St. Ursula's Church Berne

Report energy efficiency initiative 2014/15

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1. Introduction

St. Ursula’s Church is a landmark edifice of Berne, listed in the inventory of cultural heritage monuments of the city of Berne. The “Englische Kirche” is well known far beyond its congregation. When asked about it, people immediately know where this lovely church stands.
This is very honourable and gives us good reason to be proud of, but it entails also the responsibility to take care and maintain it. This is easy to say, but to bear the costs of ownership for a historical monument is challenging for a self-sustaining church. Ever rising expenditures for running and maintaining the infrastructure take a big portion out of our budget. And it keeps growing. Of major concern are the running costs, predominantly the expenditure for energy. In addition to this, current concerns about climate change, carbon emissions and the use of non-sustainable resources need to be taken into consideration.
This situation was discussed in council meetings in May and June 2013 and it was decided to launch an initiative to investigate and evaluate measures to improve the efficiency of our energy consumption. A project team was constituted and commissioned with this task.

2. What was the objective?

Our church was built in 1905, the chaplain’s house and community hall in 1959, and further additions in the following years. Long term maintenance works were carried out over time on the church and the Halls complex, though not on the chaplain’s house. But the entire building frame dates from a time when energy saving was of no, or at best, of minor concern. The infrastructure is outdated and inefficient by current technological standards. This led us to believe that we use too much energy and that our energy efficiency might be lower then what it could and should be. This led to the discussions in Church Council mentioned in para.1 and the decision that a project team should analyze the efficiency of our energy consumption and to summarize the findings in a report to the council.

During the pre-analysis phase it became obvious that a systematic and comprehensive assessment was necessary to analyze all aspects of energy efficiency. The following approach was chosen:

- Obtaining a precise picture of the present status. This required the compilation of data from:
  - Building frames
  - Infrastructure
  - Appliances, lighting, kitchen, church applications
  - Energy usage
  - Usage pattern
  - Operational aspects

- In a second step this data needed to be analysed and possible solutions evaluated:
  - Assessment of functionality, quality, performance, efficiency, usage
  - Location of problem areas and deficiencies
  - Evaluation of options for improvements
  - Evaluation of concrete solutions
- The final step was to quantify the saving potential of the proposed projects and to provide investment considerations (for details refer to part. 5)

3. Current status and assessment

3.1 Building frame

3.1.1 Building dimensions

Building frame assessments were carried out on the base of the following architectural plans:

- Grundriss Zwischenbau, 5. Juli 1991, M 1:50, Architekt Niklaus W. Stoll
- Grundriss 1 Stock, 8. Dez. 1975, M 1:50, Architekt Niklaus W. Stoll
- Grundrisse Zwischenbau, 5. Jul. 1991, M 1:50, Architekt Niklaus W. Stoll
- Dachstockausbau, 8. Dez. 1975, M 1:50, Architekt Niklaus W. Stoll
- Dachstockausbau Schnitt A-A, 8. Dez. 1975, M 1:20, Architekt Niklaus W. Stoll
- Erdgeschoss, 15. Nov. 1992, M 1:50, Architekt Niklaus W. Stoll
- Untergeschoss, 15. Nov. 1992, M 1:50, Architekt Niklaus W. Stoll
- Fassaden Ost + Nord, 15. Nov. 1992, M 1:50, Architekt Niklaus W. Stoll
- Schnitte A-A und B-B, 15. Nov. 1992, M 1:50, Architekt Niklaus W. Stoll
- Westfassade, 15. Nov. 1992, M 1:50, Architekt Niklaus W. Stoll
- Anbau Kirchgemeindesaal + Pfarrhauswohnung, 29.5.1956, M 1:100 Bauinspektorat Bern

Only a small set of architectural plans could be found. A considerable amount of the required data was gathered by visual inspection and manual measurements on the subject. (For details pls. refer to annex I)

3.1.2 Issues of the construction

It became obvious in the early stage of the analysis that the building frame provided a considerable potential for energy saving, particularly the chaplain's house. This was the good news. The downside was the fact that there was no single measure that would exploit the saving potential to a significant extent. The reason for this is the fact that the entire building frame and the heating concept, date from an era when energy usage was not a pressing issue. This means that improvements are necessary in all parts of the building structure and the infrastructure.

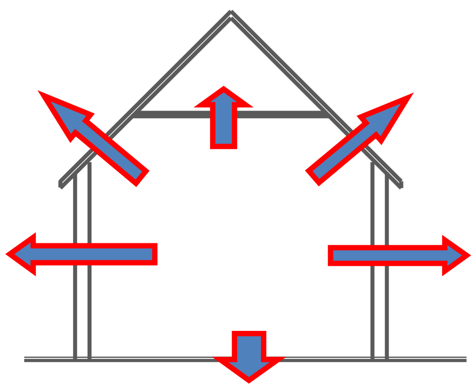
Chaplain's house:
The walls are built with bricks of ca. 25 cm thickness and an outside plaster of ca. 5 cm. The wooden framed windows date from the 1960/70's, with double glazing but without frame insulation; many traces of wear are visible. The roof is a very basic construction with the tiles resting on battens directly nailed to the rafters. No insulation whatsoever on roof, walls, or basement floor and only partially in the attic. The conclusion is that the entire building frame is energy inefficient.

