OFFICE

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

The LESO Building

Report on monitoring

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19 AUGUST 1998

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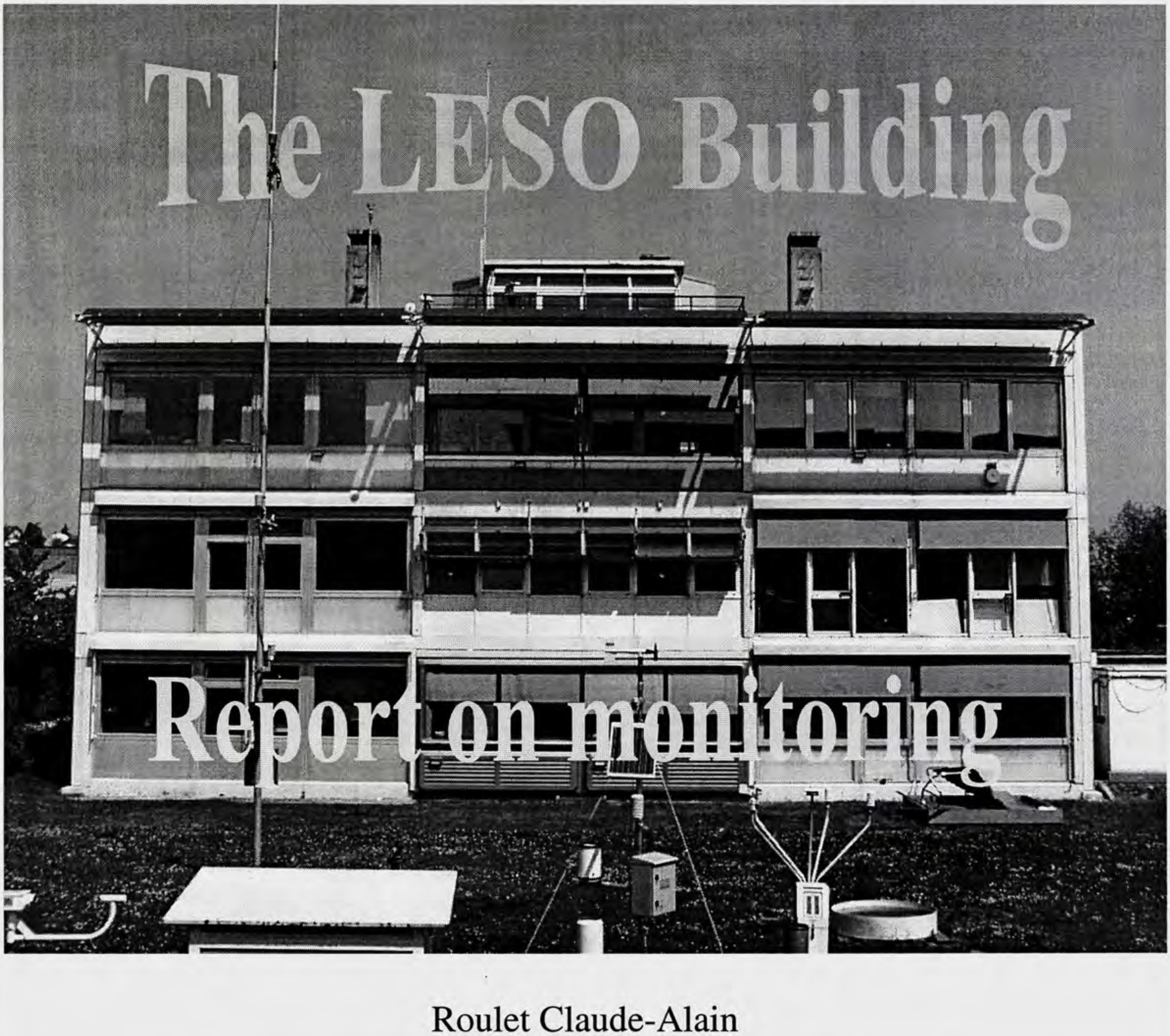

