PL1

Retrofitting of Secondary School in Swarzedz, Poland

1 Photo

Figure 1: Street Facade

2 Project summary

The school was built in 1954 as a lodging house for the people who worked in the local joinery factory. The three storey building is 31.7m long and 13.9m deep. In 1992 the hostel was bought by the local administration and converted into a secondary school. At the same time the gym hall was built (33.0m long, 18.7m deep and 7.65m high) together with the single storey link block.

3 Site

- Swarzedz, Poland,
- *latitude:* 52°20'N, *longitude:* 17°00'E, *altitude:* 89m
- mild climate
- *design outdoor temperature:* $t_{e\ obl}$ = – 18°C
- *average temperature (Pozna_):* t_o = 8°C

4 Building description /typology

4.1 Typology / Age

Typology/Age	Pre 1910	1910–30	1930–50	1950–70	1970-
The multi-storey school				●	
The central corridor school				●	

Educational level (kindergarten, pre-school, ...): Secondary school.

4.2 General information

Year of construction:	1954.
Year of renovation (as described here):	1999.
Total floor area (m^2):	1861 (main building + link block) 594 (gym hall)
Number of pupils:	1570 + 70 (staff and teachers)
Number of classrooms:	15

Typical class room

size (m^2):	38.7
window/glass areas:	6.77 m^2, 0.175 [m^2/m^2 floor]
number of pupils:	30 – 35

Hours of operation: 12 hours a day, 190 days per year

4.3 Architectural drawings

Figure 2: Basement floor plan

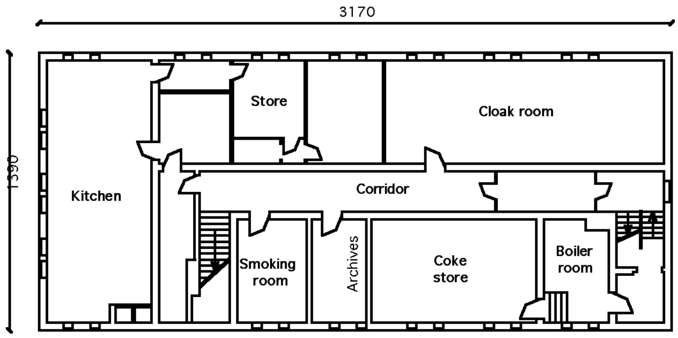
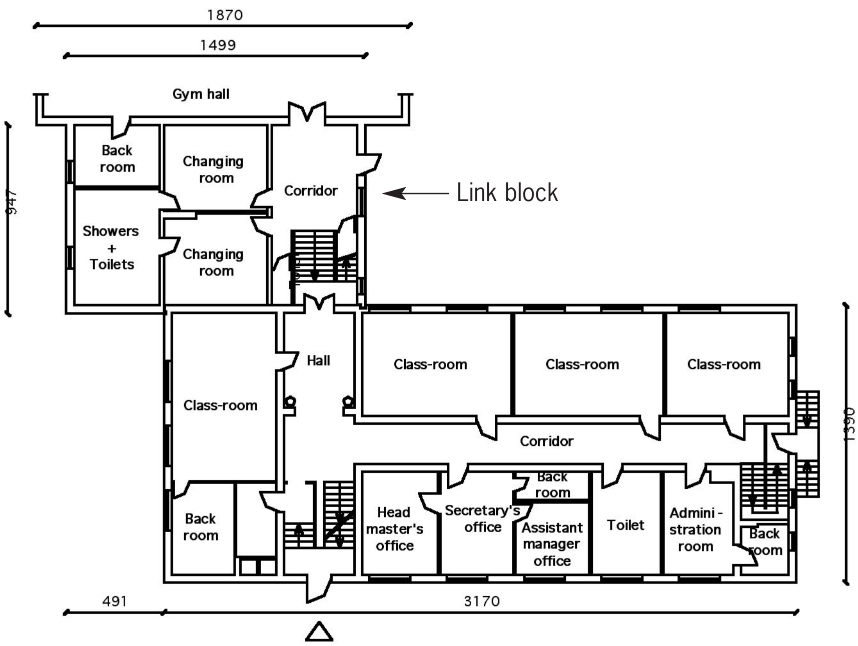
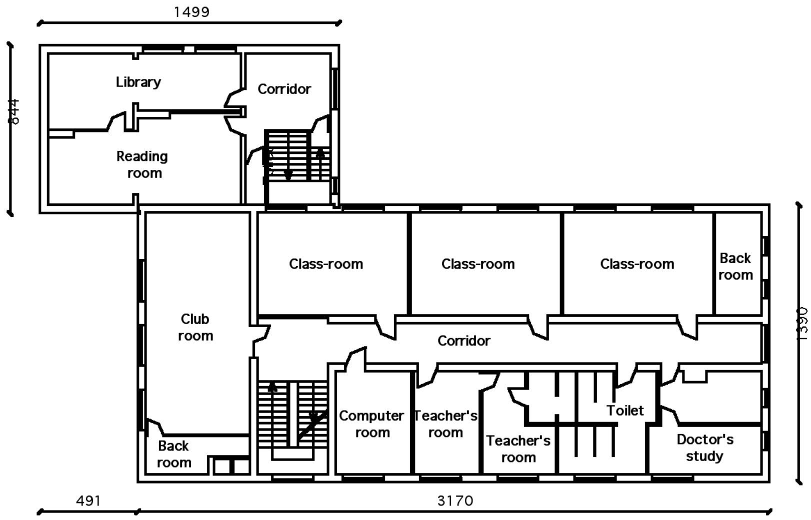
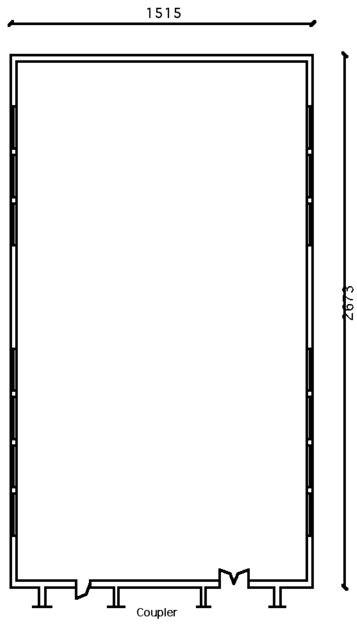