Community halls:
The roof, renovated in 2006, is of relatively solid construction, also from the insulation point of view, not compliant however with current standards. The wooden framed double glazed windows in the upper and lower halls date from a time when energy standards was not really important and windows with highly energy efficient glazing and frames were not available. Traces of usage are visible in many places. The walls on the east and west-side are not insulated and form together with the concrete floor and ceiling a substantial cold bridge. The main issues are the windows with a high u-value. They cover 80% of the wall surface.

Church complex:
Consists of solid brick walls and an outside thick-plaster with an overall thickness of 40 and 50 cm. Further details are not available. The roof was renovated in 1994. From the outside it looks as if minor insulation and some ventilation are in place. Lighting is provided by double windows, outside a metal frame with single glazing and inside with a 3 cm wooden frame and single glazing.

3.1.3 Thermal building characteristics

The thermic quality of building frames is measured by the amount of heating energy that penetrates through roofs, walls, ceilings, floors, windows and cold-bridges.



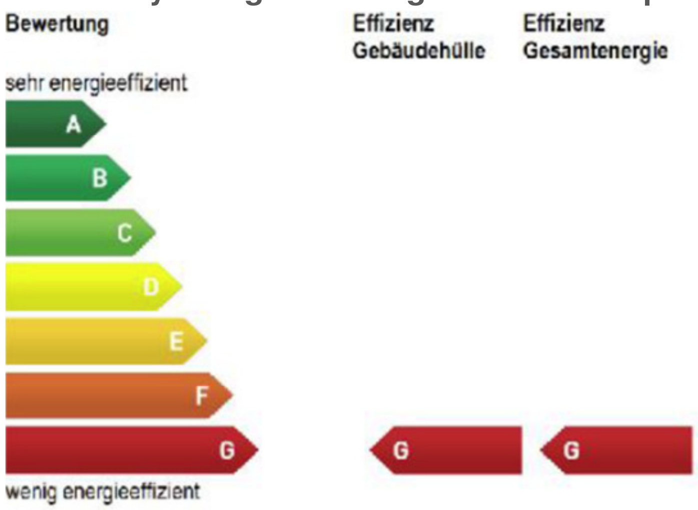
Such energy loss can be quantified by thermal physical formalisms, so called energy transmission analysis. This provides very important information for decision making and planning of energy efficiency measures. The energy loss figures that resulted from our transmission loss analysis are shown in the below table.

Building complex	Transmission loss	
	liter	kWh
Chaplains house	2'832	27'757
Halls + kitchen	2'624	25'713
Church	1507	14'768

The normative guidelines for thermic energy calculations in over-ground buildings are laid down in norm SIA 380/1, edition 2009 of the Swiss Society of Engineers and Architects (SIA). The method chosen in this report is a simplified version of 380/1, in the sense that geographical orientation, solar transmission and internal energy sources (lighting, appliances and human energy emissions) were not taken into account.
For old buildings, analytical transmission loss methods are XX not very precise. The margin of error is plus/minus 20%. The reasons for this are twofold. Firstly, there are no heat conductivity figures available for old building materials. And secondly, architectural plans of old buildings have only in rare cases detailed layer information of walls, floors, ceiling etc. In our case very few were available. However, transmission loss calculations for renovated buildings are considerably more precise because the old building elements have only a minor impact on the overall result.

The measure for energy efficiency is the quotient of the energy loss divided by the room volume. In our case the result indicates a low efficiency. The office for environmental coordination and energy of the canton of Berne classes the chaplain’s house according the below chart in the lowest of 7 categories (pls refer. To the GEAK report in annex IX)

Efficiency rating according GEAK Plus report:



3.2 Infrastructure

3.2.1 General heating aspects

What applies to the building structure is also valid for the infrastructure. It dates
from a time when today’s means for efficiency optimization didn’t exist. It is
7 therefore not surprising that technical and conceptual deficiencies were found in
most elements of the infrastructure and that the efficiency rating is very low.

Existing central oil heating system:
The oil burner and boiler date from the late 1980s and were installed in 1989. A new oil burner was installed in 2003 and is still in service. The technology is technically outdated and compared to new solutions inefficient. Additionally, it is largely over dimensioned. Outdated are also the 4 water pumps that circulate the heating water. The energy consumption of modern day pumps is ca. 85% lower than the ones installed.
At this stage the oil burner runs with an exhaust gas loss of 7%, the maximum allowed by Swiss law (“Luftreinhalteverordnung” LRV11). With age, this value tends to rise. A replacement will therefore be necessary in near future, independent of its condition.

3.2.2 Room heating concepts

Chaplain’s house:
It’s a straightforward radiator heating system, run on a dedicated heating circuit. The installed temperature controller is not operational, and is installed in an inadequate location.

