan: Jun 2010
- Final version of the project plan: Aug 2012 (for the façades)
- Decision to start the project : Aug 2012
- Startup renovation: Aug 2010 (first part of the building in which GK leases)
- Renovation project completed:
  - Outer façade Fall 2013
  - Interior adapted to tenants 2014
  - Energy class A achieved Dec 2014

3. Technicalities in short

Facts about the project:

- Originally built: 1980-1982
- Renovation architect: Terje Grønmo
- Type of building: Office building
- Employees in the building
  - Before renovation: 300
  - After renovation: 450
- Space before: 10,386 m^2
- Space after: 10,886 m^2
- Measured before: 244 kWh/m^2/year
- First planned: 96 kWh/m^2/year
- Final plan: 80 kWh/m^2/year
- Total cost: NOK 115 million (EUR 14.4 million)

  The original plan was NOK 92 million without a new façade or a new roof.
  - Estimated to be NOK 10–11 million (12%) higher than the existing building code (TEK07) at the time the building permission was given.
  - Financial grant from Enova: NOK 4.67 million (EUR 0.6 million). The grant was based on the original plan (low energy standard/96 kWh/m^2 year) and NOK 450 per m^2 of heated space.
- The final plan included an increase in the space of 500 m^2 which was combined with the new design of the building.

Picture of the renovated window area seen from inside:

Photo: Heidi Øvergaard, GK Norge AS.

Wall inside window seen from above:

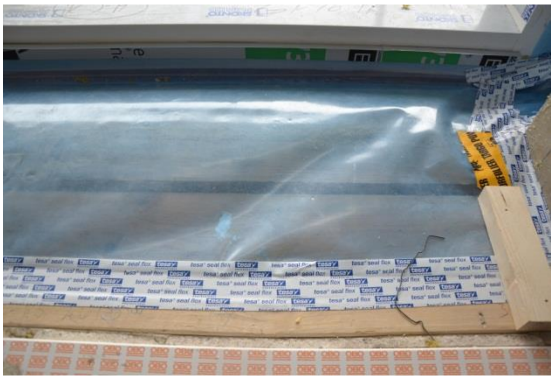

Photo: Heidi Øvergaard, GK Norge AS.

4. The main actors

4.1 GK Norge AS

GK Norge was the first tenant to move

into the building after renovation as well as the main contractor for technical systems.
The company is a total engineering contractor and service partner for indoor air quality in new and existing buildings.
Their technical expertise is in the fields of: ventilation, building automation, refrigeration, piping, hydronic energy systems, and energy.

The company also has subsidiaries in Sweden and Denmark. Their technical installations and consultation contribute to significant energy and environmental benefits in combination with optimum comfort for building users. The company is also certified to issue energy labels for buildings.

Since its establishment in 1964, GK has had a dynamic growth – at present it has approximately 1,800 employees across Scandinavia, with a turnover of around NOK 2.6 billion.

Key financial figures for GK Norge AS (the Norwegian part of the group):

In NOK 1,000	2011	2010	2009
Profit&loss			
Revenues	1 750 676	1 584 613	1 760 318
Profit before tax	1 390	30 237	95 156
Balance			
Total equity	214 187	241 273	239 124
Liabilities & equity	684 768	689 049	727 351

* NOK 1 = EUR 0.13, USD 0.17 (31.07.13)

The tenant in this building is GK's regional office in Asker.

GK was contacted by the landlord for consultation of the planned renovation. As they were looking for new premises for their department in Asker at the same time, they signaled that they may be a potential tenant as well.

Strongly linked to its core activities, the company has a strong focus on energy efficiency and environment. The company is certified as an "Environmental Lighthouse". The company has already some experience with low energy buildings. An example is GK's head office in Oslo which is currently the biggest Passive House office building in Norway. It was opened in fall 2012. The project is BREEAM certified and achieved the label "very good". The company is also involved in other renovation projects with high energy efficiency ambitions and where the BREEAM standard is used. One of these is the building owned by Oslo Areal AS which will be leased by the Norwegian Directorate of Environment. As the BREEAM standard is used from the initial planning of the project, the building is expected to reach the label BREEAM Excellent and accomplish the Norwegian Passive House Standard as well as reach the Norwegian energy class A (85 kWh/m^2/year delivered energy for heated space; this number applies for office buildings).

GK Norge AS is one of the partners in the Norwegian research project Upgrade Solutions which is associated with the IEA SHC Task 47 Renovation of Non-Residential Buildings towards Sustainable Standards.

Key persons in GK Norge for this project:

Mr Espen Aronsen was contacted at an early stage in this project as a supplier of technical solutions for the building. He is responsible for the business area "Energy" and is located at the head office in Oslo. As he knew that their department in Asker was looking for new offices, he introduced the idea of renting a part of this building to the regional manager and the landlord.
Mr Aronsen, who is educated as an engineer, has since taken several postgraduate courses in the topics of energy use in buildings and acoustics. He has a wide network of relevant competence for this project both internally in the company as well as externally. From his central position in the company he has a very good overview of the core competence of his

colleagues working with energy-related topics. As he is one of the persons representing the company in three ongoing research projects, he has also developed a network (of persons) in other companies and research organizations. Espen Aronsen finds it motivating to combine a green policy with profitability.

As the regional manager in Asker, Bengt Gyhagen is responsible for this project on behalf of GK Norge. He is an engineer and has a long experience and a wide network within this industry.

Jan Andreassen is the project manager for GK Norge for this project. He is educated as an electrician and has been working with technical services. He previously worked for a company which was acquired by GK in 1997. With his long practical experience he has worked his way up in the organization to take on responsibility to manage complex projects. He is aware of his own limitations, and so makes sure to use the best available competence and expertise elsewhere to serve the different tasks in the projects.

4.2 Banco Management AS and Solbråveien Eiendom KS

Banco Management AS is a real estate management company which administers several properties with an accumulated space of approximately 75,000 m^2, among which also includes the building at Solbråveien 23. Each property is normally organized as a separate limited company. This building is owned by Solbråveien Eiendom KS.

KS stands for "Komandittselskap" which is a special legal entity for limited partnership. The company itself is not subject to tax as the owners are taxed for their respective parts. Banco Management AS has wide proxies on behalf of the owner company. Their informal way of managing projects is not very common.

The mission for Banco Management is to invest in and manage real estate projects. The company has no ambition to become big, as the owner wants to keep the organization small; it currently has five employees. The company has no specific strategies related to energy and sustainability. This is the first project for the company with a strong focus on energy efficiency.

Key financial figures for Solbråveien Eiendom KS:

In NOK 1,000	2011	2010	2009
Profit&loss			
Revenues	1 060	0	10 194
Profit before tax	-5 011	-15 265	5 619
Balance			
Total equity	19 242	16 753	24 519
Liabilities & equity	69 296	63 030	75 843

* NOK 1 = EUR 0.13, USD 0.17 (31.07.13)

Comment: the previous tenant terminated the contract in 2009.

Key financial figures for Banco Management:

In NOK 1,000	2011	2010	2009
Profit&loss			
Revenues	5 245	5 409	5 266
Profit before tax	886	1 397	1 048
Balance			
Total equity	5 364	5 323	5 297
Liabilities & equity	6 156	6 258	5 994

* NOK 1 = EUR 0.13, USD 0.17 (31.07.13)

Key persons in Banco for this project:

Mr Sverre Monsen Sejersted is the sole owner of Banco Management through his holding company Banco AS. Mr Sejersted is also one of the owners in Solbråveien Eiendom KS. He is educated as an economist and has previously worked for a finance company. He started his own real estate business in 1997. He has no particular focus on energy efficiency; his focus is instead on developing attractive premises.

Mr Rolf Storstrøm has been working for Banco Management since 2000. On behalf of the owner he has been responsible for the project of the renovation of Solbråveien 23. He is educated as a construction engineer and has previously worked as a consultant in a large engineering company. Mr Storstrøm did not initially have a special interest in energy efficiency, but was influenced by GK Norge to see the benefits of including this into the planning of this renovation project. His experience from previous projects has resulted in good contacts with several suppliers, which also includes GK Norge AS. Through his strong engagement in a local sports club, he has a good network with different types of companies that sponsor the club. The manager of the main contractor of this project, Moderne Byggfornyelse, is among these contacts.

4.3 Moderne Byggfornyelse AS

Moderne Byggfornyelse AS (MB) is the main contractor for this project. MB was founded in 1990 by the two partners Knut Gulbrandsen and Rolf-Thore Johansen, who own the company by equal shares.

The company's mission is to be the selected partner for building construction which delivers the agreed quality on time at the right price. The company has a strong focus on energy efficient solutions as part of their business of building renovation projects. This is also reflected in the name of the company which means "modern renewal of buildings". They target customers who they are able to influence to choose good solutions. As a consequence they avoid public actors, which they have experienced have a one-sided focus on price.

The green profile of the company is also reflected by its award as the greenest company in Oslo in 2012. In 2010 MB was certified as an "Environmental Lighthouse".

The company has no experience with projects following the BREEAM standard, but is currently using "BREEAM Past" in a renovation project of an old villa which will be transformed into a kindergarten.

MB has experience from renovating buildings to achieve the Norwegian energy class B (maximum 115 kWh/m2/year of delivered energy for heated space for office buildings). The aforementioned ongoing renovation project of the kindergarten is planned to reach the Norwegian Passive House standard and the energy class A (80 kWh/m2/year of delivered for heated space for kindergartens). The same ambition level applies also for an ongoing renovation of an office building (to reach an "A", office buildings can use a maximum of 85 kWh/m2/year of delivered energy for heated space).

The company has good experience from several projects in which the different suppliers do the project managing within their respective fields. Through this methodology the costs of planning have been reduced significantly. It also results in more practical solutions.

Moderne Byggfornyelse AS is also one of the partners in the Norwegian research project Upgrade Solutions which is associated with the IEA SHC Task 47 Renovation of Non-Residential Buildings towards Sustainable Standards.

Key financial figures for Moderne Byggfornyelse:

In NOK 1,000	2012	2011	2010
Profit&loss			
Revenues	128 343	136 854	105 847
Profit before tax	904	-7 486	198
Balance			
Total equity	18 801	17 203	28 669
Liabilities & equity	43 906	43 080	52 105

* NOK 1 = EUR 0.13, USD 0.17 (31.07.13)

Based on the current backlog, it is expected that total revenues for 2013 will reach NOK 190 million. The company employs 86 persons.

Key persons in Moderne Byggfornyelse for this project:

Rolf-Thore Johansen is educated as a building engineer and has also studied subjects within economics. He was the first general manager of the company when it was founded in 1986.

Knut Guldbrandsen is now the current manager of the company and has also been working in the company since the beginning. He is a building engineer and has also studied subjects within economics. Before he joined MB, he worked for a contractor which built single family houses and for some years as a consulting engineer. Mr Gulbrandsen is enthusiastic about protecting the environment and this is also one of the reasons he acquired an electric car five years ago. He has experienced that renovation of buildings is a very good opportunity to combine energy efficient solutions that are measurable.

Mr Guldbrandsen is active in the network of sponsors of the same sports club as Mr Storstrøm in Banco Management. This network is important for him for business contacts. Earlier projects with the largest retailer of Toyota cars in Norway have brought inspiration of how a targeted and systematic philosophy leads to improved results.

5. The decision-making process

In this section we will take a look at each of the major decisions which were made by the different actors involved. The final result is a consequence of the sum of these decisions, which was formally made by the board in the owner company. However, this was done in a rather informal way – mostly by confirming via e-mail, which gave wide proxies to the managers in Banco.

5.1 Tenant terminated the contract

The previous tenant in the building, Western Geco, decided to terminate the contract in 2009 due to a need for expansion of space and dissatisfaction with the indoor air quality.

The fact that the whole building would be abandoned was on the one hand a big financial challenge for the owner, but also a great opportunity for a systematic upgrade of the building. Banco Management and the investors in Solbråveien Eiendom KS agreed to make the premises attractive to serious companies for long-term contracts.

5.2 Forming the team

Mr Storstrøm at Banco Management contacted Knut Gulbrandsen in MB to discuss renovation strategies for the building. Due to the challenges with indoor air quality they contacted GK

Norge as early as the initial planning phase. These three companies had good previous experience in cooperating together and mutual trust was already established. The owner of the building therefore did not publish an open tender for this project. Nor did they involve an architect or consultants to develop the main renovation strategies. The main responsibility for this planning was given to the two companies. MB was appointed as main contractor for the project. Other companies were also hired for specific tasks during the planning process. For instance, MB engaged an architect for defined assignments.

5.3 Initial renovation strategy
Initially there was not that strong a focus on energy efficiency in this project. However, when GK was involved to discuss strategies for improving the indoor air quality in the building, they introduced the idea of combining this with energy efficiency measures. Mr Espen Aronsen in GK also argued that energy efficient buildings would be more attractive for long term tenants. It was therefore discussed which measures were necessary to reach the label of energy class B. They concluded that this could be achieved by the following measures:

- Ventilation system with heat recovery (85%);
- Air to water heat pump;
- Automated control system for ventilation and lighting;
- Replacing all windows with u-value equal to 1.0 W/m2K and which had internal shading;
- All outer concrete walls in staircase rooms, gables, etc. were given additional insulation (0.2 W/m2K);
- 150 mm additional insulation on all roofs was added (0.1 W/m2K);
- The new window system needed less interior space and therefore increased the office space. This combined with a new layout of the offices led to reduced space and energy use per employee.

These measures were also sufficient to achieve the Norwegian low energy standard (a level which is between the Norwegian building code and the Passive House standard), which meant that the project was qualified to get a grant from the Norwegian energy efficiency body Enova. The fact that they received the grant from Enova was very motivating (but not crucial) for a stronger focus on energy saving.

Due to a noise problem from the highway just outside of the building, the new windows were made to be noise reducing.

The formal foundation for deciding to start the project was drawings and a budget for the project made by MB.

5.4 Poor response in the market
As the owner company of the building had limited financial resources, it was necessary to proceed with the renovation in line with the progress of signing new lease contracts. The first contract was signed with GK Norge and the renovation according to the measures listed above could start. Simultaneously the marketing of the rest of the free premises was done actively. They had several interested companies but could not convince them to choose this location. The energy efficient building was not attractive enough for serious actors which instead chose brand new

premises on the other side of the highway.

It became clear that the existing outer façade could not compete with brand new buildings with a nice, glossy façade.
The representative of the owner company therefore asked MB to consider if it was possible to give the whole building a substantial facelift.

5.5 Revised plan included transforming the façade

MB screened the market for potential solutions for a new façade. They found out that Schüco had a system for glass façades with aluminium profiles which would be perfect for this building. When they contacted the system supplier they were directed to companies that could install the system. The responses from these companies were, however, rather disappointing. As MB was convinced that this system would be the right solution to upgrade the façade so it would appear as a new building, they continued to search for competent installers of the Schüco system. Via contacts in Germany they found a company in Latvia which was willing to do the installation work in Norway. It was the first time MB has engaged a foreign company as a subcontractor on their projects. The result can be considered a success.

The revised renovation strategy included additional energy saving measures:

- Windows: u-value 0.8 W/m^{2}K;
- New glass façade included additional insulation.

It was expected that these measures would bring the building close to achieving an energy class A (which means a maximum of 85 kWh/m^2/year). Measurements executed in December 2014 showed better results than expected; energy class A was achieved!

5.6 Growing interest in the project

The revised project has been meeting increased interest from potential tenants. By summer 2013, contracts for about 90% of the space had been signed by the following companies: Polyplan, Honeywell, KIS, Monier, Intergraph, Vingmed in addition to GK Norge. The remaining 1,200 m^2 is expected to be let/leased as well.

The energy efficient building was also presented publicly in the local newspaper *Budstikka* in Asker. The picture below is from the opening ceremony of the first part of the premises which was occupied by GK Norge. The mayor of Asker Mrs Lene Conradi (left) supported the project owned by Solbråveien Eiendom KS, represented by Mr Rolf Storstrøm (right).

Photo: Heidi Øvergaard, GK Norge AS.

6. Lessons learned

6.1 Introduction

All major actors in this project are private companies. As a private landlord, Solbråveien Eiendom KS was free to choose the selection criteria for contractors. Unlike public actors, they did not invite an open tender for competition between potential suppliers.