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SUMMARY

Monitoring of about 100 parameters in the LESO building was performed within the EC Joule-Thermie OFFICE research project. Monitored data include meteorological data, internal temperatures, windows and door openings, and energy consumption. Among the conclusions that can be drawn, the most important are as follows:

Internal temperature is not homogeneous. If first floor is comfortable all over the year, ground floor is a bit cold in winter, and top floor is a slightly too warm in summer, but with very few hot hours over 28°C.

The main part of energy consumption is nevertheless for heating, but 40% of energy use is for lighting and office appliances. This results from the very low heating requirement of the building (31 kWh/m² for a full year) and not from a high demand in artificial lighting or energy wasting machines. Energy signature and H-m diagram show that this building makes a large use of solar radiation.

FOREWORD

Spot measurements and monitoring of building data were planned within the EC Joule-Thermie OFFICE research project. Monitored data include meteorological data, internal temperatures, windows and door openings, and energy consumption. Spot measurement addresses air tightness and thermal transmittance of some facade elements, and questionnaires to occupants.

The aims of these measurements are:

- To collect data to fit the simulation models to reality
- To collect information on the performance of the building, with regard to indoor environment quality and energy use
- To assess the relative energy consumption for heating, lighting and other appliances
- To assess the air tightness ands thermal transmission of a poor facade element.

This report presents the results of measurements performed from April 1997 to June 1998, and interpretation of the main measured parameters.

BUILDING DESCRIPTION

General information

The LESO building is a passive solar experimental building. Its aim was as well to host the Solar Energy and Building Physics Research Laboratory of the EPFL, as to provide an experimental facility for measuring the characteristics of passive solar systems. Its southern part consists in nine "calorimetric cells" arranged in three floors. Each cell is 7.2 m broad, 3.2 m high and 5.2 m deep. It is thermally insulated from neighbouring cells, and closed, on its south wall, by the facade element to be tested. This facade element can easily be changed within a week. Most cells are divided in two office rooms by a lightweight partition wall. The north part includes services and staircase.