Community halls and kitchen/toilets:
The radiators for the heating of the halls are fed by a single heating circuit. The installed temperature controller is not operational, never really worked as it should because it is installed in the wrong location. Danfoss valves are installed on all radiators, some are broken.

Church:
The church is heated by a warm air heater complemented with radiators. Both systems are controlled by a single channel Siemens controller. For different reasons, the system has not worked satisfactory in the past. Some parts of the church don’t get heated up properly because the warm air dispersion is unsatisfactory. Another issue is the fact that once the targeted room temperature is reached the controller switches off both systems simultaneously. The effect is that the walls cool off which then causes a down-flow of cold air along the walls, felt as draughts by the congregation. Additionally the warm air inflow through the floor grids causes a disturbing noise. As a consequence the warm air blower needs to be switched to the low position during services. On cold days this is not sufficient to keep the church warm.

To handle these problems, the heater is often operated manually, which causes other problems.

Summarized church heating issues:

- The integration of the warm air heating system in the nave is unsatisfactory because the warm air is blown upwards towards the roof instead of towards sitting area
- The temperature controller does not allow the independent control of the 2 heating systems (warm air heater and radiators)
- The warm air heating system is inefficient and ineffective
- The energy dispersion in the nave is unsatisfactory, it causes an uneven temperature pattern, draughts and noise

3.2.3 Electricity usage

Electrical energy usage analysis

Users	Energy/yr. (kwh)	Overall (%)
Total Chaplain's house/yr.	8504.71	40.87%
Total Church/yr	2775.85	13.34%
Total halls + kitchen/yr.	6727.13	32.33%
Total office/yr.	2800.62	13.46%
Total overall consumption/yr.	**20808.31**	**100.00%**

House water boilers: Both outdated and one of them oversized
Energy usage compared to total Electricity consumption 45%

Lighting: Mostly LED
Energy usage compared to total Electricity consumption 7%
Hall lighting consumption compared to total lighting 64%

3.2.4 Appliances

Most of the appliances are classed in the medium range the 7 energy efficiency categories. All of them are in good working condition.

3.3 Energy usage

3.3.1 Analysis of current overall energy consumption

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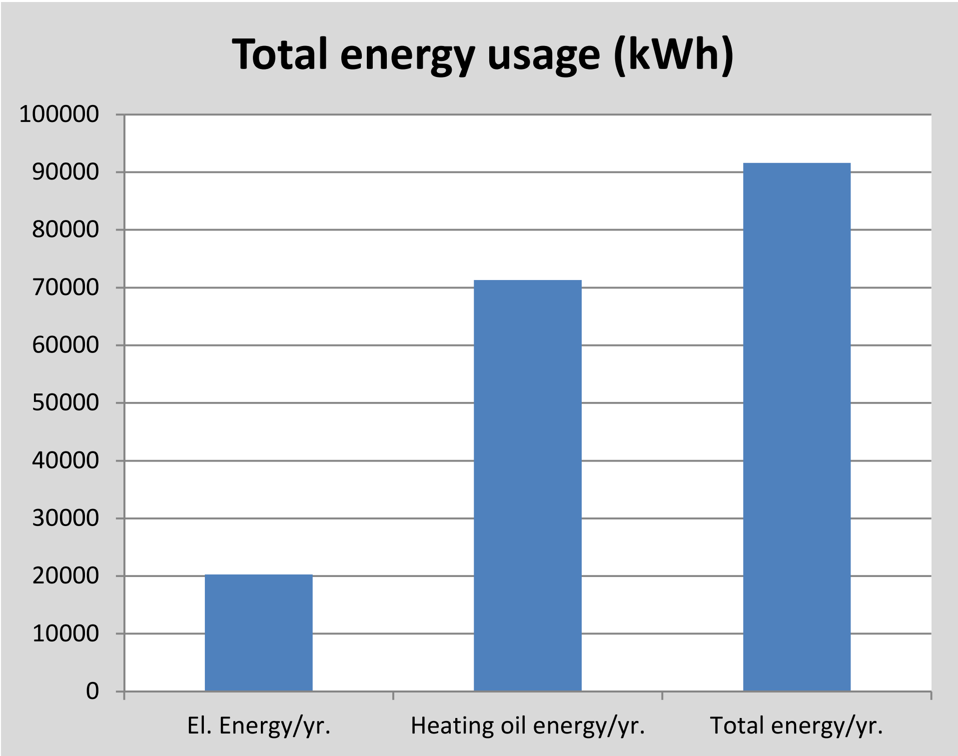

Energy	volume (liter)	Energy (kwh)	rel. (%)	total rel. (%)
Electrical energy usage/yr.				
Chaplains house		8505	41.9%	
Church		2703	13.3%	
Halls + kitchen		6273	30.9%	
Office		2801	13.8%	
Total church/halls/kitchen/office		11776	58.1%	
Elecricity consumtion/yr		20281	100.0%	**22.1%**
Heating oil usage/yr.				
Church	1179	11550	16.2%	
Halls + kitchen	2233	21883	30.7%	
Chaplains house	2411	23623	33.1%	
Heating energy usage observed period	5822	57056	80.0%	
Total oil purchase		71320	100.0%	**77.9%**
Total energy usage (kWh)/yr.		**91601**		**100.00%**

3.4 Room usage

The room usage analysis for community halls and church is based on the room reservation schedule established by the church office. The listed numbers show the yearly hours when rooms are occupied, when the heating and the lights are switched on and when the upper and the lower halls are occupied simultaneously. All figures are based on a 7 months heating period.
(For details pls. refer to annex VII).