The selection of partners for the project was made primarily on earlier experiences and informal networks.

The detailed planning work was carried out by the respective contractors in the project. They claim that they have saved substantial costs in planning by this method.

Initially the project did not have a strong focus on energy saving. But for every issue to be solved, they carefully looked for measures that could also bring energy savings. Step by step, they realized that they accumulated so much in savings that they could apply for public funding.

6.2 Important drivers

The following points are the most important drivers for increasing the ambition level of the project:

- Unattractive façade on own building which had to compete with new buildings;
- Poor indoor comfort (including noise);
- Mr Espen Aronsen in GK Norge strongly advocated for energy efficient solutions;
- MB has a green philosophy as part of their business concept; they looked systematically for improvements that were measurable;
- The building was empty, which was an opportunity to make a thorough renovation;
- Informal and open decision-making processes built on trust between the main actors.

6.3 Important barriers

There were some barriers which could have altered this project:

- Limited financial resources and no signed contracts;
- Norwegian installers of the Schüco system were probably too busy in a "heated" Norwegian construction market to take on the challenge in this project. MB therefore had to search for these actors abroad.

6.4 Main conclusions

All of the key actors consider this as a successful project, despite the challenges they experienced throughout the process.

This project demonstrates that energy efficiency is not a sales argument completely on its own. The façade had to be totally renewed in order to make the building attractive. Initially the answer to the question on how to make these premises attractive for long-term serious tenants was answered by excellent indoor comfort and energy efficiency. This may be the correct answer when competition with brand new premises is not as strong as in this case. This experience shows that the benchmark for existing buildings is the standard of new buildings, which also means energy efficiency and good indoor comfort.

The actors in this case looked for how to achieve very good functions, attractive design and energy efficiency by combining known solutions in a systematic way.

The decision-making process in this project was influenced by the interest and values of individuals involved, a business philosophy and single events. Mr Aronsen in GK motivated the other key partners in the project to put a strong emphasis on energy saving. This matched well with MB's green philosophy and they supported this idea, which meant targeting an energy class B-building. The idea was easier to accept as the financial support from Enova also gave prestige to the project which it could use in the marketing of the free premises. When they faced the necessity to also make some substantial changes to the façade, they also used this to further improve energy efficiency, so that the building eventually could become an energy class A building and close to meeting the Passive House standard.

In other demonstration projects in IEA SHC Task 47 we see that architects and consultants play an important role in high ambition renovation projects. As many of these projects are owned by public owners, the suppliers are normally selected through tendering processes. That way there is less space for deviation from the initial plan. The actors in this case have experienced the advantages of a more pragmatic process. They have found that the craftsmen executing the work may see better solutions than from what is being planned from a theoretical perspective.

Input to authorities:

- For their own projects public authorities (as landlord or as tenant) should request an energy class B as a minimum.
- The building owners do not recover the VAT on incoming invoices for renovation work before they have signed contracts for the respective space. This brings an additional financial burden for the landlord and may alter him to choose less sustainable solutions.

The support from Enova was important not only financially but also as moral inspiration internally as well as bringing prestige to be used as part of their marketing towards potential tenants. Enova's incentives should be maintained and developed to be more flexible. It should be easier to receive a grant as the minimum criteria should be less strict. A higher grant share of the costs would make it more attractive to put a stronger focus on energy efficiency in renovation projects.

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  http://www.budstikka.no/%C3%B8konomi/miljoforvandling-i-neringsbygg-1.6349285
- Presentation made by GK Norge for Molde Næringsforum, slides 49-54 :

  http://www.moldenaeringsforum.no/site/img/62/GK-Ramb__ll.pdf
- News story about the project on GK's website:

  http://www.gk.no/no/om_gk/nyheter/GK+Norge+AS+s%C3%B8kte+Enova+p%C3%A5+vegne+av+kunde+og+byggherre+Banco+Management+-+som+fikk+tilsagn+p%C3%A5+4%2C6+mi.b7C_wJbUXb.ips

For more information about:

- Banco Management AS

  http://banco.no/
- Moderne Byggfornyelse AS

  http://www.byggfornyelse.no/

  Facebook:

  https://www.facebook.com/pages/Moderne-Byggfornyelse-As/294874653891998
- GK Norge AS

  http://www.gk.no/

  https://www.facebook.com/pages/GK-Norge-AS/118678901539687
- BREEAM

  http://www.breeam.org/

Picture from a meeting room

Photo: GK Norge AS.

Annex 9: Norwegian Tax Administration Building, Oslo, Norway Decision-Making Process

Illustration: LPO Arkitekter, Norway

1. Introduction

There exist very few outstanding examples of ambitious renovation projects in the non-residential sector in the world. The IEA SHC Task 47 studies the best demonstration projects in the seven participating countries. In subtask B the decision-making processes are studied in particular.

This paper deals with the decision-making process in the most ambitious renovation project within the non-residential sector in Norway - the office building (35,000 m2) rented by the Norwegian Tax Administration in Oslo. The building is owned by Entra Eiendom AS. After renovation the building will comply with the Passive House standard, achieve the energy label A and be BREEAM certified as “very good” (it cannot reach excellent as the BREEAM standard was not used from the initial planning phase). The renovation started in August 2011 and was completed by October 2013.

This paper is a result of interviews conducted during the summer 2012 (midway in the renovation process) with the following key actors:

- Norwegian Tax Administration as tenant.
- Entra Eiendom AS as landlord.
- Optimo Prosjekt AS as project manager.
- AF Gruppen AS as contractor for structural works and coordination.
- In addition the energy consultant Arne Førland Larsen has contributed directly to the paper as co-author.

The purpose was to learn how this project evolved from the initial idea to how it is now renovated.

A second round of interviews was conducted with representatives from the same organizations in the spring 2014 (after the project was completed) in order to learn more from experiences during the renovation phase and first use of the renovated premises.

2. Milestones

These are the milestones for the project:

- Initial idea launched: 01.09.2009
- First version of the project plan: 01.02.2010
- Kick-off meeting (tenant and project group) launching idea of A/PH class 14.09.2010
- Workshop with project group launching new environmental program and quality plan for A/PH class for the project group 23.09.2010
- Process with tenant adjusting client brief 22.10.2010 – 01.12.2010
- Contact Enova for possible funding 20.12.2010
- Workshop with main tenant representative from various user groups, launching the idea of class A/PH 11.01.2011
- Final version of the project plan: 01.03.2011
- Decision to start the project (as class A/PH) 01.03.2011
- Application for funding from Enova 15.03.2010 submitted
- Funding of EUR ~70 per m2 granted from Enova 04.05.2011
- Contract with main contractor: 01.06.2011
- Start up renovation: 01.08.2011
- Renovation project completed: 01.10. 2013

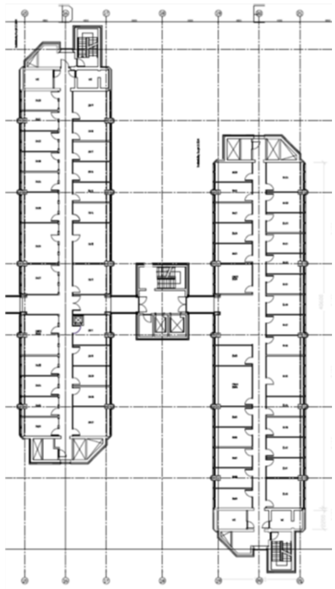
3. Technicalities in short

Facts about the project:

- Built: 1982
- Original architect: FS Platou
- Renovation architect: LPO Arkitekter
- NTA's employees in the building:
  - Before renovation ~ 860
  - After renovation ~ 1060
  - Increase due to relocating of other employees in Oslo
- Office building incl in-house big data central and print shop
- Before: 31,000 m2
- After: 35,000 m2
- To be leased by NTA: 22,000 m2
- Measured before: 190 kWh/m2/year (including all energy consumption)
- First planned: 129 kWh/m2 year (including all energy consumption)
- Final plan: 89 kWh/m2 year (including all energy consumption)
- Total cost: NOK 400 mill (EUR 54 mill)
  - Estimated to be 10% higher than building code
  - Financial grant from Enova: NOK 18.5 mill/EUR 2.5 mill
- After renovation about 30% of the space will be rented out to other tenants.

The overall design strategy based on:
- Optimizing the building envelope
- Optimizing technical system
- Utilization/recovery of energy from data facility in the building

The increase of the space is a result of linking the original five building blocks together with building new intersections between them and replacing the gateway bridges which previously linked them together. This concept means increased space and simultaneously reduced outer façade per m2, which is very energy efficient (see picture on front page).



Typical floor plan before refurbishment

Typical floor plan after refurbishment

Improving measurers for the building envelope

	Before	After
Roof/attic	~ 0,2 – 1,0 (average 0,5)	0,12
Floor/slab	~ 0,1	0,1
Walls	~ 0,2 – 0,4	0,17
Ceilings	~ 0,3	0,12
Windows	~1,8	0,72
Airtightness	~3,0	< 0,6

Improving measurers for technical system

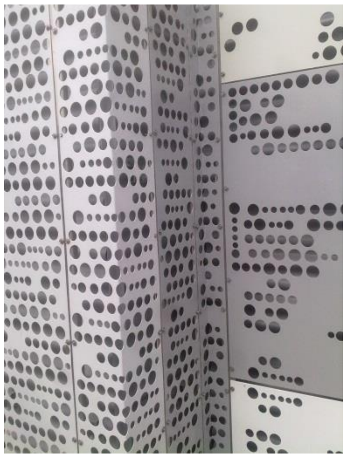
HEATING SYSTEM
Before - Electrical heating
After - Water based heating systems

VENTILATION
Before – CAV mechanical ventilation
After – VAV mechanical ventilation
Low SFP, < 1.5, and efficiency of heat recovery > 85%

HOT WATER PRODUCTION
Before - Central electrical heated boiler
After - Central boiler heated with waste energy from data facility in basement in combination with electricity/district heating

RENEWABLE ENERGY SYSTEMS
Before – none, all energy consumption was based on electrical supply.
After - Reuse of waste energy from data facilities in basement in combination with district heating from public supply. Night cooling strategy for reduced cooling. (Førland-Larsen, 2012)

The facades are made by 85% recycled aluminum (see picture below):



During the renovation the tenant had to move their employees to temporary buildings in other parts of Oslo, with the exception of the data central which remained in the building (basement) during the renovation. This relocation was taken care of by the landlord.

4. The main actors

4.1 The Norwegian Tax Administration

The Norwegian Tax Administration (NTA) is the tenant of the building and has been strongly involved throughout the process of this project.

The NTA is a public body whose main activity is to administrate the Norwegian tax system. The body also operates an in-house computer center and a print shop in the same building. The latter activities also include providing services to other public bodies. The NTA has employees located in about 170 buildings throughout Norway.

NTA is a member of a national project called “Green State Project”. As part of this the body also keeps accounts of its CO_2 emissions. These accounts show that after two years, a third of NTA’s emissions are from their buildings (nationally). Another third is from transport of employees between their homes and their job location. The final third includes printing, internal travel (between locations), etc. NTA has a standard requirement for new lease contracts that the building should meet the label B requirements.

Key persons in NTA for this project:
Director of the real estate department Erik Braun was the project owner of the project on behalf of the tenant. He is a building engineer and has 25 years of experience from different areas in the building industry - as contractor, consultant and landlord - before he started working for NTA.

Tor Steinsland has been working with IT for NTA the last 26 years. He is very dedicated to environmental issues. He has therefore been a person who has advocated for increased ambitions for the project.

Svein Riise works with development, competence development and project management for the IT department at NTA.

Top management was partly involved:
Managing director Svein Kristensen is an economist and has been working in NTA since 1996 and as managing director since 2006.

IT director Inga Bolstad, has studied law and management and has worked in NTA since 2000 and in her current position since 2007. She has a strong focus on CSR (Corporate Social Responsibility), and was in close contact with the project owner during the decision-making process.

4.2 Entra Eiendom AS

Entra Eiendom AS (Entra) is a professional landlord of non-residential buildings.
It is a private limited company but owned 100% by the Norwegian state.
Key financial figures (in 1000 NOK):

	2011	2010	2009
Profit & loss			
Revenues	1 467,8	1 501,8	1 774,9
Profit before tax	805,6	947,1	1 037,5
Balance			
Equity ratio	31.1 %	31.3 %	30.6 %
Total equity	7 391,4	6 952,4	6 608,7
Total liabilities and equity	23 740,3	22 225,6	21 343,4

* 1 NOK= EUR 0.136, USD 0.166 (03.08.12)

Entra’s business concept is to add value by developing, leasing and operating attractive and environmentally friendly premises.

A short time after signing the lease contract (for a class B building), Entra concluded “an Environmental strategy” which stated that the company should be a leading actor in the development of sustainable buildings.

Key persons in Entra for this project:
Director of projects and development Bjørn Holm is an engineer in building and construction. He has previously worked as CEO of a construction company and before that as a project leader. He has worked in Entra for eight years.

Market director Anders Solaas holds a Master in business and economics. His previous experience includes working as CEO of a real estate company and as a financial manager. He has been employed in Entra for the last 12 years.

Managing director Kyrre Olaf Johansen (until April 2012) is an engineer and has previously been CEO in road construction companies. He was the manager of Entra for four years. He played an important role in particular in the latter part of the decision-making process.

4.3 Optimo Prosjekt AS (OP)

The company was a part of Entra until 2010. The managing director Bjørn Grepperud is now the majority owner of OP. The company's activities include project planning and management, engineering and construction site management.
Assignments for Entra count for more than half of the company's activities.

The company also energy certifies other companies. OP did not have previous experience with BREEAM before this project, nor with passive houses. However, the company has experience from upgrading three buildings to reach the energy label B.

Key financial figures (in 1000 NOK):

Profit & loss	**2011**
Revenues:	78.311
Profit before tax	4.016
Balance	
Equity ratio	26%
Total equity:	13.876
Total liabilities and equity	53.218

* 1 NOK= EUR 0,136, USD 0,166 (03.08.12)

Key person in OP for this project:
Managing director Bjørn Grepperud was responsible for the planning and management of this project. He is a building engineer and economist. Previously he has worked for other large Norwegian building consultant companies and for a construction company. For the past 11 years he has worked in OP and for Entra.

4.4 AF Gruppen Norge AS (AF)

AF is a publicly listed company. This project was carried out by the company's division for renovation projects.

The general mission of the company (group) is to clean up from the past (which includes a strong focus on sustainability) and building for the future (focusing on efficient use of materials and use of renewable energy).

The company does not have a special strategy for energy efficiency. Their philosophy is to adapt to customer specifications, but actively promote better solutions they have experienced before (which happened in this case).

This is the first project that AF has used BREEAM in a renovation project. However, this has not changed the way they planned to operate the project. Now, several employees are being trained and will be certified in BREEAM.
The company is not ISO-certified, but has its own QA system. This system is now being adapted partly to BREEAM.

The company has no previous experience with retrofitting with energy efficiency ambitions. However, the experiences from a project in Kristiansand (Kilden) using prefabricated wall elements were extremely relevant for this project.

Key persons in AF for this project:
The project director Philip van de Velde was the project responsible on behalf of the contractor for this project. He is a Dutch building engineer. He has many years of experience as project manager

for bigger contractors with projects in the Netherlands (where he already had a strong focus on sustainability in buildings), Portugal and in the Middle East. He has worked for AF for the last six years.

Tommy Simenstad was the project manager for AF. He is a master carpenter. Earlier he ran his own company as contractor of smaller buildings. He has been working for AF for the last six years.

4.5 Other important actors

Enova is a state-owned enterprise that works to trigger energy efficiency measures and renewable energy production. In this project, Enova gave investment support to the measures that were necessary to bring the project to passive house level, according to the Norwegian definition.

Katharina Bramslev from the company Hambra was the environmental coordinator on the project, and is an Approved Breeam Professional. She has a long experience in green building design, is one of the leading persons for the Norwegian Green Building Alliance, and has been involved in a number of pioneering building projects in Norway.

Arne Førland-Larsen from EnergeticaDesign was the energy consultant on the project. He has a long experience in green building design and is working as a consultant for the Norwegian Green Building Alliance. He has also been involved in a number of pioneering building projects in Norway.

5. The decision-making process

This section will look at each of the major decisions made by the different actors involved in the project. The final result is a consequence of the sum of these decisions.