Figure 3: Ground floor plan







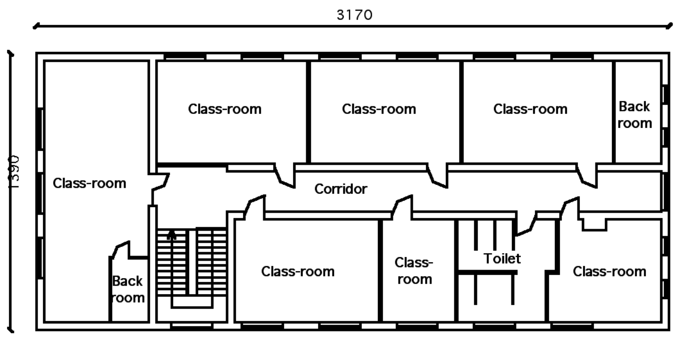


Figure 4: *Above left:* 1st floor plan *Above:* Gym hall plan (ground floor). *Left:* 2nd floor plan

5 Previous heating, ventilation, cooling and lighting systems

Heating

General data :

- Two pipe down-feed heating system
- Open expansion vessel, on the garret
- Central de-aeration system
- Heat source – 3 coal-fired boilers with hand-fired grate
- Domestic Hot Water (DHW) accumulator 1600 dm^3
- Coke consumption – 40 to 45 [t/a] (central heating and DHW)
- Heat demand for central heating purposes Q = 244,8 kW (main building + link block + gym hall)
- Yearly primary energy consumption Q_a = 1644,6 MWh.

Main building :

- Steel heating system, uninsulated pipes
- Sectional cast-iron radiators with old type radiator valves
- Large amount of boiler scale in pipes and heaters
- DHW water was centrally heated only in the heating season.

Gym hall :

- Steel heating system, uninsulated pipes
- Heaters: finned pipes
- DHW for showers in the link block is provided by electric heaters.