3.4.1 Usage pattern of church and halls

7 months heating period/5 months non-heating period

location	occupied hours	heating hours	lightning hours
Church			
Heating period	740.63	1153.13	393.75
Non- heating period	431.75	0.00	33.00
Total	1172.38	1153.13	426.75
Upper Hall			
Heating period	937.50	5040.00	525.00
Non- heating period	522.50	3036.00	8.25
Total	1460.00	8076.00	533.25
Lower Hall			
Heating period	930.00	5040.00	523.13
Non- heating period	624.25	3036.00	44.00
Total	1554.25	8076.00	567.13

3.4.2 Transmission losses in the 3 buildings

Building complex	**Heating energy**		**usage**
	liter	kWh	%
Chaplains house + office	2'832	27'757	40.7%
Halls + kitchen	2'624	25'713	37.7%
Church	1507	14'768	21.6%
Total transmission loss	6'963	68'238	100.0%

3.5 Operational aspects

Church users take it for granted the church facilities function perfectly and run to their best comfort. All would agree on this.
However, during the observed period the energy team observed operational deficiencies, reflected in the day to day running of the church. What this means is that some important tasks were not taken care of in an organized manner; i.e. rooms were too cold when events started, or defective temperature controllers

were not discovered and repaired. Not that those tasks were neglected, but mostly they were taken care randomly by different persons, often as a reaction to complaints from the congregation. Nobody was really in charge of it. One such problem was the temperature control in the church and the community halls because the heating system often needs to be operated manually. This caused
11 undesirable effects. One of them was that room temperatures, particularly in the church, varied from one event to another. This was uncomfortable for the congregation and led repeatedly to complaints. Another one was that some rooms didn’t get heated up in time, or that the heating was running at full gear during periods when rooms were unused. In other cases, the heating didn’t get switched off in spring or switched on at the appropriate time in autumn. In another case it was not discovered, presumably for a long time, that a heating water sensor was defective. This caused the 3-way valve to oscillate in minute-intervals between the 2 extreme positions. It is likely that this finally caused the failure of the valve. The list could be continued.
It’s a known fact that to run systems like central heaters reliably, regular supervision is necessary. Not only is this a matter of keeping it well-functioning, but it also has a direct impact on energy consumption and in our case also the comfort of the congregation. The importance of the operational aspects has lately attracted enough attention in Clean-Tech organisations that efforts to introduce an operational label are in preparation. The reasons are the awareness that operational deficiencies can cause energy inefficiency, out of order time, increased maintenance expenditures and an unhappy congregation..

4. Evaluation of improvements and recommendations

4.1 General evaluation aspects

The analysis, judgments and proposals that will follow are strictly based on technical criteria. The objective was to point out areas and ways to reduce energy consumption. This is to what extent these assessments cover ecological aspects.

4.2 Replacement central oil heating system (project P1)

As outlined in para 3.2.1 the oil fired boiler needs to be replaced for ecological and in the not too distant future also for legal reasons. The later because it runs with an exhaust gas loss of 7%, the maximum allowed by Swiss law ("Luftreinhalteverordnung" LRV11). This value rises with age.
An integral part of the oil heater project is the replacement of the 2 house-water boilers and the renovation of the chimney, necessary to avoid condensation problems with modern day low exhaust temperature systems

Project recommended for implementation! (refer to para. 5.1)

Arguments in favour of it:

- The system is inefficient and wastes a lot of energy
- Savings have a direct impact on overall consumption
- A new heating system could be downsized to run more efficiently
- The replacement will eventually be necessary for legal reasons
- The heater replacement project should be carried out, after completion of all other improvement projects

4.3 Improvements church complex

4.3.1 Reducing energy transmission

The options are:

- Insulation of the church walls, outside and inside
- Improvement of roof insulation
- Replacement of windows

Project is recommended to be dismissed!
Arguments against:

- Outside insulation is not possible, because "Denkmalschutz" wouldn't approve
- Inside insulation would be risky for thermo-physical reasons, and the injunctions of "Denkmalschutz" would make it very expensive
- The later would also apply for replacing the windows. Additionally, the cost/benefit ratio would be low because the windows cover only about 6% of

the total wall surface, and the church itself uses only 20% of total heating energy consumption.
- The currently applied usage-based heating pattern is efficient and doesn't offer any options for improvements

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4.3.2 Improvement of heating system (project P2)

This project addresses specifically the comfort issue. The objective is to resolve the known problems (temperature, draught and noise). The core issue is that the warm air is blown upwards towards the roof and heats up the sitting area only as a secondary effect. The result is that i.e. the temperature in the back of the sitting area remains lower than in the front. The second problem is noise caused by the air inflow through the metal grids, which makes it necessary to turn down the heating during service. A 3rd problem is the effect of the cooling down of the walls when the heating is turned down, which is the reason for the draughts. The aim is to correct this by directing the heating energy directly towards the sitting area and to solve the noise issue, which in turn would allow running the heating at full power during a service.