5.1 Expiration of existing contract

The landlord contacted the tenant to discuss the terms for prolonging the existing contract.

NTA rejected this proposal as they wanted to check the market for options. Reasons for this were:

- Big contracts should be won through tendering processes.
- The occupants were not satisfied with the indoor comfort of the existing buildings.
- They wished to have more space-efficient premises, i.e. fewer m2 per employee.

NTA established a project group comprising persons from the IT department, the real estate department and from the consulting company OPAK. With additional assistance from the architect company Mellomrom, the description of the request was made.

The general terms for NTA to enter new lease contracts requested a B class building.

5.2 Entra's reaction to the tender

Due to the size of the building, it was extremely important for Entra to win this competition. The company would face a challenge in making the existing building attractive for a new tenant with a similar space requirement. It is questionable if Entra would take on the risk to upgrade the building to such a high standard without having signed a contract with a new solid tenant.

Entra concluded that they had to come up with/develop something innovative. Therefore three architects were hired to work independently to come up with some innovative suggestions. The architects were not given any special requests regarding energy efficiency. However, energy efficiency was an important part of the recommended solution from the architects. The solution was to link the five building blocks together with new sections between them and to replace the gateway bridges which previously linked them together. This gave some important advantages:

- Increased space and simultaneously reduced outer façade per m2, which of course is very energy efficient. However, they faced a challenge in achieving sufficient daylight on office areas facing the new enclosed volume.
- Better interactions between different departments of NTA due to easier access between the blocks.
- New possibilities for new lay-out of the premises which resulted in more efficient use of the space (reduced m^2 per employee).

In addition to this, Entra also found a solution as to how the data central could remain in the building during the renovation. Relocating the data central would have been very costly. If it were to have been moved to a temporary location and then back again, this would have been a significant disadvantage compared to the competing offers. By letting the data central remain in the building this was switched to a competitive advantage.

Another big challenge was how to deal with about NTA's 860 employees during the renovation process. It was questioned whether they could be relocated internally between the five blocks during the construction process, as NTA leased about 70% of the building. However, this was not a realistic solution as there would be very intense work also going on between the blocks.

It was therefore concluded that Entra would have to include relocation to temporary premises for two years as part of the package. Entra offered NTA to move into newly renovated offices in a very attractive location.

5.3 NTA's evaluation of the offers

NTA received in total 17 offers for rent of locations. After some evaluations of the offers, there remained three very good solutions for NTA.

Based on a set of selection criteria such as price, effective layout (i.e., number of m^2 per employee), good working conditions for all categories of employees (including print shop and data central), access to public transport, extremely high security level for access to the building, NTA's image as concern for the environment/sustainability and modesty in expenditures, they eventually chose the offer from the existing landlord.

5.4 Entra suggests A label/PH building

Two important initiatives entered the process after the contract for a label B building was closed between the two parties; a) Entra's board concluded a new strategy to be a leader within energy efficient buildings, and b) the energy consultants advocated strongly that the building could be upgraded to the Passive House standard and achieve the energy label A.
Such a solution would also result in a grant from Enova, the Norwegian energy efficiency body, which would cover about half of the additional costs for increasing the ambition level. The management in Entra launched this idea for NTA and

argued that this would give them a better building and stronger image.

5.5 NTA rejects and later accepts it

NTA was very concerned that this change of increasing the energy label from B to A would bring a negative impact on indoor comfort. They had several critical questions regarding the consequences of changing the plans. This also included a possible delay in the progress of the project and the fact that they already had put much effort into developing the B label building. The initial responses were not enough to convince NTA that this was a good solution. As a consequence they rejected the proposal.

Entra prepared a consequence analysis of moving from a B class building to a PH/A class building.

After Entra had presented the consequence analysis, NTA's new project manager Arne Nordrud from Uniconsult played an important role to turn the skepticism in NTA into a positive conclusion. This process involved the top management of NTA, which supported the idea due to the expected positive image building of the organization. Further, it was used as an argument that Enova (the Norwegian energy efficiency body) already had expressed that they would support the project. Discussions focused on the fact that this could be an outstanding reference project not only for NTA but probably even more for Entra.

NTA finally accepted the proposal of upgrading the building to an energy class A and Passive House standard. However, they were not willing to discuss increased rent compared to the already signed contract.

After convincing NTA to opt for class A/PH, the different organizations within NTA also had to be convinced. Their concerns where primarily that the A/PH class would damage a good indoor climate – and the impact would be indoor temperatures that are too low in winter months, and indoor temperatures that are too high in summer months.

In order to present these concerns a meeting was set up with representatives from different groups in the organization as well as an architect, an energy consultant and other members from the project group. The topics for the meeting were the architectural visions and contexts of the project and the indoor climate in the new building (air quality, thermal indoor climate, daylight, etc.). In order to make it easier to understand, a simulation of the indoor climate in the existing building was presented together with comparing the indoor climate compared with the refurbished building.

5.6 Entra goes for A-label/PH building

The response from NTA was not what Entra had hoped for; however, they had serious discussions as to whether it was possible to take on the additional costs at Entra's own expense. Many would argue that it is commercially wrong to let the tenant benefit from lower energy costs without paying for it. Nonetheless, Entra accepted this since they saw more benefits from this conclusion than from a reduced profit. Important arguments for this decision were: image, i.e. it would look strange after completion that an actor claiming to be "a leader in energy efficient buildings", did not have higher ambitions than a class B for such an important building. The investment will last far beyond the period of the new contract, meaning that they will now get an attractive building that can also be leased in the future. As they increase the area of the building, about 30% of it will be rented out to other tenants. They should expect some higher rent for this area. The grant from Enova was also important for the conclusion. In addition to the economic aspect, it was also considered as prestigious that Enova confirmed this as a very good demonstration project.

5.7 Tendering process to contractors

When the final conclusion was reached, Entra started a tender process based on renovation to class A/PH. In order to keep a tight time schedule it was decided that the project be split into three parallel contracts:1. main construction (structural), which was won by AF Gruppen ASA (AF), 2. technical, which was won by YIT, and 3. interior, which was finally decided to be managed as a separate task by the landlord's representatives.

5.8 AF's efforts to win the contract

The contractor AF Gruppen considered how they best could develop a competitive offer. As the blocks are quite tall and big they saw it as a huge challenge to secure a dry building. The costs of mounting a “tent” over the building would be very expensive. They concluded that they could take advantage of experiences from another project in Kristiansand where they built a big culture center (not PH standard) by using prefabricated wall elements of wood. The key person in the subcontractor which manufactured these elements had previous experience from a PH project using prefabricated elements. Their offer was therefore to develop a similar concept.

The approach presented to Entra was different from the other offers. AF made a video to illustrate their concept and the advantages of it. Entra concluded that this was the most competitive offer and contracted AF for the biggest contract which included dismantling the old outer façade and roof and replacing these with new elements, as well as the construction of a new area between the existing blocks and the overall responsibility for Health, Environment & Security for the project.

5.9 Completion and relocating

In November 2013 most of the employees could return to the upgraded building. The Norwegian Tax Administration wanted to increase their rented space by another two floors, representing about another 10% of the building. This meant that the available space for let/lease to other actors was reduced from 30% to 20%.
The print shop was postponed to spring 2014 due to investments in new machinery by the tenant.
Due to a delay in the delivery of the aluminium façade, the relocation had to be done in parallel with final installation and testing of the technical systems, and this was not optimal. The delay was due to bankruptcy of the sub-supplier of the panels. The main contractor had therefore to organize the final production of the façade. Also the manufacturer of the wooden elements went bankrupt, but luckily they managed to complete their deliveries before they had to close their business.

The responsible for this project on behalf of the tenant summarized the completion of the project:

- The overall experience with this project has been very positive.
- Due to the delay in completing the finishing, they had to move into the building while installation work and testing was still going on. This was not optimal but they had informed the employees in advance to expect some inconvenience due to noise, etc.
- Already after the second week, most of the installations functioned impressingly well. The indoor air quality felt very good

and only few complained about the temperature.

- The tenant may now profit from a substantial reduction in energy costs due to the passive construction and the use of the excess heat from the data central. Before the use per m2 could on cold days be typically 250 kWh/m2, but so far (until May 2014) the average energy use have been 110 kWh/m2. This means a potential for savings in energy costs for NOK 3-3.5 mill a year.
- Before leaving the building before the retrofitting started, all employees used cellular offices. In the temporary offices the ratio between open space and cellular offices was 90/10, in the upgraded building the ratio is 85/15. Most of the employees are content with the open solution. The legal and the development departments have experienced difficulties with the open solution and some adjustments have been done, but still there are some challenges. For other departments the change has been positive, but it is a prerequisite than people change their habits regarding phonecalls (have separate small conversation rooms) and tidiness (no separate garbage bin for each workplace).
- On sunny days the shading system is not good enough. The shading goes down automatically but can also be manually controlled. The problem is however that 6% of the shading is perforated and it feels like 20%. Other shading systems use 3% perforation. This issue is yet not solved.
- Still the NTA uses Energy class B as a minimum requirement for new projects. However, this building will be a good example of how to plan space efficiency; 23m2 per employee (36m2 before retrofitting). For new projects passive house/class A standard will only be chosen if it can compete (taken into account additional energy savings) with Energy class B.
- Due to the high space efficiency the rent cost per employee has decreased and is now about 15% lower than the average of alle building NTA currently is renting The rent (incl energy costs) per m2 is slightly higher than NTA's portfolio of rented premises.

The project manager summarized the main experiences from this project:

- Major technical installations (heating, ventilation and electricity supply) functioned satisfactorily. Only minor adjustments regarding temperatures in different zones of the building were needed.
- The decision to use BREEAM was taken too late in order to get an optimal result. As a consequence, they could not achieve the targeted class "excellent", but the project qualified for BREEAM class "very good". For future projects they will motivate landlords to use BREEAM from the beginning if they want to focus strongly on energy efficient buildings. He argued that if you want to go for low energy or passive house standard, the use of BREEAM is not an additional challenge, but rather a good tool to secure a good process towards the goal of a sustainable building.
- This project has increased the focus on sustainability among all actors involved. They have experienced that it was not that difficult.
- They experienced the challenge of having the data central in the

basement during the construction work. Other challenges involved incidents with water leakages and vibration problems, but these were resolved without disturbing the operations of the NTA.

6. Lessons learned

6.1 Introduction

This project focused from the very beginning on energy use, as NTA had requested a B label building in the tender. This was a consequence of the organization's procurement policy which specified this claim for new lease contracts.

The most interesting point in this case was how and why the project turned out to be even more ambitious regarding energy efficiency.

6.2 Important drivers

The following lists the most important drivers for increasing the ambition level of the project:

- It was already an energy efficiency focus from the tenant's side.
- Entra's had a new strategy to become the industry leader in environmental efficiency.
- The energy consultant advocated strongly that it was possible, feasible and sustainable to renovate to Passive House standard.
- The project leader hired by NTA also believed in the idea and convinced the landlord that the proposed solution would be beneficial.
- One of the key persons at NTA was very enthusiastic about the idea and was an internal promoter of increased ambitions.
- Enova's grant was the final argument (but not decisive) for concluding the proposed alternative. Enova's support encouraged the decision makers to see this as a prestigious and sustainable visionary project/a visionary project in terms of sustainability.
- The top management in both NTA and Entra saw that the project would support their respective organizations' social responsibility objectives and thereby strengthen their image.

6.3 Important barriers

There were some barriers that could have altered this project:

- The need for relocation to temporary offices was a significant disadvantage. If it would have been necessary also to relocate the data central, it is likely that NTA would have chosen another landlord. It would also have been questionable whether Entra would then have been able to renovate the building to such a high standard.
- Lack of knowledge by the tenant in combination with imprecise information from the landlord and consultants regarding the consequences of increasing the energy standard of the building. The tenant expected that the indoor comfort would be poorer with the chosen solution. In particular, they worried about significant delays in adjusting the indoor temperature.
- NTA could not accept an increased rent. As a public body they focused on efficient use of the tax payers' money. It would also be a deviation from the tender.
- Tight time schedule made it difficult to consider the consequences of the new proposal. However, intensive work by the consultants and the increased

involvement of the top management overcame this barrier.

6.4 Main conclusions

Some factors may be both a driver and a barrier depending on how they are dealt with. One is communication which is extremely important in such projects. Due to imprecise information, the idea of increasing the energy standard was first rejected. When better documentation was presented the conclusion was changed. An example of good communication is how AF developed a video to sell the innovative idea of using prefabricated elements instead of traditional on-site renovation.

Due to the extensive construction work in the existing building, it would be more convenient for the occupants to move directly to new premises. But as a solution was found for the data central, this disadvantage was turned into an advantage.

The final result of this renovation project will be looked at as visionary and innovative. This is mainly a consequence of:

a) Companies challenged by competition. This can be seen first in Entra searching for new approaches to solutions for the tenant, and later by AF which launched the idea of using prefabricated elements.

b) Company policies which expressed ambitions regarding energy and sustainability.

c) Individual persons combining their skills and enthusiasm to convince others to increase the ambition level.

d) The increased public focus on sustainability has influenced this indirectly through the persons involved and the company policies.

The project responsible on behalf of the tenant summarizes the conditions for accepting the same standard for their next project as follows:

- The rent may not be significantly higher than an energy label B building.
- More landlords to offer PH buildings (need to have competing offers).
- Reduction of the number of cellular offices in order to reduce the number of total m2 to rent.

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http://www.afgruppen.com/

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

Annex 10: City Hall in Kristiansand, Norway
Decision-Making Process


(Photo: Strømme)

1. Introduction

There exist very few outstanding examples of ambitious renovation projects in the non-residential sector in the world. The IEA SHC Task 47 studies the best demonstration projects in the seven participating countries. In subtask B the decision-making processes are studied in particular.

This specific case profiles the city hall (Rådhuskvartalet) in Kristiansand, which by number of inhabitants (85,000 by 3rd quarter 2013, source: SSB) is the sixth largest municipality in Norway.

The municipal administration is located in various owned and rented buildings in the centre of Kristiansand. The poor indoor air quality has been a great issue for several years. This combined with the disadvantages of an administration spread over several buildings has made it necessary to take action. The municipal council concluded that the administration (about 500 employees) should be gathered around the old city hall square centrally located in Kristiansand. The new and renovated premises consist of about 15,000 m2, of which 10,000 m2 is new construction and 5,000 m2 renovation. The old façade of buildings built in the 1890s is restored as an envelope of the new building towards the square. The renovated building was built in the 1970s. The renaissance-style square originates from the 1640s when the Danish-Norwegian king Christian IV founded the city (in July 1641). It was therefore important to maintain the renaissance-style city plan which included the square.

The municipality has also defined itself as a frontrunner in developing green energy and sustainable projects. It was therefore an aim to combine high energy ambitions, protecting the historic values of the area with very functional premises with universal and good indoor air quality. Net energy need was calculated to be 84 kWh/m^2/year, while estimated delivered energy was 73 kWh/m^2/year.

Due to the complexity of the project a partnering contract model was chosen.

The following individuals were interviewed in order to learn from the decision-making process in this project:

Representing the owner and users:

- Mayor Arvid Grundeskjøn;
- Deputy mayor Jørgen Kristiansen;
- Councilman Tor Sommerseth;
- Director of real estates Hans-Christian Gram;
- Project manager Arne Birkeland

Other key actors:

- Richard Strømme, representing the main contractor;
- Engineering manager Erik Borgenvik
- Technical advisor Yngve Arntzen

2. Milestones

These are the milestones for the project:

- Initial idea launched: Jan 2006 (co-locating)
- Order by the council: January 2007
- Partnering contract signed: Autumn 2007
- First outline project: April 2008
- Revised regulation plan for the area: November 2009
- Council decided to postpone the project for one year due to strict budgets: Dec. 2009
- Revised outline project: 2010
- Council decided co-locating: March 2010
- Decision to aim for class A/low energy: March 2010
- Final version of the project plan: Dec 2010
- Council approves project plan: March 2011
- Start up renovation: Summer 2011
- Renovation project completed: Feb 2014

3. Technicalities in short

Facts about the project:

- Originally built: 1890s and 1970s.
- Original architect: Brandtzeg's Arkitektkontor
- Renovation architect: HRTB Arkitekter
- Employees in the building before renovation: 300 (200 of these had to be relocated temporarily)
- Type of building: City hall, service and grocery shop.
- Space before: 5,000m^2 (renovated building)
- Space after: 14,300m^2 (some replaced demolished buildings)
- Planned energy use:73 kWh/m^2/year (delivered)
- Total cost: NOK 535 mill, (EUR 67 million)
- Construction cost: NOK 485* million (EUR 61 million)
    - Estimated to be 6% higher than building code (by 1997)
    - Financial grant from ENOVA NOK 6 million (EUR 0.7 million)
    - * Note: prognosis
- BREEAM: Very good (aim)

Renovation measures

Initially, the idea was to make this as a showcase which also included fiberoptic and solar panels. Due to costs and that the local production of solar wafers was moved to China, this idea was abandoned.