Ventilation
- Partly inefficient natural ventilation in the main building.

Lighting system
- Low efficiency (52 lumens/W)

Electricity consumption for lighting in main building and in link block during the school year was 28.4 MWh/annum

5 hours/day in summer (85 days)
11 hours/day in winter (128)

6 Retrofit energy saving features

6.1 Energy saving concept

Retrofitting variants

Variant	Heat source	Insulation	Heating system	Windows	Lighting
A	X (1)	X		X	X
B	X (1)	X			
C	X (1)	X	X		
D	X (2)	X		X	
E	X (2)	X	X	X	X
F	X (1)	X	X	X	X

(1) – traditional gas boiler
(2) – condensing gas boiler

6.2 Building

Insulation

Insulation of walls, roofs and floors in the main building and link block with 5/8/12cm foamed polystyrene (*walls:* 0.30 W/m^{2}K, *floor:* U=0.51 W/m^{2}K, *roof:* U=0.28 W/m^{2}K). Walls in the gym hall already met the Polish standards.

6.3 Heating

Heat source

Replacement of old coal-fired boilers with modern, high efficiency gas boiler with automatic weather compensation control system.
Replacement of open expansion vessel with membrane equaliser pressurisation unit.
Replacement of old circulating pumps with continuous glandless pumps.
Pipe system adjusting (pressure control).

Heating system

Replacement of steel pipes and sectional cast-iron radiators with copper pipes and steel panel radiators.
Installation of thermostatic radiator valves.

6.4 Ventilation

Strategy and systems:	natural
comfort cooling:	No
dehumidification:	No
Pre-heating of ventilation air:	No
Heat recovery:	No
Controls:	No

Windows
Replacement of windows (from U=2.6/5.6 W/m2K to U=1.3 W/m2K) and doors (from U=5.6 W/m2K to U=2.6 W/m2K) in link block and main building.

6.5 Lighting
Replacement of lighting system with Osram's 5200 lm Lumilux delux 58W/830 lamps together with new fittings.

6.6 Other environmental design elements
None

7 Resulting Energy Savings
Energy consumption before and after (be as specific as possible):
Heating:
Cooling:
Ventilation:
Lighting:

Estimated Before
Heat energy demand: 244.8 kW
Heat energy consumption: 1644.6 MWh/annum
Electricity: 28,448 kWh/annum