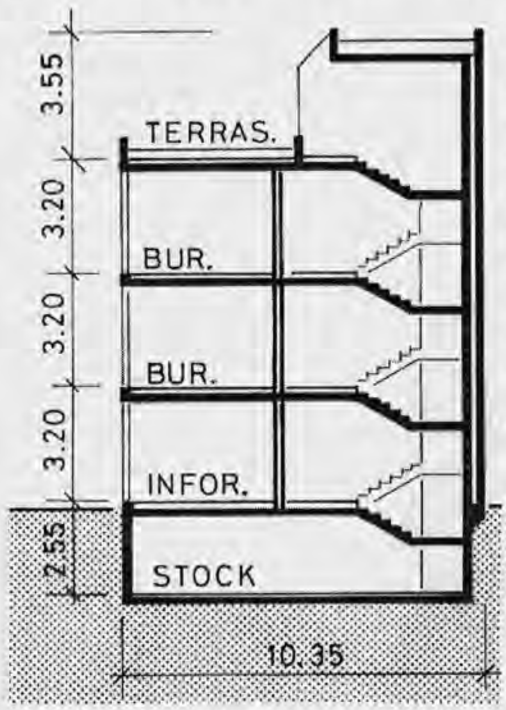


Figure 2: Vertical cut

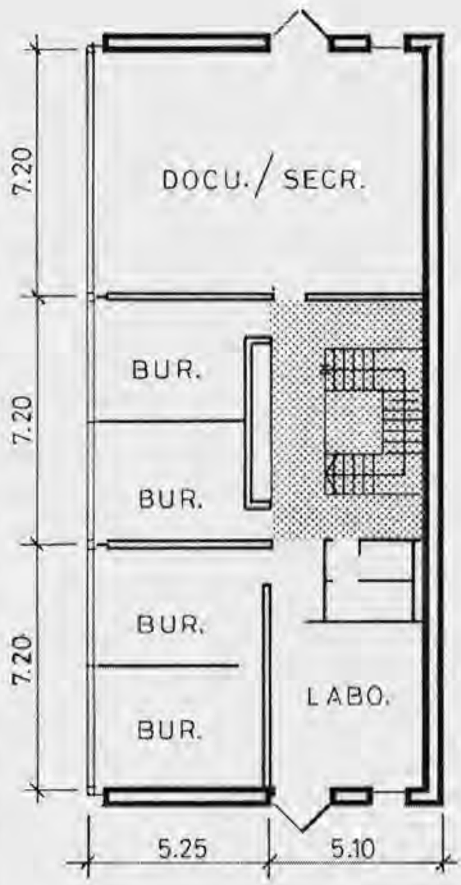


Figure 1: Plan of first floor

Heating system

All south-oriented office rooms are equipped with a direct electric heater, 1 kW peak power per 16 m² room. This heater is controlled by a precision PI (proportional integral) controller, which adjust the room air temperature to the set-point chosen by the occupants.

The staircase and north-oriented rooms are heated by hot water district heating. Radiators are equipped with Danfoss thermostatic valves.

Cooling system

Climate control in summer is based on passive free cooling. During the day, the ventilation rate is kept at a minimum. Windows and doors are closed, to avoid outside warm air entering the building. External solar protections (projection fabric blinds) are kept down, to limit solar gains to a minimum. Before leaving the office, the occupant's open doors and windows located at the building entrance and at the top of the building. These openings are protected against driving rain and intruders. Most office doors are also kept open. The massive structure of the building is thus slowly cooled during the night by the airflow rate generated by stack effect. In the morning, the building is ready to store the limited thermal gains of the next day.

Another active cooling system is used in the workshop located at ground floor, just above the underground rock bed. Small fans, of the type used in electronic devices, blow cool air during the night through the rock bed, which cools down. The next day, this rock bed stores the heat flowing through the floor, thus cooling the floor and the workshop.

Ventilation system

Ventilation is mostly natural, either through windows or by exchange through office doors with the staircase, which is ventilated by stack effect.

Only lavatories have extract fans, switched on during office hours by a clock.

One facade element, the parietodynamic one, includes a ventilation system located below the windows. The outdoor air is filtered, then passes through a plate heat exchanger and an electric heater before being blown in the room. Extract air passes along the glazing, between the external, double low-e coated glazing and an internal single glass pane. This ensures an active thermal insulation of the window. Then the air passes in the heat exchanger before being blown out.

Electrical network and equipment

This experimental building includes many facilities for monitoring its thermal behaviour. Each cell is heated independently with an electric heater connected to a counter. Lighting and other electric appliances (one of two desktop computers per room) are connected to another electric counter. Therefore, the electricity use of each cell can be measured.

A cable network connects each office room to the EPFL network, itself directly connected to an electronic highway. This includes telephone, telefax, and Internet (though optical fibre).

The LESO building is fully instrumented. A central data logger collects the data provided by ten peripherals, each offering the possibility to connect up to 50 sensors. One peripheral is located in each cell, and one is dedicated to the meteorological station. The central data logger is also connected to the computer network, thus making the data available to everybody at any time.

MEASUREMENT PLANNING

Introduction

The LESO building is fully instrumented, and can therefore be monitored in very detail. Therefore, the monitoring design described below contains many measurements, which cannot be performed elsewhere. However, the treatment of large amount of data is expensive in time and money. Therefore, monitoring is limited to data that are useful to achieve the following objectives:

1. To provide data for adjusting the computer simulations required to estimate the effect of the planned retrofit measures
2. To control the effects of retrofit measures.
3. To help in planning some other retrofit measures

First retrofit actions were planned for spring '97, but were effectively taken in November 1997. Therefore, the monitoring period was a bit disturbed by the retrofit works. The advantage is that we got measurements before and after retrofit.