- Initial plan – Energy class A–close to PH
    - Upgrading of building envelope
    - Very efficient heating and ventilation systems
        - Use of energy wells and heat pumps and DH for peak loads
        - Heat recovery from data central
    - Energy efficient lighting
        - Regulation on need+ daylighting, LED
    - Combined with new construction
    - BREEAM: Very good (aim)
- Revised plan – Energy class B and low energy standard for existing and PH for new buildings
    - Due to the necessity to use DH – class A was not possible.
    - BREEAM: Good

The old façade towards the square was kept and used as the façade of a new modern building. This part of the project may therefore be called "new construction". One of the buildings, the Fevennen building (5,000 m2) was originally built in the 1970s and was renovated in line with the old style of the surrounded buildings.

The aim for the renovated building was to achieve label B and low energy standard, while for the new construction the aim was to achieve an energy label A and Passive House level. However, due to the choice of district heating as the primary heating source, an energy class A could not be achieved for the renovated building or for the new construction.

The Fevennen building (Photo: Google Maps

It was also decided to restore the old fire tower, which is an important historic symbol for the city (it can be seen in the top of the picture above).

4. The main actors

4.1 Municipality of Kristiansand (MK)

Kristiansand is located at the southern tip of Norway.

The 500 employees in the municipal administration have been located in eight different buildings, all of which had rather poor indoor air quality. The distributed locations also led to challenges in the daily operational work as well as to building a common organisation culture. Due to low efficiency in square meters per employee, it has been necessary to rent offices from private landlords in addition to the buildings owned by the municipality.
MK therefore plays the role of both user or "tenant" of the buildings and landlord of the buildings in this project.

MK is a member in the national project "Framtidens byer" (Cities of the Future) which is a collaboration between the Norwegian Government and the 13 largest cities in Norway to reduce greenhouse gas emissions and make the cities better places to live. The project started in 2008 and was completed in January 2014.

New businesses related to renewable energy have been established in the region of Kristiansand. The regional university also has a strong focus on this business and sustainability.

Political, educational and business actors in Kristiansand have therefore joined forces to establish the city as a leader within the development of sustainable concepts for buildings and renewable energy.

Key persons in the Municipality of Kristiansand for this project:

Per Sigurd Sørensen was mayor of Kristiansand from 2007-2011, during which time it was decided to start the project. He was very enthusiastic about the idea to make this project a showcase of how to make use of energy efficient solutions to build *"the buildings of the future"*. When he fronted this idea publicly he stated: "We will build Norway's most energy efficient city hall, and this will contribute to converting/transforming Kristiansand into a low carbon emission society".

Mr. Sørensen represents Høyre, the Norwegian Conservative Party. He is educated as an economist and has previously held management positions in international-oriented companies and in banking. After his period as mayor he started working as director of the Faculty of Economics and Social Sciences at the University of Agder which is located in Kristiansand.

Arvid Grundeskjøn was the successor mayor of Mr. Sørensen. He also represents the Norwegian Conservative Party. He is educated in economics and law. His work experience is from shipping and real estate businesses.

Mr. Tor Sommerseth has been the councilman in Kristiansand since 2003. In this project he was also the chairman of the steering group.

Mr. Erik Sandsmark has not been involved directly in this project, but as he is the local project manager of the national project "Cities of the future" he influenced the ambition level. He advocated strongly for high ambitions for all sustainability aspects.

Mr. Arne Birkeland has been the project manager of the project. He is employed in "Kristiansand Eiendom" (real estate) which is a separate department of the Municipality of Kristiansand. His previous excellent record as project manager was an important reason for this appointment which included a high degree of delegation.

4.2 Arbeidsfellesskapet Kruse Strømme DA

The main contractor of this project is Arbeidsfellesskapet Kruse Strømme DA, which is a 50/50 joint venture between the two construction companies Kaspar Strømme AS and Kruse Smith Entreprenør AS. Both companies are based in Kristiansand.

Key financial figures for Arbeidsfellesskapet Kruse Strømme DA:

In NOK 1,000	2012	2011
Profit & Loss		
Revenues	122 113	41 319
Profit before tax	9 715	4 224
Balance		
Total equity	13 939	4 224
Liabilities & equity	55 999	23 842

Kaspar Strømme AS is family owned company which in a few years will be managed by the fourth generation of the family. The company has taken on a special social responsibility by supporting children in Uganda with two soccer fields with accompanying facilities. The project is also supported by the employees in the company, and has become a part of their business philosophy.

The company has no official strategies regarding energy efficient buildings, or does it have experience from other low energy building projects. They have a more modest style by stating: "since 1936 we have let the buildings express what we stand for – no big words are needed".

Key financial figures for Kaspar Strømme AS

In NOK 1,000	2012	2011	2010
Profit & Loss			
Revenues	167 310	265 297	110 701
Profit before tax	2 551	-3 574	-1 940
Balance			
Total equity	27 225	22 601	25 011
Liabilities & equity	75 277	100 509	72 574

Mr. Richard Strømme, son of the managing director of the company, has been responsible for the joint venture of this project. He graduated as an engineer in 1994 and worked for seven years for another big Norwegian contractor before he started working in the family business. He was enthusiastic about this project due to the size and prestige of it. The contract model was also not common, so it has been a very interesting "journey".

Kruse Smith is Norway's sixth biggest contractor and is also active in real estate development. The group's main market is the southern part of Norway, and includes these divisions: building construction, building retrofitting and real estate development.

Kruse Smith has a strategic focus on research and development: "The mandate for R&D is to keep up-to-date with new methods, processes and materials that can be used to make building projects more efficient. One of the measures implemented by R&D is LEAN (Lean Manufacturing) in addition to an increased use of BIM (Building Information Modelling) during engineering work". (From Kruse Smith Entreprenør AS's annual report).

The Kruse Smith Group highlights environmental protection during projects. The Group has also carried out R&D within sustainable buildings which they expect will have a positive impact on their competitive edge. The company has previous experience in constructing new office buildings fulfilling the Norwegian Passive House standard.

Key financial figures for Kruse Smith Entreprenør AS:

In NOK 1,000	2012	2011	2010
Profit & Loss			
Revenues	3 634 704	2 717 401	2 540 585
Profit before tax	52 906	35 570	14 070
Balance			
Total equity	296 493	291 733	280 120
Liabilities&equity	1 406 460	1 251 075	1 074 911

Mr. Yngve Arntzen graduated as an engineer in energy and climate in 1979. He worked for about 30 years as advisor in an engineering company before managing a ventilation company for three years. He worked two and a half years in the municipality of Kristiansand before he joined Kruse in October 2012. Mr Arntzen was employed in Kristiansand Eiendom at the start of the planning of this project. At that time he worked as technical advisor for the project manager. The company wanted him to continue being the advisor for the municipality in this project, even though he is now employed in one of the contracting companies.

4.3 Rambøll Norge AS

Rambøll Norge is a subsidiary of the Danish engineering consultancy Rambøll Group which is represented in 21 countries. The company is one of the major companies within its field in Norway with its 1300 employees distributed in their 21 offices. Sustainability is one of the pillars in their business philosophy and they have been involved in planning several low energy building projects. The department located in Kristiansand has earlier been involved in two big renovation projects, both with substantial improvements in energy performance and with old protected facades.

Key financial figures for Rambøll Norge:

In NOK 1,000	2012	2011	2010
Profit & Loss			
Revenues	1 519 062	1 265 106	1 074 967
Profit before tax	74 957	24 464	54 369
Balance			
Total equity	166 992	175 094	175 653
Liabilities&equity	558 755	569 613	503 112

Mr. Erik Borgenvik took over the responsibility for the engineering work of the planning of this project in spring 2010. He graduated as an engineer in 1981, and worked until 1997 in another engineering company before he joined Rambøll. He has a special interest in projects such as this that focus on sustainability.

He has also had a strong support team in Rambøll, including an energy advisor, building physicist and certified BREEAM advisor.

4.4 HRTB AS

HRTB has 30 employees and has carried out the architectural work in this project, including the zoning. The company is organised as a partnership between the experienced employees, who have contributed to the design of several big projects in Norway.

Key financial figures for HRTB AS:

In NOK 1,000	2012	2011	2010
Profit & Loss			
Revenues	45 208	45 856	34 920
Profit before tax	5 164	7 463	4 795
Balance			
Total equity	8 304	11 221	9 911
Liabilities & equity	23 438	25 320	20 656

In this project, one of the senior employees, Kjell Beite, and the new partner Tove Eidskrem have been the key persons representing HRTB. Mr. Beite has been a creative force in the project, while Mrs. Eidskrem has been the structured organiser from the architectural side.

4.4 Subcontractors

YIT Norge AS (now owned by the German company Caverion) has delivered ventilation and electric systems to the project.
The local company Halvard Thorsen AS has delivered the plumbing services.

5. The decision-making process

This section will have a look at each of the major decisions that were made by the different actors involved. The final result is a consequence of the sum of these decisions.

The table below shows how the different actors considered the importance of different factors for why the project was initiated. As the interview respondents have been interviewed separately and represent different perspectives, it is natural that the weighting differs slightly. We see that indoor comfort, the organization's strategy together with economic factors such as energy costs and m2/workspace are pointed out by all as the most important factors. It is interesting to note also that co-locating was not presented as an option during the interview, but were added to the list as important by two of the respondents.

	Very important	Important	Some importance	No importance
High energy costs	TS EB		HCG* AB* RS	JK
Poor façade		EB		TS HCG AB RS
Indoor comfort	JK TS HCG AB EB	RS		
Availability of subsidies		JK	TS HCG AB	
Organization objectives/policy	TS EB	JK AB		
Other:: Co-locating Universal design M2/workplace Location(square) Nice premises	TS AB AB RS	JK RS TS RS RS		

Table 01 : Reasons for initiating the project
* During planning this became more important

Abbreviations:
JK: Deputy mayor: Jørgen Kristiansen
TS: The councilman Tor Sommerseth
AB: Project manager (internal) Arne Birkeland
HCG: Director of real estate Hans-Christian Gram
EB: Engineering manager Erik Borgenvik
RS: Main contractor Richard Strømme

5.1 Conclusion of location

The poor working environment for the MK administration had been an issue for several years. The current councilman is the third person who has been working with this issue. However, due to strict budgets and higher priority given to care homes, schools and kindergartens the construction of a new city hall had been postponed.

Finally the conditions had worsened so much that it had become a critical issue. In fact, the Labour Inspection Authority requested in 2006 for action to be taken otherwise some of the premises would have to be closed down. There were also some embarrassing situations such as when they had to stop meetings with guests due to bad indoor air quality.

Various options of future solutions to locate the administration were discussed, including relocating the administration to offices outside the city centre.

In January 2007 the politicians decided that the administration should be co-located at the old city square, and that a concept for how this could be solved should be developed. This decision was the starting point for the project.

5.2 Contractual form and organising

Due to the complexity of the project the administration wanted to include the practical competence of contractors from the beginning of the planning process. Through a tendering process the selected team was chosen to contribute in a "partnering contract".
The first part of the contract deals with the planning process. The second part is optional for the municipality and is about the construction phase. When the planning project was completed, Kristiansand municipality decided to hire the same team for the completion of the building project. The contract model set a target budget for the whole project and deviations from this (positive or negative) should be shared between the contractual partners according to a defined key (including the municipality).

The initial idea of involving the executing contractors at an early stage in the project was not followed to the extent it was planned.

Internally, the project manager who is employed in the municipal real estate department reported (unusually) directly to the councilman. This meant a stronger involvement of the top management in MK, but also wider proxies to the project manager.

5.3 Choice of concept

In 2008 a concept plan for combining new construction and renovation of part of the area was developed. The proposal had to be developed in line with the zoning plan. A major issue to be solved was to find solutions which could gather all 500 employees. The first draft included a solution which had 5 floors. This option was rejected as the height would be higher than the old façade which had to be preserved. Focus was therefore to design layout of floor plans which were more efficient regarding employee/m^2. It was decided the ratio between the number of work space covered by cellular offices and landscape would be 20/80.

The process was complicated as there were many interests to take into consideration. Users were also strongly involved in the planning phase. In parallel with the construction project, the municipality had an organization development process with broad involvement from representatives of the employees. The steering group gave input to the building project as well.

This lasted about one and a half years before a revised zoning plan was approved by the city council in November 2009.

Due to strict budgets, the city council decided in December 2009 to postpone the project for one year.

5.4 Choice between five options
The key questions to be answered before starting the detailed planning were:

1. Should the building be rebuilt and refurbished?
2. Should it be demolished and replaced with a new building?
3. Should neighbour buildings be refurbished so that less new construction would be necessary?

Five different options were analysed and LCC comparisons were made.

In addition to the economic evaluations of the options, a qualitative evaluation of the solutions based on the following criteria was also made:

1. enable more integrated management
2. facilitate cooperation and involvement across departments
3. contribute to a better and more attractive workplace
4. good security
5. facilitate better customer service
6. good internal and external communication
7. physical flexibility also for long term
8. low operational costs (energy, cleaning and maintenance)
9. environmentally friendly solutions with good indoor air quality

In a meeting in March 2010, the Municipal Council chose the option which had the highest overall score on the qualitative criteria (50 of a maximum of 54 points), and the third best score on economy. This option included new construction behind the old facades towards the square, retrofitting of the Fevennen building, and continued use of the Treasure building.
The second best option had the lowest lifecycle cost but a lower qualitative score (34 of a maximum of 54 points). The difference with this option was to construct a smaller new building by the square and construct another new building outside the city square and not to retrofit the Fevennen building, which some of the technical experts argued was not economical. The building was however special to many of the politicians as when it was constructed in 1972 it was nicely designed in line with the other old buildings (see photo §3).

In the final evaluation of the options, the chosen one was also considered to be well in line with a good owner strategy:

1. Secure long term flexibility with regards to future needs
2. Vacant space to be let to other tenants until future needs are known
3. Develop vacant buildings in order to increase value of the municipality's real estate portfolio

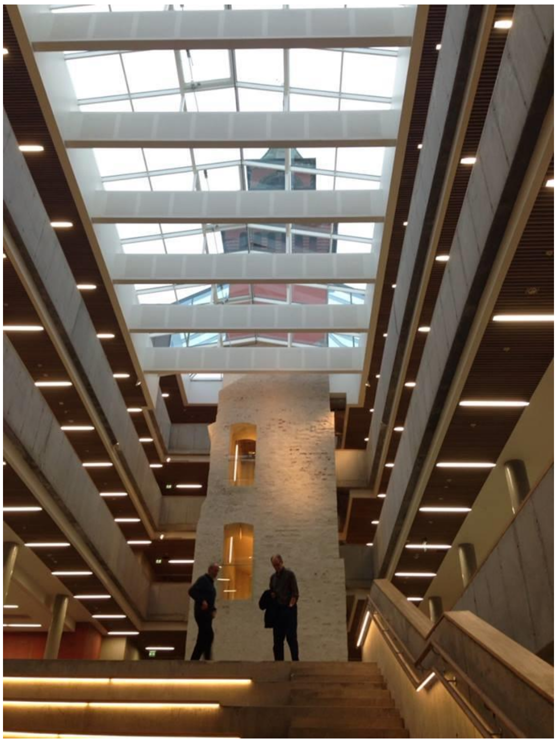
Photo: Inside the atrium and with the old fire tower behind (Kristiansand Municipality).