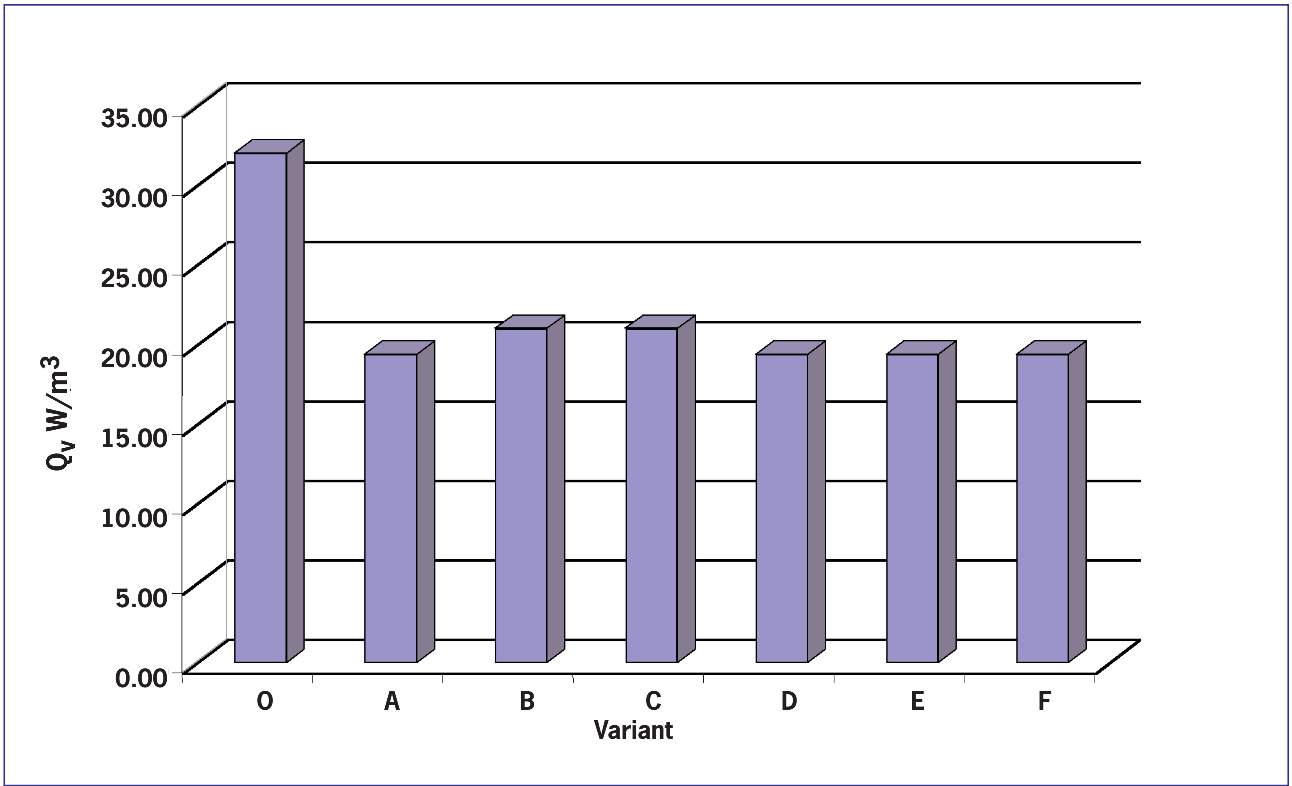


Table 1: Heating power demand index Q_V for each variant (Variant "0" – before retrofitting)