Monitoring to adjust simulations

Thermal properties of building elements: No monitoring is necessary for this, only point measurements of the following data are required:

- Visualisation of thermal bridges in envelope using thermal imaging,
- *U*-value of panes in envelope elements using the heat flow meter technique,
- Global heat loss through these elements using guarded hot box technique.

These measurements are reported elsewhere [Roulet, 1997]

Artificial lighting : The use of electricity was monitored separately and in each office room for heating and other appliances on one hand, and for lighting on the other hand.

Electrical equipment: Electric consumption for heating and other appliances was monitored in each room. This gives an indication on the use of electrical appliances outside the heating season.

Monitoring to control the effects: Retrofitting measures (planned for and financed by another research program) are taken during the OFFICE project, and measurements will be performed to assess the efficiency of the measures taken.

Electrical equipment: Monitoring of electric consumption for lighting and other appliance in each room.

Continuous monitoring

The following data were continuously monitored at the LESO, since April 1 and during one year for the OFFICE project:

- Meteorological conditions.
- Electricity use for heating, office appliances and lighting
- Air, and globe temperatures, occupancy, doors, windows and sunscreen positions in 10 office rooms

A detailed list of monitored channels is in Annex 1.

RESULTS

Outdoor climate

Figure 3 shows monthly averages of some meteorological data during the "OFFICE" year, that is from June 97 to May 98. As usual in continental Europe, the coldest month is February, while the hot days are in July. There is not much wind in this area, and average relative humidity is nearly constant.

As shown on Figure 4, it temperature was below zero during 3% of the 1997-98 year, median temperature throughout the monitored year was 12°C, and there were very few hot hours (31 hours above 28°C) in Summer 1997.

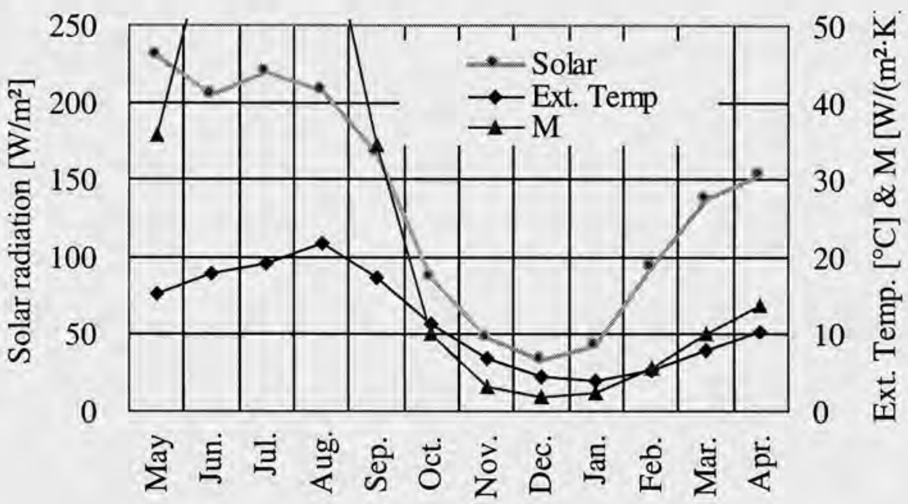


Figure 3: Monthly averages of some meteorological data.