5.5 Content and goals
In December 2010 the administration presented a solution which would

achieve a low-energy standard for both new and existing buildings, as well as an energy label B (maximum 115 kWh/m2/year of delivered energy for heated space for office buildings) for the new building and an energy label C for the existing Fevennen building. The politicians meant that this ambition was not in line with the overall goal to be a leading city within sustainable development. They therefore asked the administration to come up with a plan to reach a Passive House standard and energy class A (85 kWh/m^2/year delivered energy for heated space for office buildings). The mayor Per Sigurd Sørensen responded defensively and publicly announced his ambitions: "*We are going to build the most energy efficient city hall in Norway*". He had broad political support for his view.

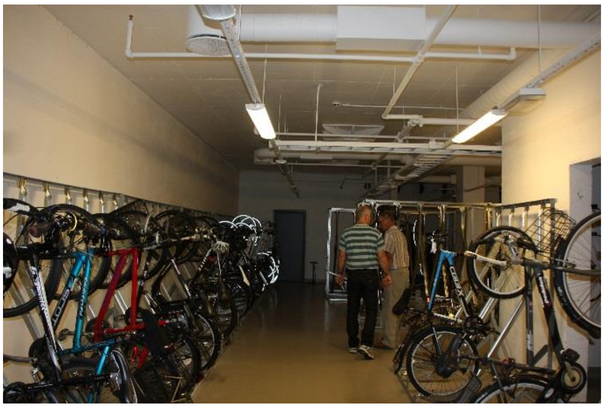

Photo: Bicycle garage (Janne F. Leivdal)

After analysis and calculations by the planner, it was concluded that it was necessary to use energy wells and heating pumps in order to reach Energy class A. As the municipality is one of the major owners of the regional district heating company Agder Energi, it was decided that district heating would be used as the main energy supply for heating. This meant, however, that Energy class A could not be reached. This conclusion frustrated most of the local politicians, as it was difficult to accept that district heating was not found as sustainable as energy wells. National authorities have for several years promoted district heating. Now, they were "punished" for using it on this project. However, they decided to stick to district heating as the primary heating source for the project.

The following goals were defined by the city council in March 2011:

- The project should support the overall project "Sustainable Kristiansand"
- Obtain status as a pilot project in "Cities of the Future"
- Environmental:
    - Low energy standard
    - Energy class B
    - 50% reduction of CO2 emissions
    - BREEAM: "Very good" ("Excellent" was not possible as they already had started the planning before BREEAM was used.)

The idea of installing solar panels and use fiber optics was abandoned mainly due to high costs (cost per kWh for solar panels is more than three times higher than the electricity price).

5.6 Construction

About 300 employees had to move to temporary premises during the construction phase. This was solved by moving 100 of these employees into rented offices which had recently been vacated by the municipal health care administration as they moved into other permanent premises. The other employees were temporarily relocated to other offices (some rented and some owned by the MK).

The grocery shop in the Fevennen building wanted to remain in the building during the retrofitting of the façade, roof and entrance.

During renovation, the main contractor was focused on good communication with this tenant as well with the neighbours. Any conflicts regarding disturbance have therefore been on a moderate level.

Among the project partners there was a lack of experience in using BREEAM. This methodology increased the focus on searching for sustainable solutions at all steps of the process. However, it also meant additional costs directly and indirectly as the partners spent more hours and some frustration by adjusting to the BREEAM requirements.

Protecting the facades and the old fire tower was more challenging than expected and additional measures had to be taken during the construction process. As an example; the architect came up with the idea (after they had started) that the foundation of the fire tower should be made visible in the interior hall.

5.7 Completion and hand over

On 3 February 2014, employees started their first working day in the new offices as planned. The following weekend, the project completion was celebrated by a ski competition for children at the city square outside the new city hall.

Photo showing one of the main art pieces in the building. A line through with small pictures of the city's history is shown on both sides of a central wall in the building. The art is made by Jan Freuchen.

Photo: Svein Tybakken.

More pictures from the opening:

http://www.kristiansand.kommune.no/no/ressurser/Nyheter/Nyhetsarkiv/Folkefest-i-Radhuskvartalet/

The project manager summarized the results as:

- Delivery in line with the plan.
- Space efficiency has been better than planned due to smarter layout of technical rooms and meeting rooms.
- The “icing on the cake” is the fire tower and the atrium which also includes an exhibition of the history of the city.
- The original idea was that the cafeteria for the employees should be outsourced to a company which could use the facilities as restaurants in the evenings. So far, no one has shown interest in this idea.
- There is some free space in the renovated Fevennen building that can be let out.
- Very positive feedback from most occupants.
- Some few complaints regarding lighting and ventilation from occupants have been received.. Measures have already been

taken to adjust to users' needs. All defaults have been registered in a database and are continuously followed up.

- One department was not satisfied with the open layout, and has been adjusted to secure more private work space for about 10 persons (of 250 persons who work in cellular offices).
- The sustainable concept by avoiding car parking as part of the project and instead offering free bicycle parking in the basement and a new bus stop right outside the building has been a great success. All 250 bicycle places are being used. However, the capacity of the wardrobe facilities is too low, and need to be increased.
- The project exceeded the budget by 9% for the municipality after discussion and negotiating with the partners of how to share the extra bill. This means that the partners did not achieve their normal profitability in this project.

6. Lessons learned

6.1 Introduction

This project illustrates that the decision-making process is not straight forward. The complexity due to protection and integration of existing and new construction required a special form of organising as well as broad involvement.

In the initial phase, users were strongly involved in order to communicate their requirements and expectations of the new premises. In the next phase, the project management was given wider proxies in order to respond quickly on issues occurring "unexpectedly" in such complex projects.

Photo: Project manager Arne Birkeland on the roof, in front of the fire tower (Janne F. Leivdal)

6.2 Important drivers

These were the most important drivers for increasing the ambition level of the project:

- Poor indoor quality
- Need of co-locating the organization
- Very enthusiastic and committed mayor with broad support
- Municipality's strong focus on sustainability and on being a frontrunner. This included the membership in "Cities of the Future" which included a local project manager who actively argued for increasing the ambition level.
- High energy costs
- Universal design
- More efficient layout
- Located near to public transport
- Highly respected internal project management which was committed to the idea of high ambitions and good communication skills

- The use of the BREEAM standard increased the consciousness on choosing sustainable solutions. However, this also created some frustration among involved actors.

6.3 Important barriers

There were some barriers which could have altered this project:

- Complexity
- Historic protection
- Lack of an example to replicate
- Issues discovered during renovation which led to a need to make changes to the plan
- No previous experience with BREEAM (and the Norwegian version of this was not available from the project start) led to frustration and increased planning costs

6.4 Main conclusions

- All key actors consider the project a conditioned success:
  - A project to be proud of and expectations of a more efficient organization also due to enthusiasm
  - Did not keep costs within budget frame (+9%)
  - The partnering model was an expensive experience for the partners. This was due to little experience with this form of model, and that the contractors should have been more involved in the planning phase. Post evaluation is needed. The project manager states that for the execution of the project it would have been better to have one contract with one responsible main contractor. For the planning and design phase it may have been appropriate to use a partnering model.
- The specific energy targets should have been defined earlier to avoid the frustration with consequences of choosing district heating as the primary heating source.
- Recommendations to the authorities:
  - More consistent standards; did not reach level A (with DH) due to new definitions in the standard.
  - ENOVA, the Norwegian Energy Efficiency Body, was useful with subsidies and promotion. However, reporting procedures are too bureaucratic.
  - Regulations should differentiate between new construction and retrofitting due to their different challenges.
  - A national body should systematize and disseminate experiences from such projects.

Photo: A history exhibition in the building's atrium (Janne F. Leivdal).

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The Norwegian energy labeling system:

http://www.energimerking.no/no/Energimerking-Bygg/Energimerking-av-bolig/Om-energiattesten/Energimerkeskalaen/

BREEAM

http://www.breeam.org/

This project described by other sources:

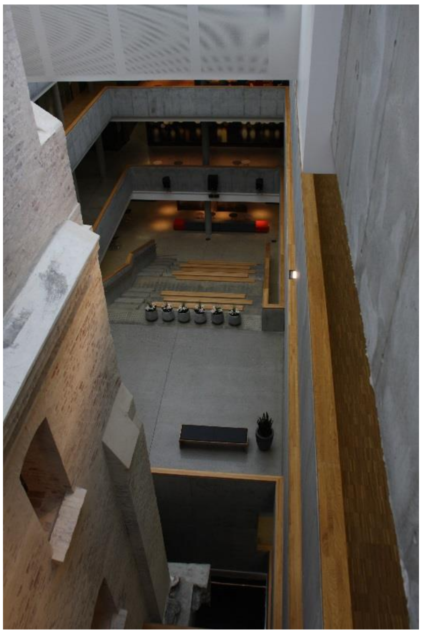
http://www.arkitektur.no/brod-miljo-frokost-med-faglig-pafyll7

http://www.arkitektur.no/?nid=233025

http://www.kristiansand.kommune.no/no/ressurser/Nyheter/Nyhetsarkiv/Radhuskvartalet-pilot-i-Framtidens-byer/

http://www.kristiansand.no/no/Nyheter1/Nyhetsarkiv/Radhuskvartalet-i-Kristiansand--flott-og-publikumsvennlig/

http://www.nbef.no/fileadmin/Kursprogrammer/2013/1350106_Livslopsplan_LCC/LCC-Forum-080213_Ramboll_Raadhuskvartalet_Slagstad.pdf



Photos: Nice view from the fire tower and into the atrium (Janne F. Leivdal)

More info about:

Municipality of Kristiansand

http://www.kristiansand.no

Kaspar Strømme AS

http://kaspar-stromme.no/

Kruse Smith Entreprenør AS

http://www.kruse-smith.com/

Rambøll Norge AS

www.ramboll.no

HRTB AS

http://www.hrtb.no/

Photo: The old fire tower, Strømm

Annex 11: School in Cesena, Italy
Decision-Making Process

1. Introduction

There exist very few outstanding examples of ambitious renovation projects in the non-residential sector worldwide. The IEA SHC Task 47 studies the best demonstration projects in the seven participating countries. In subtask B the decision-making processes are studied in particular.

This paper describes the decision-making process of the renovation of the Tito Maccio Plauto secondary school in Cesena, Italy:

- Owner: Municipality of Cesena
- 30 classes and labs, 389 students, 49 employees
- Area: 6,420 m2; Volume: 24,554 m3
- 3 Storeys + Basement
- Global Energy Performance index:
  Before the renovation: 154.3 kWh/m2
  After the renovation: *32.3 k*Wh/m2
  (IT Practice in this climatic zone: 79 kWh/m2
- Expected primary energy savings: 79%
- Target ambition increased from 40 to 36 kWh/m2 and finally to 32kWh/m2 during the process.

Tito Maccio Plauto school was built in the 1960s, and building has not undergone any energy renovation or important maintenance since.

The school is a C-shaped isolated building in a medium-size town in northern Italy, 2130 Kd (basis for calculation 20°C), located in the second coldest climatic zone (E) in Italy.
The use profile of the school is as follows:

- Offices and school classrooms: morning and afternoon (Monday to Friday), morning on Saturday
- Gym and music hall: also used in the evening and during weekends, with variable schedules
- No use of the buildings in July and August.

The renovation project (2011-2014) aimed at lowering the net energy consumption and improving the indoor environment quality. It included:

- energy conservation measures on the whole building envelope and on the heating, ventilation and lighting systems
- measures on energy supply, integration of RES (PV plant)
- advanced monitoring and control within the urban management system.

The renovation was characterised by limited additional costs, even if they increased compared to forecasts, and resulted in the re-design of architectural features and benefited from user participation. Particular concern and challenges resided in guaranteeing the school could continue to function during renovation for lessons, use of facilities and office activities.

Cesena municipality is a signatory (2009) to the EU Covenant of Mayors and its SEAP (2011-2020) contains ambitious energy efficiency targets for the public building stock. Prior to the renovation, the Municipality carried out an energy auditing campaign, identifying Tito Maccio Plauto school as performing particularly low in terms of energy use and indoor comfort.
In spite of limited economic resources in Italian public authorities at present, the opportunity for co-funding as a renovation demonstration case within the VII FP project 'School of the Future' was extremely helpful to develop a new process, which hopefully will be replicated.

As a partner of this project, from the beginning of the renovation process, ENEA continuously liaised with the following key actors in the chain:

- Process Responsible (Executive Director, Department for public works, Cesena Municipality)
- Designer (Energy renovation), Energie per la città (Cesena Municipality in house society)
- Regional, National and European Projects Service , Municipality of Cesena
- Construction site supervisors; Municipality of Cesena

The Municipality staff released two further interviews for reporting within IEA Task 47, supplying data on the contractors, on the occupants' evaluation surveys and information on the process.

2. Milestones

The milestones of the project are:

Idea was born
At the beginning of 2011

First brief project description completed
April 2011

Detailed project description completed
December 2011

Tendering process started
at the beginning of 2012

Signing of contract with main contractor
Springs 2012

Start renovation
Summer 2012

Renovation completed
at the beginning of 2014

Evaluation among occupants
February 2016

3. Technicalities in short

Design

- Energy Renovation Design: Energie per la Città
- Architectural design: Municipality of Cesena - Department of Public Works Technical Office

Energy performance index

- Before: 154.3 kWh/m2
- First planned: 41.04 kWh/m2
- Final planned: 32.3 kWh/m2 year
  Expected primary energy savings: 79%
  100% Electric energy covered by RES

Predicted cost for EU funding

- EUR 709,000 + VAT (about EUR120/m2)
- ENVELOPE: EUR 585,000 + VAT
- HEATING SYSTEM EUR 45,800 + VAT
- PVS: EUR 77,946 + VAT
- EU 7 FP contribution: EUR 452,000
- Remaining costs: Public Funding from the Municipality

Real costs

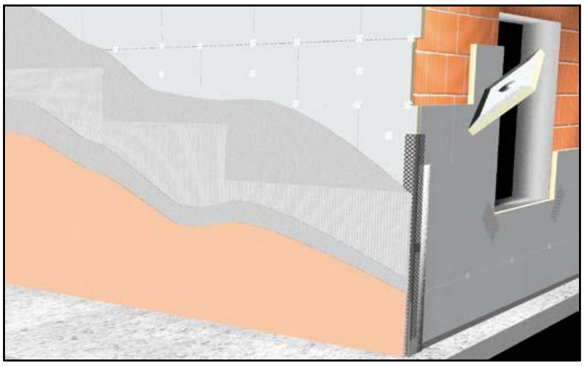
Costs increased by 30% owing to the higher performance level decided during the renovation process and due to the unpredicted conditions during the executive phase.
The renovation included the following measures:
Energy conservation: auditorium basement and roof insulation, gymnasium walls insulation, window replacement (old iron single frame windows cover 30% of the building envelope), thermostatic valves at the radiators, installation of a mechanical ventilation system with heat recovery, lighting control and high efficiency lamps.

Summary of U values *W/m²K*	**Before**	**After**
Slab/ceiling (attic floor)	2,31	0,185
Walls (school)	1,85	0,30
Floor/slab (basement)	1,33	0,31
Windows	5,71	1,14
Gym roof	2,32	0,28
Gym Walls	1,85	0,37

Efficient energy supply: replacement of traditional natural gas boilers (1977) with high efficiency condensing boilers
RES Integration: installation of a 28 kW PV plant on the southern roof pitch.
Advanced control and monitoring: BEMS and monitoring system connected with the centralized urban management system. BEMS will control thermal, acoustic, ventilation, lighting and PV functionalities.

Renovation works timetable:

- ENVELOPE 5/07/2012 to 18/09/2013, interruption during the school year (September 2012 – June 2013)
- HEATING SYSTEM 12/07/2013 to 8/8/2013
- PVS: 15/04/2013 to 20/08/2013



4. The main actors

1. *Municipality of Cesena* – Owner - Department for Public Works and Integrated Projects Office
2. *Energie per la città* spa – Energy Manager
3. *Main contractors*
4. Building users, school coordinator
5. *ENEA*, Technical Unit for Energy Efficiency, Building unit, energy consultant

4.1 Owner and main customer: *Municipality of Cesena*

Cesena has nearly 97,600 inhabitants in an area of 250 km^2. The number of communal employees is almost 600 with some 45 involved in public building management and urban and planning.
The department for public works was responsible for initiating and managing the project.
Previous experience in the department:

- 30 interventions on technical equipment and systems (in 30 buildings)
- 18 PVS, 446 kWp power supplying 488,000 kWh electric energy
- Remote management and consumption control of boilers in 56 schools and sporting facilities and in 34 public buildings
- Planning, design, responsible for execution, commissioning of public buildings.