Solution A:
Installation of warm air ducts below the windows on the right and left side of the nave. This would direct the flow of the warm air towards the sitting area. In addition, a two-circuit temperature controller might have to be deployed.

Solution B:
Increasing the overall surface of the radiators. The additional heating capacity could allow to decommissioning the warm air heater, thus saving the electrical energy consumed by the air blower.

. **Project recommended for implementation!** (refer to para. 5.2.2)
Arguments in favour/against solution A:
- Pro: solves the known problems of uneven temperature and draught and would marginally lower energy consumption
- Against: Installing air ducts below the windows could be visually disturbing and might be contested by "Denkmalschutz". Unsure is also to what extent noise emmission could be kept low.
  The installation of an enhanced two-circuit controller would have to replace the existing Siemens controller

Arguments in favour/against solution B:
- Pro: solves the known problems and energy consumption would be lower than in solution A (ca. 1011 kWh/yr.)..
- Against: Radiator piping in the church would have to be adapted

Both solutions need to be investigated further before a final decision.

4.4 Improvements to the community hall complex

The current method for heating the community hall complex burns up almost the same amount of energy as the chaplain's house. Considering the many similarities, this doesn't come as a surprise:

- The room volumes are similar
- Both are heated up 24h a day/7days per week
- Both have large wall surfaces facing toward the outside. In both cases the heat transmission values (U-value) is high.
- Fact is also that the community hall is only used a fraction of the time compared to the chaplain's house

The conclusion is that a big potential for energy savings exists in 2 areas. The first one concerns the heating loss through window and walls, and the second one by switching from a 24/7 heating schedule to a usage-based scheme. The following 3 measures were investigated and found effective.

4.4.1 Reducing energy transmission (project P3)

Improvement of the heat tightness of the walls, which includes

- Replacing the windows of the upper- and lower Halls
- Neutralizing the cold-bridge between upper and lower hall by insulating the outside walls between the upper and lower hall windows

As the window surface covers about 80% of outside facing walls, the energy saving potential for this measure is high.

Project recommended for implementation! (refer to para 5.3.1)
Arguments in favour:

- The cost of replacing windows is reasonable compared to the effect it achieves
- The cold bridges on the east and west side wall drain a lot of energy
- Subsidized by "Gebäudeprogramm"

4.4.2 Introducing temperature controller (project P4)

Install a temperature controller in upper hall. This would allow heating up the 2 halls only when one of them or both are used

Currently the halls are heated up 24/7, or during 5110 hours while only occupied during 1255 hours, or 25% of the time. By introducing usage-based heating, energy consumption could be substantially lowered.

Project recommended for implementation! (refer to para. 5.3.2)
Arguments in favour:

- The price to introduce effective temperature controlling is reasonably low compared to the achieved effect
- Technically not complicated

4.4.3 Splitting the heating circuit (project P5)

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Split the single heating circuit of the upper and lower hall into 2 circuits. This would necessitate a modification of the piping. It would allow to heating up the halls individually when in use. Of the 1255 hours when the upper and the lower halls are occupied, only 497 hours overlap. If the halls are controlled separately, instead of heating up both during 1255 hours, it is possible to heat up one or the other during 758 hours, a saving of 25% in addition to the previous measure 5.4.2 (Installation of temperature controller in the lower hall.

Project recommended for implementation! (refer to para. 5.3.3)
Arguments in favour/against:

- A technically uncritical modification that is rewarding enough to do it
- Costs for changing the pipe configuration need further investigation

4.5 Improvements Chaplain's house (project P6)

The chaplain's house assessment was part of the GEAK Plus analysis (refer. to annex IX). Recommended is a total thermic renovation of the building complex. Summarized this includes:

- Replacement of windows and doors
- Insulation of the outside walls
- Insulation of the basement ceiling
- Insulation or renovation of the roof
- Replacement of the central heating system

Project recommended for implementation! (refer to para. 5.4.)
Arguments in favour:

- The Chaplain's house has received no maintenance since it was built in 1959, which means that thermic improvements can be partially considered as maintenance.
- The energy saving potential is high
- Subsidized by the "Gebäudeprogramm" and the program of the canton
- It's a much needed improvement for the living standard of the Chaplain's family, which in certain conditions was found to be borderline (not by the chaplain by the way)

4.6 Appliances

The appliances are in good working condition, and the fact that most of them are installed in heated rooms, with the exception of the freezer in the garage, the washing machine with dryer and the freezer in the basement of the chaplain's, it is recommended to replace them only at the given time for reasons of failure, maintenance, performance or size.