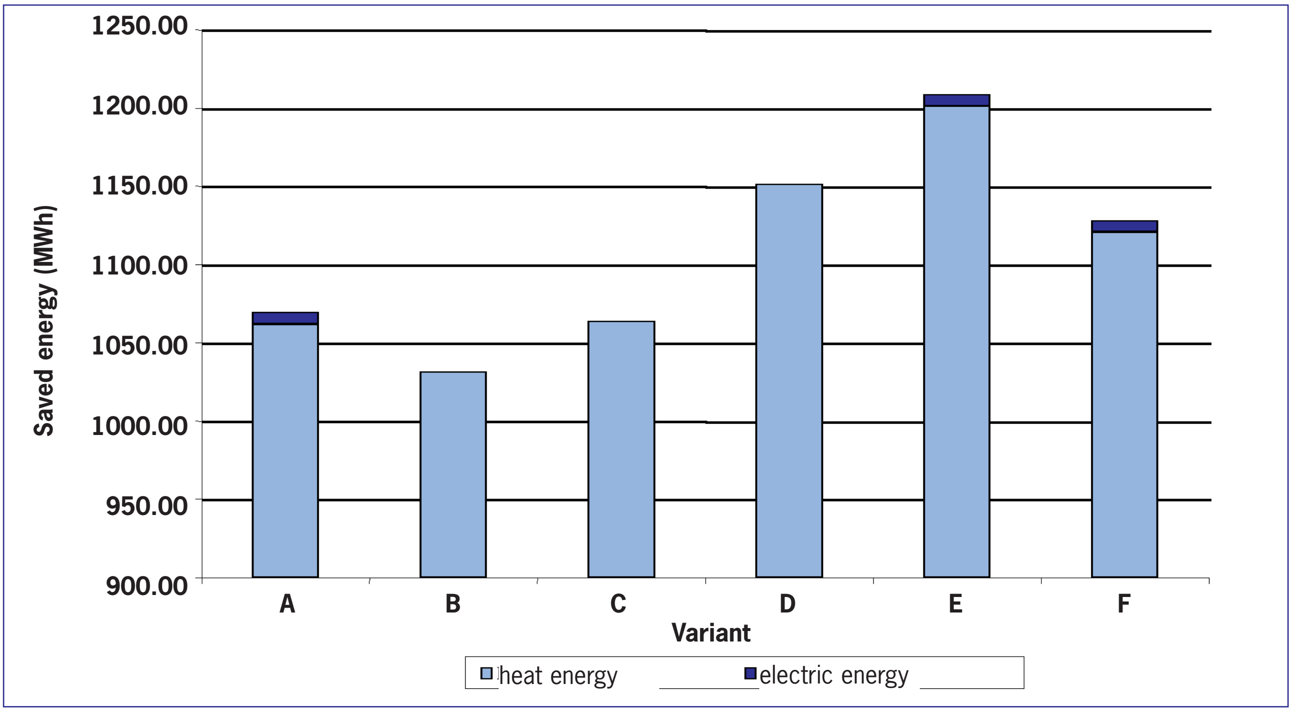


Table 2: Electricity and thermal energy savings

8 User evaluation

Indoor air quality:

In general terms: good if windows are slightly open, stuffy and smelly if windows are closed accidently. (inefficient ventilation)

Dry, humid, smelly, etc.: as described above

Irritations (eyes, nose, throat, skin, ..): no

Quality of daylight / artificial light: both good

Sound quality: good

General feeling: good

General well being: good

Headache: no

Difficult to concentrate: no

Technical functionality: thermostatic valves are easy to adjust and provide sufficient temperature control even with various window positions. New windows are easy to operate, providing better natural ventilation.

Architectural quality: not applicable

9 Renovation costs

Specific cost per technology (as specific as possible):

4 PLN = ca.€1

Table 3a: Capital costs

Description	Variants					
	A (PLN)	B (PLN)	C (PLN)	D (PLN)	E (PLN)	F (PLN)
Heat source	68 400	68 400	68 400	104 600	104 600	68 400
Windows	63 600	0	0	63 600	63 600	63 600
Insulation	108 500	108 500	108 500	108 500	108 500	108 500
Heat system	0	0	90 600	0	94500	85900
Lighting	113 900	0	0	0	113 900	113 900
Σ	**354 400**	**176 900**	**267 500**	**276 700**	**485 100**	**440 300**