PROGETTI DEL COMUNE DI CESENA PER LA SOSTENIBILITÀ E PER LA RIDUZIONE DELLE EMISSIONI DI CO_2	
SOCIETÀ ENERGIE PER LA CITTÀ Società creata dal comune per lo sviluppo e la realizzazione di progetti in campo energetico	Energie per la Città
SCUOLE SOLARI Installazione di pannelli fotovoltaici sui tetti delle scuole di Cesena (a cura di Soc. Energie per la città)	
SCHOOL OF FUTURE Progetto europeo per la riqualificazione energetica della scuola media T.M. Plauto	
ULTIMO KM Percorsi partecipati sulle politiche di mobilità della città	
PIEDIBUS Un modo divertente e sicuro per riscoprire l'importanza di andare a scuola a piedi	
IO RIDUCO - ZERO TRADE Azioni di riduzione dei rifiuti e degli impatti in collaborazione con il commercio e i supermercati	
DIFFERENZIAMOCI! Nuovo servizio integrato per l'incremento della raccolta differenziata dei rifiuti	DIFFERENZIAMOCI
PA IMPATTO ZERO ACQUISTI VERDI, criteri ecologici per gli acquisti del Comune	
Per saperne di più: www.comune.cesena.fc.it/cesenambiente	

List of projects for sustainability in the Municipality

Key persons for this project:
Gualtiero Bernabini, process responsible, Architect, Executive Director of department for public works.
Works as technical staff of the Municipality of Cesena since 1976 and manager of the Public Building sector since 1999. Has experience in building design and building yard direction.

Serena Nesti, responsible for networking and communication, several years of experience in project management, Office for integrated and EU projects. Architect.
Responsible for the EU School of the Future 7FP project.

Roberto Ceccarelli, site manager

Vittorio Tassinari, site inspector and accounting officer and accounting bookkeeper/accountant.

4.2 Energy Manager (and second customer): *Energie per la città*, in-house company

This in-house municipal company was founded in 2011 following the adhesion to the Covenant of Mayors, performing Energy management for the Municipality, and has operated the renovation of 83 public buildings and installed PVs in 22 schools and monitored the results. It performs continuous monitoring and diagnosis of heating systems in public buildings and is also a partner in several EU projects.

Key persons for this project:
Giovanni Battistini, responsible for the Energy renovation design, Engineer.
Relevant experience in:
•Technical design (public buildings);
•Managing and monitoring public energy plants and systems;
•Solutions design for energy production from RES.

Some activities from *Energie per la Città*: “Boilers in the Grid” and “Global maintenance” in public buildings

4.3 Main contractors

4.3.1 PVS: *Sistemi Fotovoltaici.com*

Installation of electronic PV, Heat Pumps, Wind and other RES plants, domotics and control systems.
Has been in the market since 1978.

Certification ISO9001and OG9 cat IV.
Specialised in global service.
Technical responsible: Mr. Critofori Luca, engineer

4.3.2 Heating systems: *Canali Ravenna* (Emilia Romagna Region)

Installation, supply, retail of thermal-acoustic insulations. Installation of air conditioning, heating and cooling systems. Asbestos removal and reclaim.
Technical responsible: Mr. Vichi Raoul, engineer

4.3.3 Envelope insulation: *Adriatica Costruzioni Cervese* Cooperative (Cervia, Emilia Romagna Region)

Certified UNI EN ISO 9001
Alessandro Dozza (technical responsible): surveyor and responsible for the construction of a kindergarten (Rimini) issued of CasaClima energy label (2012-2013).

4.3.4 Technical Systems: *Car Rimini (Consorzio Artigiano Romagnolo - Artcraft Union*)

Certified UNI EN ISO 9001 and ISO 14001. Specialised in global service.
Annual Budget EUR 31.5 million. 320 associated companies (2011).

4.4 Occupants, school coordinator

The school coordinator, assistants, pupils, and sport societies were involved in the renovation site organization.

4.5 ENEA (National Agency for new Technologies, Energy and Sustainable Development): dynamic and stationary simulations, consulting in monitoring and evaluation during the building site and POE (post occupancy evaluation) in the next two years.

5. The decision-making process

The ambition of the project was decided at Municipal and consultancy level (Energie per la Città and ENEA) with the intention to operate a demonstration project.
The Municipal in-house management of the project and the care in networking and liaising with the various actors helped solving unexpected circumstances limiting negative impacts and paving the way for the settlement of an exemplary methodology.

5.1. Preliminary analysis and auditing

Building inspections and survey, pathologies and defects diagnosis, energy and indoor environment quality simulations preceded the design phase.

5.2. Design phase

The design phase was characterised by continuous adjustments during the whole demonstrative process, aiming at increasing the target ambition. Additional insulation and solutions to solve cooling problems (shading, ventilation) were decided as the project was underway. For example, indoor comfort was addressed by completing the predicted windows replacement with the introduction of demand controlled mechanical ventilation systems which are uncommon in Italy. The lowest primary energy consumption also took advantage of attaining an electricity neutral building by increasing the effect of the RES integration (wider PV surface and power from 28 to 55KW), making use of the feed in tariff RES incentivizing scheme in Italy.

5.3 Tendering

Owing to the economic amount of the project, there was no open tendering bid. In order to save time the contractors were chosen by private auction through a simple negotiated procedure, in accordance with the Italian “public contracts code” 163/2006.
The Municipality invited 15 contractors, mainly local enterprises, with 9 of them participating in the selection procedure, based on the most economic proposal.

Further simplification was due to a running contract for the retrofitting of heating systems in public buildings.
It was required to follow legal criteria, with requirements being quite stringent in the Italian public procurement regulations.
Inscription to local chambers of commerce and the "SOA certification", mandatory for construction enterprises to participate in public tenders and works, qualify the enterprises on financial and employment regularity, skills, experience and education requirements of the technical responsible and employees according to the kind of labour.

5.4 Executive phase

Works in the classrooms have been performed during non-operating hours and during the school summer break. Nevertheless the building site phases were adapted pursuant to security matters even when related to other school areas (e.g. scaffoldings on the classrooms facades, fire escape measures). Some compromise was unavoidable: lessons carried on with reduced natural lighting due to façade scaffoldings.
Some minor delays were due to problems affecting product suppliers (including bankruptcy, delays in payments and absence of workmanship) due to the crisis affecting construction enterprises in this period, as well as to the summer vacation period of dealers.
Three on-site visits, beyond the common practice, have been performed by ENEA, the customer (municipality) and the design staff, during the construction phase.
The tight timing of the summer works implied superposition of workmanship and processing.

5.5 Monitoring and operation

Guidelines for occupants' behaviour and use of envelope and technical systems will be produced and provided by the Municipality and the in-house energy management company within the first year after renovation, together with a training session.
Post occupancy evaluation will be performed in 2016 (two years after the end of the renovation).
Continuous monitoring will be assured through the urban management system.

6. Lessons learned

The energy performance after the renovation has overcome the initial forecast, common practice of the Municipality renovation of non-residential buildings, as well as the Italian minimum energy performance requirements.

Particular strength is to be found in the good network, team work between actors and communication with the school users.

A process organization procedure for the renovation of this type of building without interrupting their functionality has been sketched for replication.

6.1 Important drivers

The process has been managed with particular attention paid to project being a demonstration case, with each phase having been regularly monitored. This was also an important driver for increasing the renovation target ambition and the timely delivery.
Participation in the EU project also contributed to the process success, encouraging networking and periodical evaluation and reporting.
The executive process phases were mainly decided according to the requirement for the school to remain functional, involving regular communication between the school coordinator and staff in order to limit interference with the yard organization as well as taking into account safety measures.

Occupants were also involved in the periodical evaluation through proper questionnaires; this also contributed to driving the design choices.
Individual skills of the decision makers and the exemplary role decided for the project allowed to overcome the initial target. For example, the introduction of the mechanical ventilation, unusual in Italy, will demonstrate the feasibility of the measure in relation to the occupants' acceptability and behavior.

6.2 Important barriers

As mentioned above, the main barriers were the economic difficulties and delays affecting product supply during the summer months.
Adapting the execution phase to the school functionality in order to limit interferences was very challenging, though necessary.
The project increased slightly in cost as a result of unexpected problem-solving due to the need for the school to be fully functional.

6.3 Main conclusions

The final performance level reached after the renovation process increased during the process and was favoured by good overall coordination and cooperation between various trades and occupants.
The ambition of the project was decided at Municipal and consultancy level (in-house energy management) with the intention to operate a demonstration and exemplary case as well as a replicable process.
The Municipal in-house management and coordination favoured cooperation between the various actors and helped solve unexpected circumstances that did not finally affect the duration of the process.

As main lessons learned, the success of the process have been driven by:

- experience and practice in coordinating similar projects

- a risk assessment methodology or mitigation plan, in the case of the challenging issue of continued use of the building (interference with the occupants' activities, safety measures, etc.)

- taking into account in the contingent crisis situation issues such as economic uncertainty that may affect product supply, human resources and workmanship availability, and contractual issues.

Authors

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Michele Zinzi, ENEA, Energy Efficiency Building Unit, Italy

Serena Nesti, Municipality of Cesena, Emilia Romagna Region, Italy

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http://www.energieperlacitta.it/

http://www.efficienzaenergetica.enea.it/

http://www.sistemifotovoltaici.com
http://www.acc-cervia.com/completa.htm

http://www.carrimini.it/

Annex 12: School in Schwanenstadt, Austria Decision-Making Process

1. Introduction

There exist very few outstanding examples of ambitious renovation projects in the non-residential sector in the world. The IEA SHC Task 47 studies the best demonstration projects in the seven participating countries. In subtask B the decision-making processes are studied in particular.

The Austrian demonstration project that has been studied within subtask B is a school building located in the city of Schwanenstadt in Upper Austria. The renovation in 2006/07 was submitted as a research project in the Austrian research program "Building of Tomorrow" and demonstrated the first refurbishment of a non-residential building achieving Passive House standard with prefabricated wooden façade elements and a comfort ventilation system in Austria. The renovated building consists of the 12-class general secondary school and the 8-class polytechnic school. The project aimed to demonstrate the feasibility of a large-scale passive house renovation at reasonable additional costs in accordance with sustainable and ecological aspects. On the basis of a factor 10 renovation, the heating energy demand had to be reduced from approximately 165 kWh/m².a to the passive house criteria of 15 kWh/m².a by measures such as increased insulation, reduction of heat bridges, day-light illumination, heat-protection in summer, etc. In addition to this, the project aimed to fulfill a high demonstration effect.

The following pages summarize the decision-making process reflecting the opinion and experience of three main actors – the mayor of Schwanenstadt, the architect of the building and the leader of the research project. The guideline-based interviews were carried out via telephone in winter 2013.

2. Milestones

These are the milestones for the project:

- Submission of research project: June 2002
- Clearance with building authority: July 2003
- Submission of demo project: Sept 2003
- Assignment of general planning: June 2005
- Start of renovation: May 2006
- Renovation completed: October 2007
- Monitoring – first period: June 2007 – May 2008
- Monitoring – second period: June 2008 – May 2009

3. Technicalities in short

Facts about the project:

- Originally built: 1960s
- Renovation architect: Arch. DI Heinz Plöderl
- Type of building: secondary school and polytechnic school
- Space before: 4,140 m²
- Space after: 6,214 m²
- Heating energy demand:
  - Before: 122.6 kWh/m².a
  - After: Calculated: 14.1 kWh/m².a
  Measured 1st period: 18.6 kWh/m².a
  Measured 2nd period: 21.9 kWh/m².a
- Final energy consumption:
  - Measured 1st period: 48.4 kWh/m².a
  - Measured 2nd period: 52.9 kWh/m².a
- Primary energy demand:
  - Calculated: 71 kWh/m².a
  - Measured 1st period: 59.7 kWh/m².a
  - Measured 2nd period: 59.6 kWh/m².a
- CO_2 emissions:
  - Calculated: 10.3 kg CO_2/m².a
- Overheating in summer:
  - Measured 1st period: 11.3%
  - Measured 2nd period: 4.6%
- Total investment costs: EUR 7.7 mill
  - EUR 700,000 for passive house technology (9.1% additional costs)
  - EUR 185,000 for other energy related equipment (2.4% additional costs)
- Energy costs:
  - before: EUR 55,000/a
  - after: EUR 10,000/a – EUR12,000/a
- Funding from the research project:
  - approx. EUR 150,000 for the preliminary study
  - approx. EUR 400,000 for the demonstration project
- Post occupancy evaluation: level of satisfaction at 80-85%

The calculated values refer to the energy reference area (PHPP)
Monitoring: 1st period 2007/08 I 2nd period 2008/09
PEF (electricity) = 2.7 I PEF (heating) = 0.7
Data relating to resident's satisfaction were obtained by means of structured questionnaire

The calculated heating energy demand of 14.1 kWh/m².a is 88.5% lower than in the old building and 82.4% lower than for a conventional renovation (according to the building code in Austria). The primary energy demand has been reduced by approximately 68% and the CO_2 emissions by 75%. The CO_2 emissions for grey energy in building production were 55% lower than in a conventional renovation due to the use of lightweight timber elements and further optimizations considering ecological building standards. Due to the high thermal standard and the installation of a pellet boiler (instead of the gas heating), the annual energy costs were remarkably reduced.

4. The main actors

4.1 Municipality of Schwanenstadt, Mayor Karl Staudinger

The owner of the building is the municipality of Schwanenstadt. One of the main actors and a key person in the municipality of Schwanenstadt for this renovation project and the building process was the Mayor of Schwanenstadt, Karl Staudinger. He has worked for the municipality as civil servant his whole professional life, initially as an apprentice and up to the head of the cash desk. Although Mr. Staudinger has already retired he is still Mayor of the city.

4.2 Architect Heinz Plöderl (PAUAT Architekten)

Heinz Plöderl is architect and owner of the company PAUAT Architekten ZTGmbH which he established in 2000. The company is situated in Wels in Upper Austria and employs between 6 to 8 people. Heinz Plöderl is one of the founding members of IG Passivhaus Upper Austria, an independent organization for the passive house. From 2003 to 2006 he was chairman of IG Passivhaus. Heinz Plöderl is well experienced in Austrian building certification schemes like TQB (Total Quality Building, see www.oegnb.net/en/tqb.htm) or the "klimaaktiv" standard. Although he knows many international building standards like BREEAM or LEED, he has a critical point of view. According to him, these standards lack criteria concerning the location of a building (i.e. land use, embodied energy for infrastructure), which are covered more accurately in the Austrian building standards.

4.3 Günter Lang (LANG Consulting)

Günter Lang has been involved in several research projects of the Austrian research program "Building of Tomorrow", such as the very first renovation of a single family house to Passive House standard in Austria in Pettenbach, Upper Austria. Within the project "1,000 Passive Houses in Austria" Günter Lang set up a databank and a detailed documentation of Passive House buildings in Austria starting in 2002. He created a platform for experts, planners, developers, traders and opinion leaders to spread knowledge on Passive House standard for different types of buildings and the uses and types of construction. Since its foundation in 2013 Günter Lang has been chairman of Passivhaus Austria, an Austrian Passive House association, and was previously chairman of IG Passivhaus from 2005 to 2010.

5. The decision-making process

In this chapter we have a look at each of the major decisions which were made by the different actors involved. The final result is a consequence of the sum of these decisions.

5.1 Renovation ≠ renovation

Due to the insufficient building standard – especially the poor façade – and high annual energy costs, the school building in Schwanenstadt, which was built in the 1960s, needed a deep renovation. Linked to financial grants the demolition of the building (and to newly build the school) was excluded at an early stage. According to Heinz Plöderl, it is also very unlikely for schools because the total costs of the renovation have to be higher than 80% of the new production costs. Hence it was decided to renovate the building.