Project is recommended to be dismissed!
Arguments against:

- All appliances are in good condition, work correctly and fulfil the requirements
- At this stage, replacement should only be considered in cases of defect or performance issues:

16 4.7 Operational issue

It is in the interest of St. Ursula's church to operate the infrastructure in general and the heating system in particular to its best capacity. This means to find the balance between using as little energy as possible and maintaining a comfort that keeps the church goers happy. Or, in other words, run the heating as little as possible, and as much as necessary. For a more detailed discussion of the subject pls. refer to para. 3.5.

Project (P7), recommended for implementation! (refer to para. 3.5)

Arguments in favour:

- The deficiencies of the existing room temperature controls made it often necessary to run the heating manually by different persons. This is unsatisfactory in many ways
- The supervision of the correct functioning needs to be improved
- Switching the hating on in autumn and off in spring needs to be supervised
- The future sophisticated heating technology and temperature controllers are operationally more demanding

4.8 Summary of recommended projects

P1 Replacement central oil heating system (refer to. 5.2)

P2: Improvement of church heating system
Solution A should only be considered if solution B cannot solve the problems in a satisfactory manner (refer to 5.3.2).

P3: Improvement of the heat tightness in the hall complex by replacing the windows and insulating the walls between upper and lower halls (refer to 5.4.1)

P4: Install a temperature controller in upper hall (refer to 5.4.2)

P5: Dividing the upper/lower hall heating circuit of into 2 autonomous circuits and installing temperature controller in the lower hall (refer to 5.4.3

P6: Thermic renovation of the chaplain's house according to GEAK recommendation (refer to 5.5)

P7: Nomination of operational officer (refer to 5.7)

5 Saving potentials and investment considerations

5.1 Replacement of central oil heating system (project P1)

This project consists of 2 elements:

- The main part is the replacement of the boiler system.
- The second element is the chimney renovation. This is necessary to avoid condensation problems with modern day low exhaust temperature systems

Project costs (SFr)	**53'000**
○ Replacement of existing oil heater with a similar type	50'000
○ Chimney renovation	3'000

1) Costs are based on a budgetary offer to replace the existing system with a similar version.

Energy saving potential:

Replacement of central heating system	Current status			New heater		
Boiler efficiency	80%			94%		
	liter	kWh	%	liter	kWh	%
Energy usage	7278	71'320		6194	60'698	
Available heating energy	5822	57'056	20%	5822	57'056	6%
Saving					10'622	14.9%

5.2 Improvements Church complex (Project P2)

5.2.2 Improvements of the heating system

<u>Solution A</u> (4.3.2)
Installation of warm air ducts and temperature controller:

Project costs (SFr)	**8'500**
○ Installation of warm air duct	5'000
○ Temperature controller	3'500

1) Costs are estimates

Energy saving potential:

Heating improvement	**Savings/project**		**overall**		**rel.**
	kWh	%	litre	kWh	%
Consumption present status	11'550	100.0%	5822	57'056	100.0%
Savings	577	5.0%	59	577	1.0%
Consumption after project	10'972	95.0%	5763	56'479	99.0%

Exact savings cannot be determined by analytical means

Solution B (4.3.2):
Increasing radiator capacity and decommission warm air heater:

Project costs (SFr)	**10'000**
- Installation additional radiators	7'000
- heating pipes upgrading	3'000

1) Costs are estimates

. **Energy saving potential:**
1100 kWh/yr. of electric energy would be saved if the warm air heater is decommissioned. Savings on heating energy cannot be determined by analytical means. Estimated 8-10%

5.3. Improvements Halls complex (Project P3)

5.3.1 Insulation and replacement of windows/door

Project costs (SFr):	**33'000**
- Replacement of windows in upper and lower halls	25'000
- Insulation of the walls between upper and lower halls	8'000

1) Costs are estimates

Energy saving potential

Room temperature: $20^0C/5^0C$ Heating pattern: 24/7	**Current status**		**Repl. Windows+ insulation**	
Building part	Transmission		Transmission loss	
	kWh	%	kWh	%
Windows/door, UH+LH	12'716	45.4%	5'289	26.0%
Windows kitchen+toiletts	1'090	3.9%	1'090	5.4%
Walls east+ west, UH+LH to outside	1'788	6.4%	1'558	7.7%
Walls to outside, kitchen+toiletts	927	3.3%	927	4.6%
Walls to unheated	4'457	15.9%	4'457	21.9%
Roof staircase	407	1.5%	407	2.0%
Floor LH to earth	4'572	16.3%	4'572	22.5%
Floor kithen/toiletts to unheated	738	4.6%	738	3.6%
Ceilling UH +kitch/toiletts to unheates	1'286	4.6%	1'286	6.3%
Total Transmission loss	27'981	100.0%	20'325	100.0%
Saving			**7'657**	**27.4%**

5.3.2 Usage-based heating of both halls together

Project P4 costs (SFr):	**3'000**
- Installation of temperature controller in upper hall	3'500