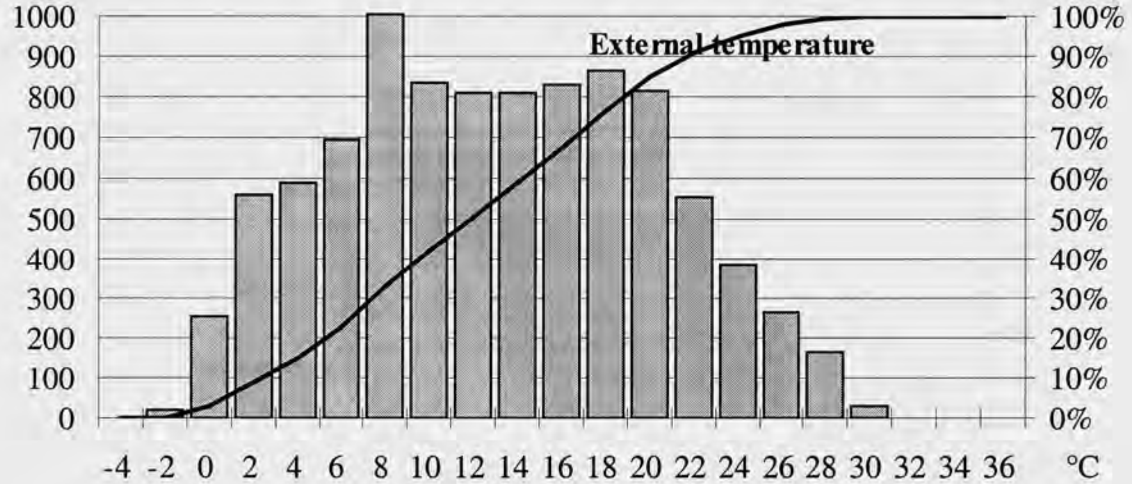


Figure 4: Differential and cumulated frequency distribution of external temperature.

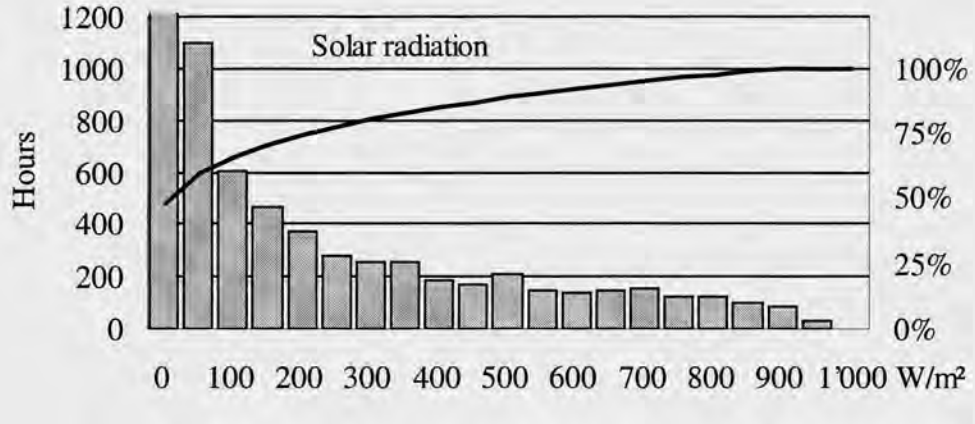


Figure 5: Differential and cumulated frequency distribution of global solar radiation on a horizontal plane.