The planning for a conventional renovation meeting minimum thermal standards had already been completed, and the decision for renovation to meet Passive House standard was affected by several variables:

- 5 persons as initiators promoting sustainable and energy-efficient building: Mayor Karl Staudinger, architect Heinz Plöderl, Christian Obermayr, head of an Upper Austrian timber construction company, Christoph Schloßgangl and Günter Lang, the latter affiliated to the Austrian Passive House association IG Passivhaus.
- Call for demonstration of sustainable refurbishment projects within the Austrian research program "Haus der Zukunft / Building of Tomorrow"
- After the elections in Upper Austria in 2003 the federal government was formed by a coalition of the Austrian People's Party (ÖVP) and the Green Party. In the general coalition agreement the renovation of the school in Schwanen-stadt was given priority, i.e. financial commitment and temporal/time preference.

5.2 "Building of Tomorrow"

After the proposal within the research program "Building of Tomorrow" was submitted and accepted for funding, a preliminary study investigating the measures for the renovation to meet Passive House standards (such as insulation, reduction of heat bridges, integration of the ventilation system in the existing building, day-light illumination, heat-protection in summer, etc.) was developed. The overall strategy was to achieve the following criteria:

- **High occupational quality**: Good fresh air quality in the classrooms, improved daylight situation, considerably improved thermal comfort. Renovation work without significant interference with everyday school activities achieved by prefabrication and short installation time on the construction site.
- **Very low energy requirement**: Heating and primary energy demand according to Passive House standard were 90% lower than in the existing school building and approx. 75% lower compared with conventional renovation. Also the energy demand of the building construction was lower due to use of lightweight timber construction elements and optimization according to ecological building principles.
- **Enhanced building quality**: High building value due to sustainable, long-term rehabilitation measures, low life-cycle costs.
- **Role-model effect:** First renovation of a public building to meet Passive House standard, forward-looking concept in the fields of energy efficiency, use of innovative technologies such as vacuum insulation, multiplier effect in the general public.

In order to achieve the ambitious requirements an integrated planning approach, allowing the evaluation and comparison of alternatives as well as dynamic building simulation and life-cycle analysis was carried out. Major elements of the renovation concept were increased compactness of the building, optimised daylight-illumination, innovative thermal renovation methods or the integration of decentralised, energy-efficient ventilation.

After the research project another proposal for the demonstration project was submitted within the research and innovation program "Building of Tomorrow“. Another step in the decision-making process was the approval from the school building authority. In September 2003 a new federal government in Upper Austria was constituted and the renovation project in Schwanenstadt was given priority. According to Mayor Staudinger, the project was part of the coalition agreement between the ÖVP and the Green Party.

5.3 The ventilation system

Before the renovation could start there were prejudices against the mechanical ventilation system. Due to lack of experience in the use and maintenance of this very innovative technology, an excursion by the decision-makers in the municipality to other schools which already had experience with such ventilation systems was undertaken. In addition to this, it was decided to test and evaluate the ventilation system in one prototype class-room for one year (see photo).

According to Günter Lang teachers were eager to use this classroom as children could pay more attention to classes because of the fresh air.
After proving the efficient use of the ventilation system the renovation started in May 2006. However, problems concerning the static requirements and the defective construction of the screed occurred right at the very beginning. The quality of the originally planned construction was poor and had to be restored in the course of the renovation causing a delay. The decision had to be made immediately and required a very flexible handling of all contractors involved in the process. Heinz Plöderl described the decision-making as very uncomplicated and unanimous.

5.4 Occupancy during renovation works

Whereas the secondary school pupils remained in the building during the renovation, the polytechnic school pupils were relocated to nearby facilities. Carrying out the renovation in an occupied building posed a major task. The level of concentration and attention of pupils decreased remarkably in relation to the construction works. In regular meetings with the school authorities the problems were discussed and solutions suggested. The most intensive works were shifted to times when pupils were not present (after school to late night, weekends, holidays) thanks to the flexibility of contractors, though causing additional costs.

In order to monitor and ensure the safety at the construction site, a coordination authority was set up. Thus the concerns of parents could be reduced and safety issues were strictly met.

5.5 Monitoring and post-occupancy evaluation

The renovation was completed in October 2007, almost within the stipulated time. 90% of the measures planned in the preliminary study could be implemented. For the first two years an energy monitoring system was established to measure the current energy demand. By replacing the gas heating system (110 kW) with pellet heating, the energy costs (heating, warm water) could be reduced from approx. EUR 55,000 to EUR 10,000/12,000. A photovoltaic system (68 m², 6.7 kW_P) was installed on the roof providing electricity. The overheating in summer (ratio of hours above 26°C during school time) was 11.3% in 2007/08 and 4.6% in 2008/09. The total energy demand was reduced by 76.5% and the primary energy demand by 68.1% (59.3 kWh/m².a). The CO_2 emissions for the “grey energy” caused by the production of the building were 55% lower than in the conventional renovation due to the use of lightweight timber.

The level of user satisfaction was also evaluated. Immediately after the renovation was completed the satisfaction level was 80%. In the second year the level increased to 85% which shows a high satisfaction and excellent quality of the building materials used. According to Mayor Karl Staudinger, the interest for visits was (and still is) high; in 2013 he was even invited to hold presentations to present the building.

6. Lessons learned

6.1 Introduction

Despite the difficult conditions (first renovation of this kind, lack of experience, ambitious targets) in energy and comfort engineering, the renovation of the school in Schwanenstadt was a true gain for the municipality. The forward-looking role-model concept offering high energy-saving potential could be easily applied to other renovation projects. Additional costs of approximately 13% for achieving the Passive House standard, daylight optimization and ecological measures were rather low and were compensated by subsidies and reduced energy costs in the operation. On the other hand, there were also some barriers and problems which occurred during the renovation.

6.2 Important drivers

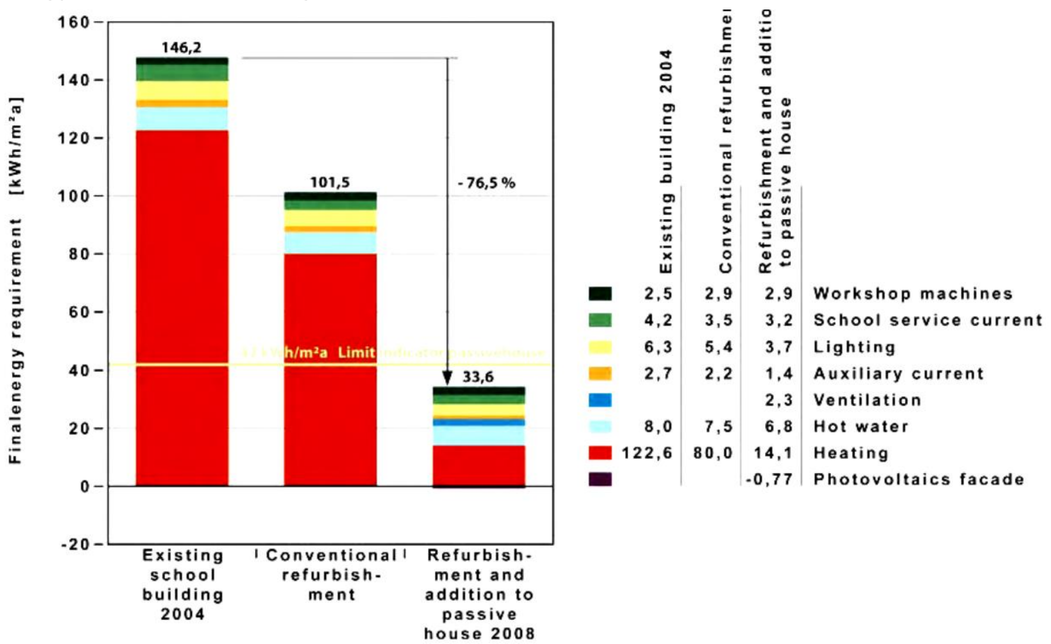
The most important drivers for increasing the ambition level of the project were:

- The initiation of this ambitious project is owed to the personal effort of five persons who are committed to the energy-efficient building
- Call for demonstration projects for sustainable renovation of the research and innovation program "Building of Tomorrow"
- Political circumstances and the commitments made to provide financial support
- Mainly local or regional manufacturers and contractors were involved (close proximity of timber construction company Obermayr which renovated the façade). Highly flexible contractors.
- Experimental testing of the ventilation system in one prototype classroom. Excursions to other schools to get to know this technology.
- Employment of a construction site coordinator
- Integral planning (simulations, analysis, optimisations)
- On-site meetings with people involved. Tenants created a wish-list

6.3 Important barriers

There were some barriers which could have altered this project:

- Lack of experience with this kind of renovation/energy standard. Prejudices and scepticism.
- Unforeseeable problems relating to previous damages, old or non-existing plans. Some decisions had to be



taken very quickly. Decisions should have been made in advance.

- Due to the occupancy during the renovation individual productions on-site (like sanitation, wet installations) represented an organizational challenge and hence caused some delays in the quite stringent timetable.
- Occupancy. Lack of attention and low level of concentration of pupils during construction works. Relocation to nearby facilities would have been better.

5.4 Main conclusions

The actors agreed that the renovation in general and the decision-making process specifically were a great success.

- **High occupational quality**: constant fresh air supply and considerably improved thermal comfort, short installation time due to high degree of prefabrication
- **Enhanced building quality**: high building value due to sustainable, long-term renovation measures, low life-cycle costs
- **Low energy requirements**:
  Heating energy demand of 14.1 kWh/m².a
  End energy demand of 33.6 kWh/m².a
  Primary energy demand of 59.3 kWh/m².a
  CO_2 emissions of 10.3 kg CO_2/m².a
- **Role-model effect**: First renovation of a public school building to Passive House standard, use of innovative technologies such as comfort ventilation, passive cooling, enhanced use of light, photovoltaic system

Heinz Plöderl underlined the advantages of a high degree of prefabrication and the flexibility of the contractors involved in the renovation. According to him, the poor existing infrastructure caused some minor delays and requires more detailed planning in the early decision-making process.

Mayor Karl Staudinger's lesson learned is to leave the building unoccupied during the renovation. The concerns and doubts of parents and the teaching staff put his knowledge of "politics of appeasement" into practice. However, the realised energy savings and reduced costs of a factor 10 as well as the gain in thermal comfort confirm his support and decision for the renovation.

Günter Lang stressed that it is often very helpful to make stakeholders familiar with new technologies, for example by visiting exemplary projects.

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Municipality of Schwanenstadt
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IEA SHC Task 47:
http://task47.iea-shc.org/

Annex 13: Kindergarten in Høje-Taastrup, Denmark
Decision-Making Process

1. Introduction

There exist very few outstanding examples of ambitious renovation projects in the non-residential sector in the world. The IEA SHC Task 47 analyzes the best demonstration projects in the seven participating countries. In subtask B the decision making processes are studied in particular.

This paper describes the decision-making processes for a renovation project involving a kindergarten in Høje-Taastrup, Denmark.

Built in 1971, the kindergarten only had a very limited level of insulation. It is one of 27 kindergartens in the municipality of Høje-Taastrup that will undergo similar extensive renovation, and seven projects have been finished by December 2012.

The method will be similar in all projects, i.e. with a strong focus on energy savings.

The building has a gross floor area of 330 m^2 and houses approximately 50 children spread over three classrooms.

The main objective was to achieve an overall renovation of the existing building, i.e. roof was leaking, windows were worn out and the building was suffering from uncomfortable draught. This was achieved while also minimizing the energy consumption by adding insulation to the façade, replacing existing windows, improving air tightness of the building envelope and replacing the ventilation system.

This paper is the result of an interview conducted during the summer of 2012 with Mette Forslund and Tove Sanderbo from Centre for Real Estate and Internal Services (CEIS) in the municipality of Høje-Taastrup. CEIS was the overall project leader in the renovation project.

The purpose of the interview was to learn how this project evolved from the initial idea to the how it is now renovated.

2. Milestones

These are the milestones for the project:

- Initial idea launched: Spring 2010
- First version of the project plan: Spring 2010
- Final version of the project plan: June 2010
- Decision to start the project: April 2010
- Contract with main contractor: June 2010
- Startup renovation: August 2010
- Renovation project completed: January 2011

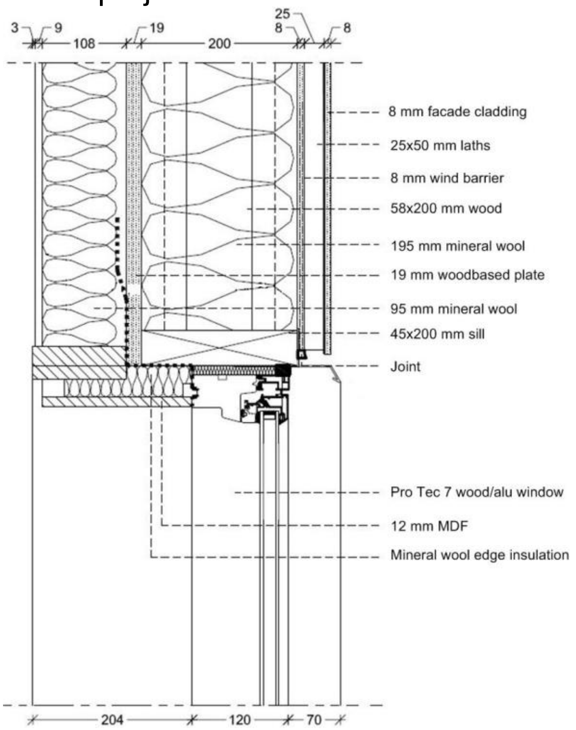
3. Technicalities in short

Facts about the project:

Built:	1971
Renovation architect:	Nøhr & Sigsgaard A/S
Energy consultant:	Terkel Pedersen A/S
Measured before:	151 kWh/m^2/year
Measured after:	69 kWh/m^2/year
Total cost:	DKK 1.5 mill (EUR 0.2 mill)

The original intention of the renovation was simple maintenance of the building, i.e. the roof was leaking, and windows and the façade in general were worn down (see picture below).

However, it soon became obvious that extensive energy renovation would result in a reasonably good payback time (energy savings vs. investment). It was an architect company working on another of the municipality's projects that initiated the discussion about optimal energy solutions and airtight buildings which eventually influenced the ambition level of this project.



The kindergarten was in use during most of the renovation process; however during the façade renovation the children were moved to a temporary location.

4. The main actors

4.1 The municipality of Høje-Taastrup

The municipality of Høje-Taastrup is the owner of the building.

CEIS (Centre for Real Estate and Internal Services) proposed the project, and the municipal council approved the budget, but one of the major challenges in the project was to document and thereby convince the city council that an extensive energy renovation was the right way to go instead of a smaller maintenance project.

Key persons in the municipality for this project:
Mette Forslund is a project leader in CEIS. CEIS is the department in the municipality responsible for property maintenance, energy management and consultancy and planning for new municipal construction and renovation. She is originally trained as an architect and has been employed in the municipality for two years.

Tove Sanderbo is the head of CEIS.

4.2 Timbra

Timbra (now a part of MT Højgaard Group) is a specialty carpentry company. Timbra acted as the main contractor in the renovation project.

Timbra perform all kinds of work in trade, main or turnkey contracts. They are involved in constructing new buildings and renovation of existing buildings. Their specialties include trade, main and turnkey contracts, construction, renovation, alteration, acoustic ceilings, mono ceilings, glass walls, interior walls, plaster walls, new windows, window replacement, roofing and new doors.

4.3 Nøhr & Sigsgaard A/S

Nøhr & Sigsgaard Architects is a medium-sized architectural firm with extensive experience and expertise in new construction and renovation projects.

Their portfolio contains a wide range of consultancy tasks completed with very different contents and scope, primarily for public clients.

All projects are carried out in close collaboration between users, builders, architects and engineers, and to ensure continuity and clarity in all phases always headed by a project leader.

4.4 Terkel Pedersen Consulting Engineers

Terkel Pedersen Consulting Engineers is a well-established consulting engineering company with primary activities in the building and construction sector.

They work within the fields of energy optimization and management, indoor air quality assessment and passive design. They have over the past few years strengthened their know-how and practical experience, by including a graduate Passive House Designer in their team.

4.5 Other important actors

The project is financed on market terms and without sponsorship of materials. Therefore, the project is a good example – and this is why the Rockwool Group has chosen to support documentation and communication of the results so others can be inspired.

5. The decision-making process

In this section we will have a look at each of the major decisions which were made by the different actors involved. The final result is a consequence of the sum of these decisions.