1) Costs are estimates

Energy saving potential

Room temperature: $20^0C/5^0C$ Heating pattern: as used	**Current status**		**Hall heating as used (together)**	
Building part	Transmission loss		Transmission loss	
	kWh	%	kWh	%
Windows/door, UH+LH	12'716	45.4%	4'756	45.4%
Windows kitchen+toiletts	1'090	3.9%	408	3.9%
Walls east+ west, UH+LH to outside	1'788	6.4%	669	6.4%
Walls to outside, kitchen+toiletts	927	3.3%	347	3.3%
Walls to unheated	4'457	15.9%	1'667	15.9%
Roof staircase	407	1.5%	152	1.5%
Floor LH to earth	4'572	16.3%	1'710	16.3%
Floor kithen/toiletts to unheated	738	4.6%	276	2.6%
Ceilling UH +kitch/toiletts to unheates	1'286	4.6%	481	4.6%
Total Transmission loss	27'981	100.0%	10'465	100.0%
Saving			**17'517**	**62.6%**

5.3.3 Usage-based heating of halls (separated)

Project P5 costs (SFr): 8'500
- Amendment of heat piping to a heating circuit for each hall 5'000
- Installation of temperature

Energy saving potential

Room temperature: $20^0C/5^0C$ Heating pattern: 24/7	**Current status**		**Hall heating as used (seperated)**	
Building part	Transmission		Transmission loss	
	kWh	%	kWh	%
Windows/door, UH+LH	12'716	45.4%	3'718	**43.0%**
Windows kitchen+toiletts	1'090	3.9%	305	**3.5%**
Walls east+ west, UH+LH to outside	1'788	6.4%	527	**6.1%**
Walls to outside, kitchen+toiletts	927	3.3%	259	**3.0%**
Walls to unheated	4'457	15.9%	1'287	**14.9%**
Roof staircase	407	1.5%	114	**1.3%**
Floor LH to earth	4'572	16.3%	1'416	**16.4%**
Floor kithen/toiletts to unheated	738	4.6%	664	**7.7%**
Ceilling UH +kitch/toiletts to unheates	1'286	4.6%	360	**4.2%**
Total Transmission loss	27'981	100.0%	**8'651**	**100.0%**
Saving			**19'330**	**69.1%**

5.4 Improvements Chaplain's house (Project P6)

The detailed facts and figures are listed in the GEAK Plus report. The key issues can be summarized as follows:

Project costs (SFr): 175'000
- Roof renovation: 40'000
- Wall 57'600
- Widows + doors 18'000
- Floors 18'000
- Project costs 133'600
  Planning, preparation and authority 42'000

Energy saving potential

Room temperature: 22^0C Heating pattern: 24/7	**Current status**			**insulation + windows/doors repl.**	
Building part	Transmission loss			Transmission loss	
	kWh	%		kWh	%
Windows/door	6'177	20.5%		2'261	19.8%
Ceiling against attic, to unheated	1'733	5.7%		1'733	15.1%
wall to roof 1st floor, outside	3'343	11.1%		557	4.9%
Walls to outside (east, south, west)	9'291	30.8%		1'761	15.4%
Walls to unheated	658	2.2%		658	5.7%
Ground floor to basement, unheated	5'421	17.9%		885	7.7%
Office part	3'584	11.9%		3'584	31.3%
Total Transmission loss	30'206	100.0%		11'439	100.0%
Savings				**18767.11**	**62.1%**

5.5 Nomination of an operational office (Project P7)

No project costs, Energy saving can not be determined by analytical means

6. Summary

6.1 Efficiency improvements

If the proposed improvement projects are carried out, the rating for building frame and overall energy efficiency will raise by 4 levels from G to C if.

6.2 Investments

Project	Invest.	Lifetime	Maint.	Depr.	Savings	1) Depr/kWh	2) Inv./kWh
	SFr	yr.	/yr.	SFr/yr.	kWh/yr.	kWh/SFr	SFr/kWh
Replacement central heater	53'000	15	1.5%	4328	10'622	2.45	5.0
Insulation works chaplain's house	151'000	50	none	3020	16'946	5.61	8.9
Windows doors Chaplain's house	23'000	20	none	1150	16'946	14.74	1.4
Church improvement, solution A or B	10'000	50	none	200	1'181	5.91	8.5
Improvm. Halls+kitchen							
Windows replacement	33'000	20	none	1650	18'065	10.95	1.8
Temperature controller UH	3'500	20	0.5%	193	15'352	79.75	0.2
Hall separation	8'500	20	none	425	16'109	37.90	0.5
Subsidies	-25'000						
Total	**257'000**			**10'966**			