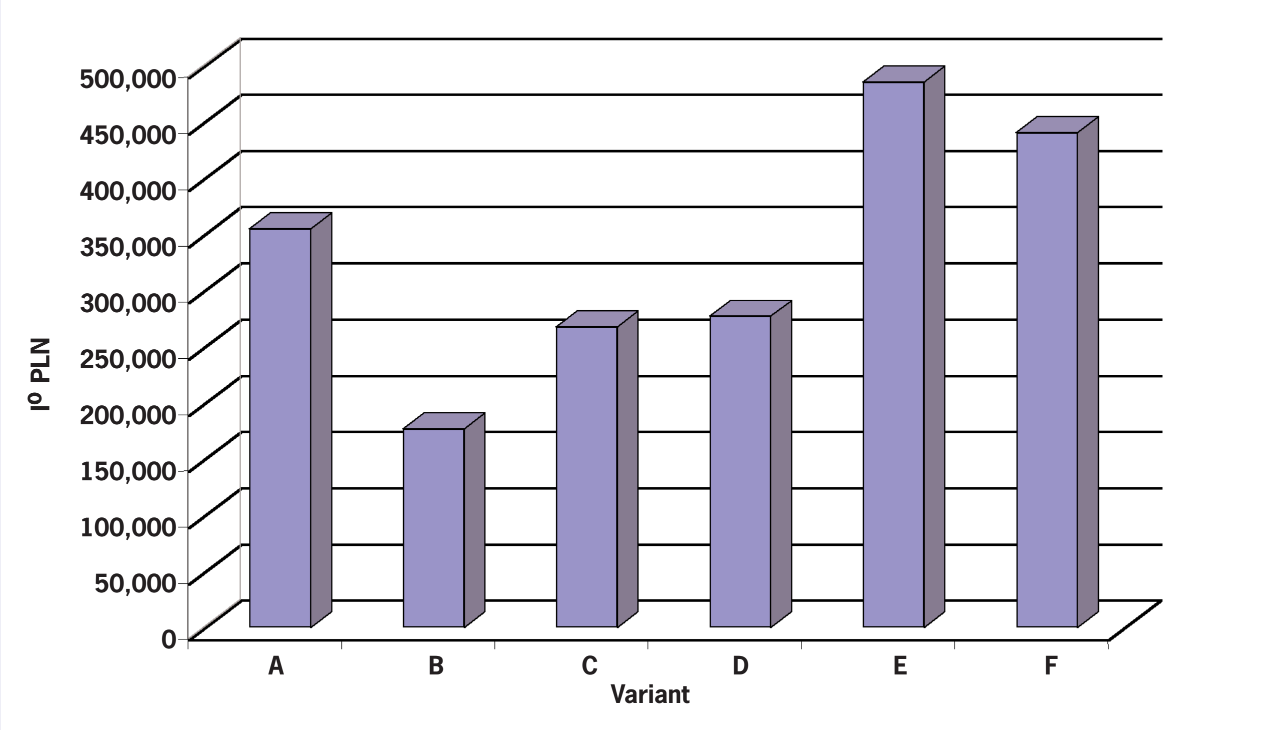


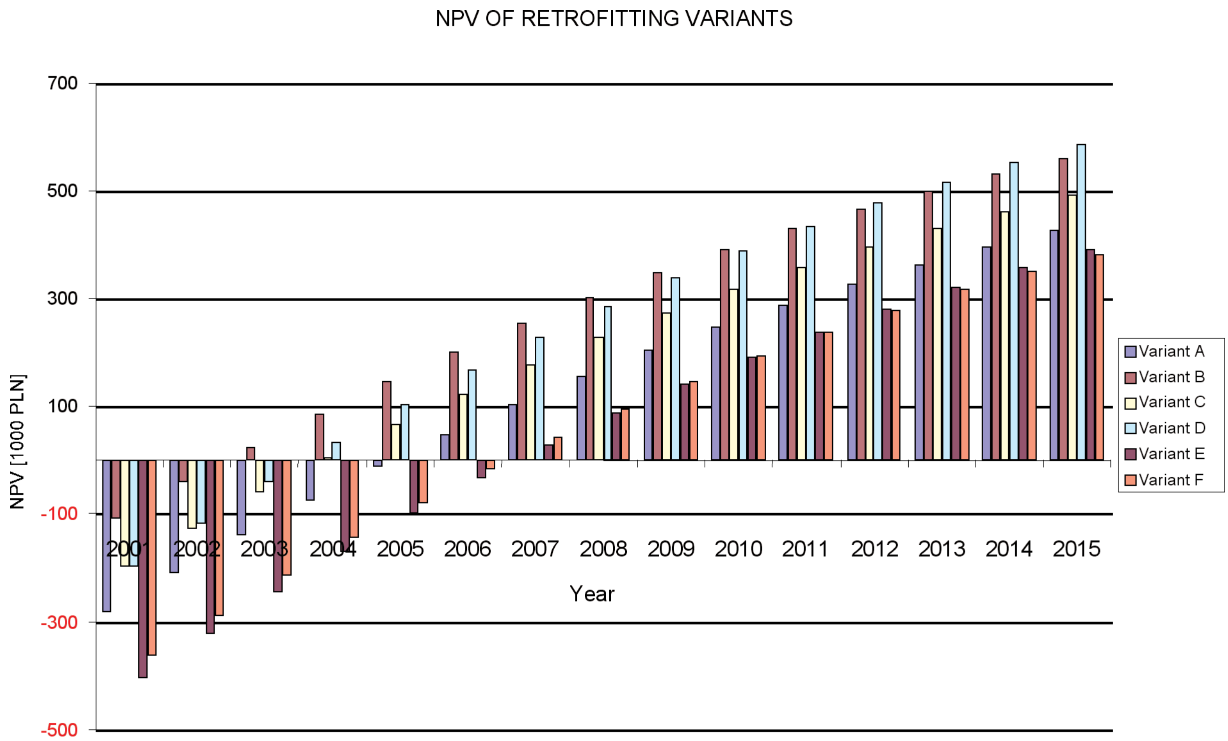
Table 3b: Capital costs

Description	Unit	Variants					
		A	B	C	D	E	F
Heat energy consumption (heating) before retrofitting	MWh/a	1644.6	1644.6	1644.6	1644.6	1644.6	1644.6
Heat energy consumption (heating) after retrofitting	MWh/a	582.5	613.1	580.8	467.8	447.4	523.7
Heat transformation efficiency in heating source	%	88.0	88.0	88.0	104.0	103.0	88.0
Heating system efficiency	%	83.7	83.7	88.4	88.2	93.1	93.1
Fuel calorific value	kWh/m^3	7.22	7.22	7.22	7.22	7.22	7.22
Electric energy consumption (lighting) before retrofitting	MWh/a	28.4	28.4	28.4	28.4	28.4	28.4
Electric energy consumption (lighting) after retrofitting	MWh/a	20.9	28.4	28.4	28.4	20.9	20.9
Fuel (gas) cost	PLN/m^3	0.4795	0.4795	0.4795	0.4795	0.4795	0.4795
GZ-35	PLN/kWh	0.0664	0.0664	0.0664	0.0664	0.0664	0.0664
Electric energy cost	PLN/kWh	0.2887	0.2887	0.2887	0.2887	0.2887	0.2887

Table 4: Values used for cash-flow calculations

Table 5: Calculations

Parameter		Variant A	Variant B	Variant C	Variant D	Variant E	Variant F
Number of years for analysis	n	15	15	15	15	15	15
Average discount rate	R	0.10	0.10	0.10	0.10	0.10	0.10
Total retrofitting capital cost	I_0	354 400	176 900	267 500	276 700	485 100	440 300
Primary energy saved (heating)	dE1	1 062 047	1 031 452	1 063 721	1 176 813	1 197 129	1 120 862
Primary energy saved (lighting)	dE2	7 504	0	0	0	7 504	7 504
Primary energy cost (heating)	P1	0.066	0.066	0.066	0.066	0.066	0.066
Primary energy cost (lighting)	P2	0.289	0.289	0.289	0.289	0.289	0.289
Total retrofitting savings	Ci	72,678	68,480	70,623	78,131	81,647	76,583