- 27 kindergartens were in need of regular maintenance. The original plan was to: Repair the leaky roofs, change the old and leaky windows and upgrade the worn-down façade.
- A technical advisor working on a new passive house project for the municipality suggested that focus should be changed from regular maintenance to energy renovation.
- The most important barrier for this project was to convince the city council to go beyond regular maintenance and also focus on energy efficiency. Calculations were carried out to show that the focus on energy would actually result in economic savings over time.
- Two different solutions were discussed, i.e. upgrading to current building regulation requirements and Passive House level. The final design (Passive House for the building envelope) was chosen based on calculations performed on energy savings vs. investment.

6. Lessons learned

6.1 Introduction

To start with this project was focused primarily on simple maintenance of the building envelope, i.e. the main idea was to stop the roof from leaking and improve the appearance of the worn down façade.

The most interesting point in the project is the fact that the focus shifted during the process and that reduction of energy consumption - and even radical reduction - was possible as well as economically attractive to the municipality.

6.2 Important drivers

These were the most important drivers for increasing the ambition level of the project:

- Originally simple maintenance, however it soon became obvious that extensive energy renovation would result in a reasonably good payback time (energy savings vs. investment).
- It was a technical advisor working on another project who started the discussion about the optimal energy solution and airtight buildings.
- Economic calculations on energy savings/investments for two scenarios were performed, i.e. upgrading to current building regulation requirements and Passive House level. The passive house level was chosen for the thermal envelope.
- Focus on energy savings in the media and other places was also a driver.
- The value of the buildings in the municipality is of high importance, i.e.

a renovation will maintain or even increase the value of a building.

- The municipality has its own “campaign” in the “Klimakommune” (Climate municipality) which sets goals for energy efficiency in the public buildings.
- The process was optimized (which will be beneficial for the upcoming 20 renovation cases).

6.3 Important barriers

There were some barriers which could have altered this project:

- Convincing the city council to go beyond regular maintenance and implement an extensive energy renovation, i.e. documenting the fact that this was indeed the right way to go, was the largest barrier.
- The relocation of the children during the renovation of the façade of the building was a problem for many parents and a speedy process was necessary for this part of the renovation.
- Separating the building site from the kindergarten activities also presented a challenge, i.e. safety for the children. This was solved by sealing off parts of the kindergarten surrounding areas.
- A harsh winter delayed the building process by several months

6.4 Main conclusions

The main conclusions from this project are:

- It is economically viable to carry out energy renovation rather than settle for ordinary maintenance, and this project has shown that even deep energy renovation (Passive House level) can result in the best overall economy.
- Experience gained in one project can be used in other projects, both in terms of planning and execution, i.e. replicability improves economy and working processes for future projects.
- It would have been an advantage if more focus had been on indoor climate from the beginning. Energy savings is one benefit, but improved indoor climate can expand opportunities and future use of the building as well. This will be a focus point in future projects for the municipality of Høje-Taastrup.

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More info about:

Danish Building Research Institute, AAU
http://www.sbi.dk/en

Municipality of Høje-Taastrup
http://www.htk.dk/Service/English.aspx

Timbra (part of MT Højgaard Group)
http://mth.dk/

Nøhr & Sigsgaard A/S
http://www.nsark.dk/

Terkel Pedersen & Søn A/S
http://www.tping.dk/

Rockwool Group
http://www.rockwool.com/

IEA SHC Task 47:
http://task47.iea-shc.org/

Annex 14: Franciscan Monastery, Graz, Austria
Decision-Making Process


(Gebetsroither A.) Southern wing of the monastery with solar thermal façade / roof

1. Introduction

There are only few outstanding examples of ambitious renovation projects in the non-residential sector around the world. The IEA SHC Task 47 investigates the best demonstration projects in the seven participating countries. Subtask B takes a look at the decision-making processes.

The Franciscan monastery in Graz, Austria is a very important historic building, particularly because of its unique architecture. It is located in the heart of the historic center of Graz, which has been declared as a UNESCO world heritage site.

When the owner of the building, represented by Father Matthias Maier, wanted to start a thermal renovation of the building and convert it into a zero-emission-monastery, the conflict of interests between the protection of

historic monuments and climate protection actions became obvious.

The monastery is a witness of its times and the preservation of its initial condition is top priority. Contrary to that, renovation with the aim of zero-emission requires energy-efficient building structures. This often means that the initial building structure has to be altered.

This conflict of interests led to a very intense discussion amongst the organizations responsible for the monument conservation, the owner and the planners.

2. Milestones

The most important project milestones are:

- 2001: Decision to aim for a zero-emission building by Father Matthias
- 2007: Finalization of the master plan regarding the future usage of the monastery, including renovation and energy aspects
- 2009: Draft version of the project plan regarding the renovation of the monastery is handed in to the building authority; start of renovation works
- May 2012: Final version of the project plan is finalized
- Project close-out: Renovation is still running, expected close-out is 2015. Currently, the renovation is in construction stage three.

(Knotzer A.)
Insulation with foam glass gravel in the floor

(Knotzer A.)
Installation of component heating

3. The main technical points at a glance

Facts about the project:

- The monastery was built between 1239 and 1648 (including enlargements and rebuildings)
- The original architect is unknown
- The architects responsible for the renovation are DI Michael Lingenhöle (master plan for renovation and energy saving), HoG architecture (third phase of refurbishment)
- 15 monks live in the monastery
- Type of building: Franciscan monastery, medieval building structure, part of the historic city walls of Graz
- Net floor area before the renovation: 3,590 m²
- Net floor area after the renovation: 3,585 m²
- Energy consumption before the renovation: 198 kWh/m²/year
- Energy consumption as planned for the energy performance certificate: 85 kWh/(m².a) (there are no final numbers available, as the renovation is still going on)
- Expected total costs of renovation: EUR 4.2 million by project close-out
- The roof has been insulated; the floor and the storey ceiling have been covered with foam glass gravel; integration of insulated but unheated buffer spaces adjacent to the exterior spaces
- The single glazing of box windows were replaced by heat-insulated glasses
- Exchange of high temperature system with low temperature system and installation of component heating and radiators with individual room thermostat control
- Two water heat pumps with 200 kW each (fed with well water) were installed
- Solar collectors and the two heat pumps (see above) generate hot water, district heating functions as backup
- 193 m² roof-integrated flat-plate collectors and 180 m² façade panels have been installed on the south wing of the building. These renewable

energy systems are used for water heating, component heating and for preheating the well water for the heat pump

4. The main actors

4.1 Franciscan Order Graz (Owner)

- The Franciscan Order in Graz consists of 15 monks living in the monastery. Apart from the living areas for the monks, the building consists of two churches, a historic library, seminar rooms and common areas and facilities.
- Being a mendicant order the Franciscan Order has no financial assets. The renovation of the building is therefore financed by public funds and donations.
- Apart from being environmentally friendly, the declared goal was also to help the monastery save money by reducing the operating costs.
- Key person in the Franciscan Order for this project: Father Matthias is the construction manager of the monastery and the initiator of the renovation process. He was deeply involved in the communication between the authorities (National Heritage Agency/BDA, UNESCO World Heritage, Old Town Conservation of Graz/ASVK, Building authority) and the planners. His main aim was to fulfill the master plan regarding the zero-emissions building and to implement the solar power plant.

4.2 Architect DI Michael Lingenhöle

- He teaches at the technical university in Graz and has a lot of experience with adapting and renovating historic buildings.
- He created the master plan for the implementation of a zero-emission monastery.
- He is responsible for the first parts of the renovation and the adaptation of the historic building parts.

4.3 HoG architects – Hope of Glory

- HoG architects was founded in 2006 by Martin Emmerer, Clemens Luser and Hansjörg Luser.
- They have carried out a number of projects aimed at renovating historic buildings.
- They were responsible for the submission of the plans for the solar plant at the roof and at the façade on the southern tract of the monastery.
- They are currently responsible for the planning of the third construction stage of the renovation.

4.4 TB Köstenbauer-Sixl (engineering office)

- They are the planners for the heating and cooling installations.
- They have a lot of experience with component heating systems.

4.5 TB Rosenfelder & Höfler (engineering office)

- They are responsible for the planning of the building physics.
- They were also responsible for the scientific investigation of the hygrothermal behavior of the inner insulation systems.

4.6 AEE Intec

- AEE Intec was founded in 1988 as a research institute.
- The main topics are basic research in the field of solar thermal energy use, low-energy and zero-energy buildings as well as efficient energy supply systems.
- They carried out a research project on the use of renewable energy sources and energy efficiency in historic buildings (New4Old[20]).
- They supported the project team and offered advice during the decision-making process.

4.7 Güssing Energy Technologies

- Research institute with focus on

[20] See: http://www.new4old.eu/

renewable energies.

- Conception and optimization of the housing technologies for the monastery.

4.8 National Heritage Agency (BDA)

- The national heritage agency is the responsible authority for the protection and the preservation of historical monuments. Its tasks are (among others) the preservation, renovation and cataloguing of architectural and artistic monuments.
- For building measures of protected monuments, an authorization of the national heritage agency is necessary.
- The national heritage agency was involved in the discussion regarding the compatibility of the solar plant with the requirements of monument protection. It was also involved in the decision-making processes and the authorization process.

4.9 Committee of Experts of the Old Town of Graz (ASVK) and Public Defender of the Old Town

- The legal basis for the activities of the ASVK and the defender of the Old Town is the so-called “Old Town Preservation Law” with defined protection zones in Graz.
- The ASVK provides an expert opinion on building projects within these protection zones. Special focus lies on the evaluation of the architectural ensemble. The ASVK’s expert opinion supports the building authorities with their decision-making process.
- If the building authority decides against the expert opinion of the ASVK, the Public Defender of the Old Town is consulted. He will try to find a solution and he can also raise an objection against the official decision of the building authority.

4.10 UNESCO World Heritage - ICOMOS

- ICOMOS is an advisory board for the UNESCO World Heritage committee. It is responsible for the protection and the conservation of all monuments and historical sites listed in the UNESCO World Heritage List.
- When renovating the Franciscan monastery, ICOMOS’ special focus lay on the conservation of the cityscape.

4.11 Building Authority of the City of Graz

- The building authority provides assessments of building projects. Building projects which are located in protected zones require expert opinions of special committees, which support the building authority in its decision process.
- Regarding the renovation of the Franciscan monastery, the decision making on the part of the building authority was influenced by three committees, namely the national heritage agency, the ASVK and ICOMOS.

5.The decision-making process

In this section we will have a look at each of the major decisions which were made by the different actors involved. The final result is a consequence of the sum of these decisions.

5.1 Initiation of the refurbishment

The construction manager of the Franciscan Monastery (Father Matthias) initiated the project. The central theme of the project is the **vision of a zero-emission-monastery**. The energy supply should be completely independent from fossil energy sources.

5.2 Master plan

2001 – 2007: a master plan with four main areas was developed in collaboration with the architect Michael Lingenhöle. The overall strategy to realise the vision of a zero-emission-monastery is:

- **Step one - Increasing the energy-efficiency:**
  :: Insulation of building components – if it is in line with monument preservation requirements and if it is technically feasible;
  :: Integration of unheated buffer spaces;
  :: Thermal renovation of box windows.

- **Step two - solar collectors and component heating:**
  :: Roof-integrated flat plate collectors and façade panels are installed on the south wing of the building;
  :: 50 % of the hot water consumption and 40 % of the heating energy consumption covered by the solar system;
  :: Exchange of high-temperature system with low-temperature system;
  :: Drainage of the walls on the ground floor through component heating with the excessive heat of the solar plant during the summer.

- **Step three - efficient heating and intelligent heat pumps:**
  :: Remaining heating energy is produced by two heat pumps;
  :: Existing connection to district heating functions as back-up system.

- **Step four - additionally required energy is produced ecologically:**
  :: Electricity will be provided by green power.

5.3 Solar plant: the main conflict

The solar thermal system is a core element to realize the vision of a zero-emission-monastery. The strong influence of thermal collectors on the appearance of the monastery has led to long discussions and formal as well as informal negotiations. Within the whole process of regulatory permissions the solar thermal system has been the main conflict of interests.

The solar plant has to be permitted by two public authorities:

- the Building Authority of the City of Graz (planning and building permit)
- National Heritage Agency (official notification)

These permissions are set in coordination with:

- ASVK, the committee responsible for the conservation of the old town of Graz (and in case of different decisions by the Building Authority also by the Public Defender of the Old Town);
- ICOMOS, representing the UNESCO world heritage.

In May 2010, the first draft for the solar panel on the middle and south wing of the Franciscan monastery was submitted. At this time, none of the above mentioned committees had been contacted before. This resulted in a negative assessment of all four committees in the first stage.

Between June and September 2010, three round tables took place. All parties, i.e. the owner, the planners and the four committees were represented. The declared aim was to find an acceptable solution for all parties involved.

The idea of a solar plant within the protected roof landscape in Graz caused a lot of resistance among the four committees. During the first round table, no consensus towards a solution was found. There was only willingness to discuss a solar plant applied to the façade of the south wing of the monastery. However, this would have resulted in a lower solar energy yield and was therefore rejected by the owner and the planners.

In the subsequent round tables different drafts were presented. A combination of solar collectors on the roof and on the façade of the south tract obtained a basic approval of three of the four committees. A re-submission of the solar plant based on the results of the last round table was accepted by the Building Authority of the City of Graz, of the National Heritage Agency and of ICOMOS.

Only the Committee of Experts of the Old Town of Graz (ASVK) refused a positive statement. As the regulatory permission of the Building Authority of the City of Graz deviates from the ASVK's result, the Public Defender of the Old Town had to be consulted. Nevertheless, the objection of the Public Defender on the positive decision of the Building Authority was not sustained and the renovation work (including the solar thermal plant) could begin.

6. Lessons learned

6.1 Introduction

The specific challenge in this project was to bring the issue of historic monument protection (preservation of cultural values) and the concerns of climate change (reducing greenhouse gas emissions) in line/together. The process to realize a comprehensive refurbishment of a protected building is very complex: complexities are related to technical as well as to legal framework conditions.

6.2 Important drivers

The following were the most important drivers for increasing the ambition level of the project:

- Mission of the Franciscan Order – conservation and preservation of the building
- Master plan for the implementation of a zero-emission monastery
- Reduce heating in order to save operating costs and donation money
- The need of new urban functions (meeting rooms, conference center, event rooms)
- Improving indoor comfort
- The building owner was very committed to make this project a success. Father Matthias has a personal passion for sustainable solutions.

6.3 Important barriers

There have been some main challenges with strong influence on the project:

- Protection of historic buildings
- Protection of the historic ensemble of the City of Graz (including roofs) in the center of Graz (installation of solar collectors)
- UNESCO award of world cultural heritage
- Specific and differing requirements from various public authorities
- Lack of experience with this kind of comprehensive refurbishment of a historic building within a protected ensemble of a city

6.4 Main conclusions

Despite a long experience in Austria with energy efficiency on and in buildings, the technical know-how regarding the thermal renovation of historic/protected buildings is currently insufficient. The thermal-hygric behavior of the building components cannot be depicted in a way that guarantees a damage-free construction element. This lack of knowledge and lack of experience generally hampers comprehensive (energetic) refurbishments of these buildings.

In addition, the regulatory approval procedure is much more time consuming than for buildings from the post-war period. In the case of the Franciscan monastery, four public authorities have had to be taken into consideration – all of them with different interests.

Finally, the comprehensive (energetic) refurbishment of a historic building requires a lot of individual planning and design solutions – standardization is currently not practicable. These individual, and in many cases, complex technical solutions lead to relatively high costs for the refurbishment of historic/protected buildings.

The main success factors for realizing the comprehensive refurbishment including the solar plant at the Franciscan Monastery in Graz are:

- involvement from the very beginning of all public authorities (National Heritage Agency/BDA; UNESCO World Heritage, Old Town conservation of Graz/ASVK)
- a coherent vision with a technically feasible refurbishment concept
- a convinced and convincing building owner with power of endurance.

For future refurbishment projects of historic/protected buildings scientific research is still needed to increase the technological knowledge in order to avoid structural damages caused by energetic refurbishment. This research includes also the pan-European dissemination of best practice projects as well as their routine evaluation to increase confidence of all relevant parties in comprehensive energetic refurbishments of historic/protected buildings.

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www.lingenhoele-architektur.at/

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