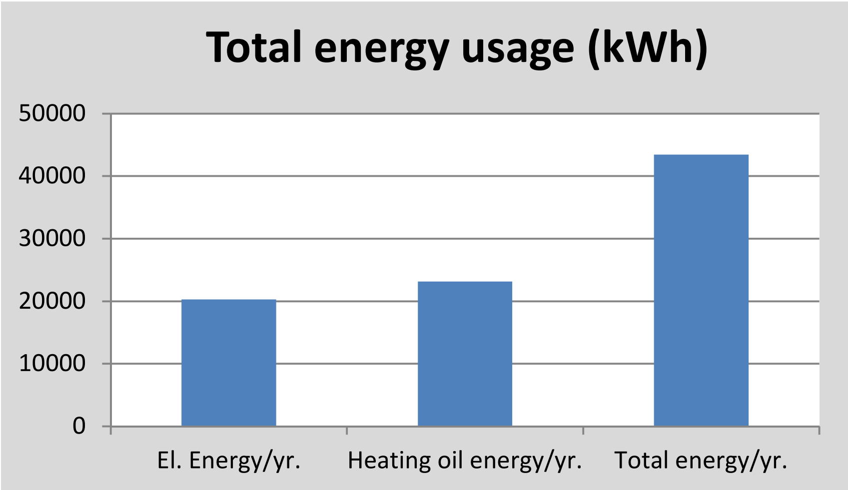
1) Saved energy/yearly depreciation

2) What is the investment/kWh saved energy

6.3 Accumulated energy savings

Heating energy projects	Savings/project		savings overall		rel.
	kWh	%	litre	kWh	%
Purchase observed period	71'320	0	6841	67041	100.0%
Replacement of central heating	60'698	15%	5822	57056	14.9%
Church heating renovation	57'663	5%	5763	56479	15.8%
Chapl. h insulat.+ repl. windows/door	21'837	62%	4265	41801	37.6%
Halls insulation+windows repl.	15'861	27%	3654	35813	46.6%
Both halls as a single circuit	5'932	63%	2639	25863	61.4%
Halls seperately heated	4'904	69%	1519	14882	77.8%

6.4 Energy consumption after completion of para 6.3 projects



Energy	volume (liter)	Energy (kwh)	rel. (%)	total rel. (%)
Electrical energy usage/yr.				
Chaplains house		8505	41.9%	
Church		2703	13.3%	
Halls + kitchen		6273	30.9%	
Office		2801	13.8%	
Church/halls/kitchen/office		11776	58.1%	
Total electricity consumption		20281	100.0%	**46.7%**
Heating oil usage				
Church/yr.	1120	10972	47.4%	
Halls + kitchen/yr.	188	1838	7.9%	
Chaplains house	913	8946	38.7%	
Heating energy usage observed period	2220	21756	94.0%	
Total oil purchase		23145	100.0%	**53.3%**
Total energy usage (kWh)		43425		**100.00%**

7. Energy source considerations

7.1 Fossil fuel powered boiler for heating and warm water

As the subject of fossil fuel deployment was and still is widely covered in the media, this report will address this issue only on some basic issues. .

Oil as an energy source is what we have deployed in St. Ursula’s in the past. Choosing this option also in the future would simply mean the replacement of our system with a new and more efficient boiler and oil burner, and to adapt the chimney for lower exhaust fume temperature. In terms of infrastructure adaptations, this would be the least complicated version. The big advantage of oil boilers is that they run basically without operational supervision.

The option of deploying a gas boiler would imply to connect the gas line from the neighbour’s house to our basement. The chimney renovation would be necessary as in the previous case. The operational aspects of gas boilers are very similar to oil boilers. Advantages are that no oil tank maintenance is required and that gas based boilers seemingly operate more efficiently over a wide power range.

7.2 Wood fired central heating systems

Heating with wood is not quite the same as using a gas or oil boiler. The reason for this are the characteristics differences of the energy media and , logistical, operational and maintenance issues. .

Positive aspects are:

- It helps to sustain the regional economy where we live
- Prices are less impacted by world markets
- It’s a sustainable, renewable, and a relatively carbon-neutral fuel source

Negative aspects are:

- Large storage space is required:

Source	Energy density by volume
Wood chips	870 kwh/m^3
Wood pellets	3100 kwh/m^3
Heating oil	10’000 kwh/m^3

- To maintain best efficiency, wood-fired heating systems need regular operational staff-time to remove ashes and to have the heat exchanger brushed clean during the heating season
- Presently two types of wood fired heating systems are deployed:
- Wood pallet systems
  Deployed mainly in single home environments
- Wood chip systems
  Deployed mainly in domestic and industrial environments with large heating energy requirements such as in build-over residential areas, housing complexes and villages.

7.3 Geothermic ground source heat pump systems

Well proven technology, widely deployed in domestic and industrial applications. The installation of earth probes is subject to a governmental drilling permit, which is granted according geological considerations. In the area were St. Ursula's church stands permits have been issued in the past. Drilling conditions, however, might be hazardous as experienced in a near-by project. For large heating requirements, as is the case at St. Ursula's church, several earth probes need to be installed.

7.4 Solar panels as supplementary energy source

The subject of introducing solar panels in a future Energy concept was not a subject of this analysis. It must be understood that in our case, solar panels can only be considered as a complementary energy source. An in depth technical and economic evaluation will therefore only be possible in the context of the overall energy concept.

8. Annexed documents

ANNEX I: Dimensions building frame

ANNEX II: Energy transmission loss calculations

ANNEX III: Lighting energy usage

ANNEX IV: Obsolete

ANNEX V: Electric energy usage

ANNEX VI: Temperature profile church

ANNEX VII: Room usage analysis

ANNEX VIII: Assessment building frame

ANNEX IX: GEAK Plus report