CF0		72,678	68,480	70,623	78,131	81,647	76,583
CF1		79,946	75,329	77,685	85,944	89,811	84,241
CF2		86,342	81,355	83,900	92,820	96,996	90,981
CF3		92,386	87,050	89,773	99,317	103,786	97,349
CF4		97,005	91,402	94,262	104,283	108,975	102,217
CF5		101,855	95,972	98,975	109,497	114,424	107,328
CF6		104,911	98,851	101,944	112,782	117,857	110,547
CF7		108,058	101,817	105,002	116,166	121,392	113,864
CF8		111,300	104,871	108,152	119,651	125,034	117,280
CF9		113,526	106,969	110,315	122,044	127,535	119,625
CF10		115,796	109,108	112,522	124,485	130,086	122,018
CF11		118,112	111,290	114,772	126,974	132,687	124,458
CF12		120,475	113,516	117,068	129,514	135,341	126,947
CF13		122,884	115,787	119,409	132,104	138,048	129,486
CF14		125,342	118,102	121,797	134,746	140,809	132,076
CF15		127,849	120,464	124,233	137,441	143,625	134,718



10 Experiences/Lessons learned

10.1 Energy use

10.2 Impact on indoor climate

Thermal:
IAQ:
Drafts:

10.3 Economics

The case study shows how to do net present value calculations as part of options appraisal, it also shows the sensitivity of the calculations to fuel prices.

10.4 Practical experiences of interest for a broader audience

10.5 Resulting design guidance

11 General data

11.1 Address of project

Zespól Szkól Zawodowych
ul. Podgórna 12
62–020 Swarzedz

11.2 Project dates

Project initiation:
Design completed:
Renovation construction completed: October 2000
Monitoring and evaluation completed:

11.3 Date of report / revision no.

17 Dec 2001

12 Acknowledgements

Builder:
Architect:
Engineer:
National, international support programmes:

Author (of this description): Radoslaw Górzenski

13 References

none