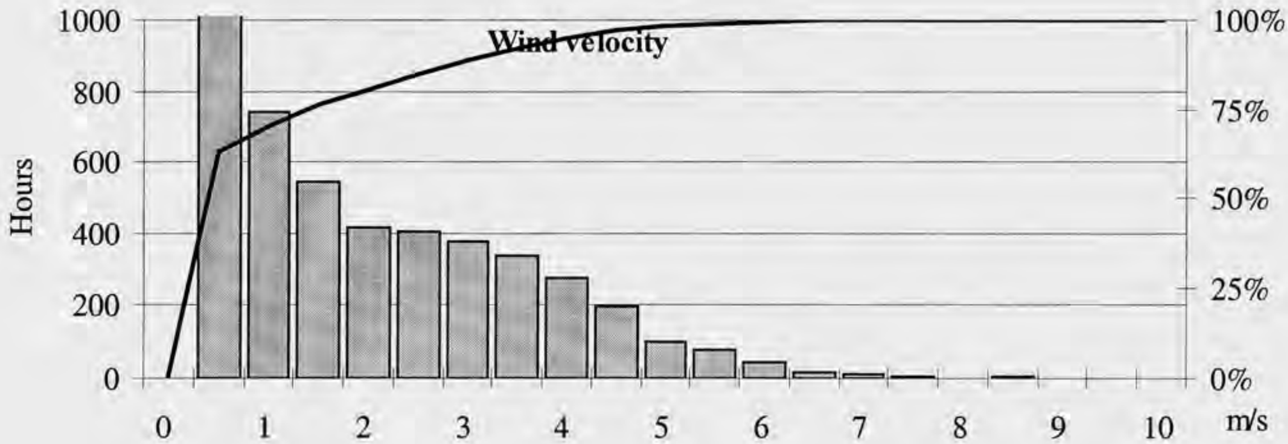
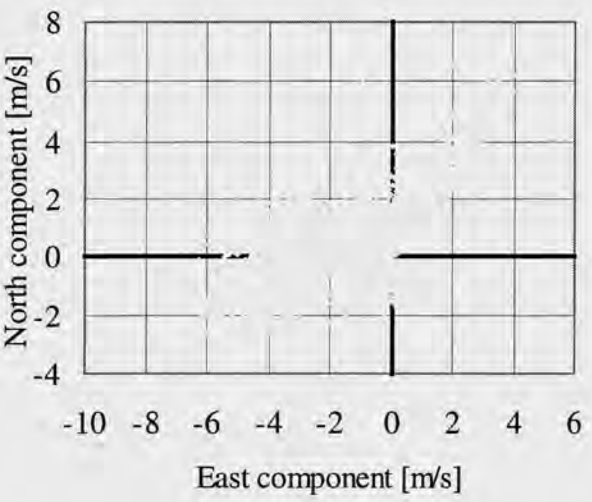


Figure 6: Differential and cumulated frequency distribution of wind velocity



Wind velocity is low (Figure 6) and comes mainly from west (fronts) and from northeast (cold wind in front of anti-cyclones). These main directions result from the Jura mountains, oriented northeast to southwest, and from the Alps, which protect from south winds..

Figure 7: Wind rose at Leso. Each dot is a hourly measurement

Indoor temperatures

Ambient indoor temperatures were measured at 18 locations: in two office rooms at ground and second floor, in seven in first floor, and at six different heights in the staircase. These measurement points were chosen to assess the differences between floors.

Average temperature in the measured office rooms is 22,5°C.

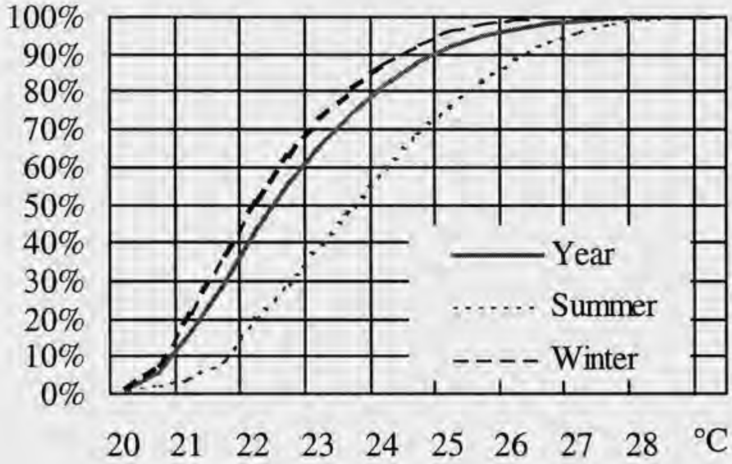


Figure 8: Cumulated frequency distribution of average air temperature in office rooms.

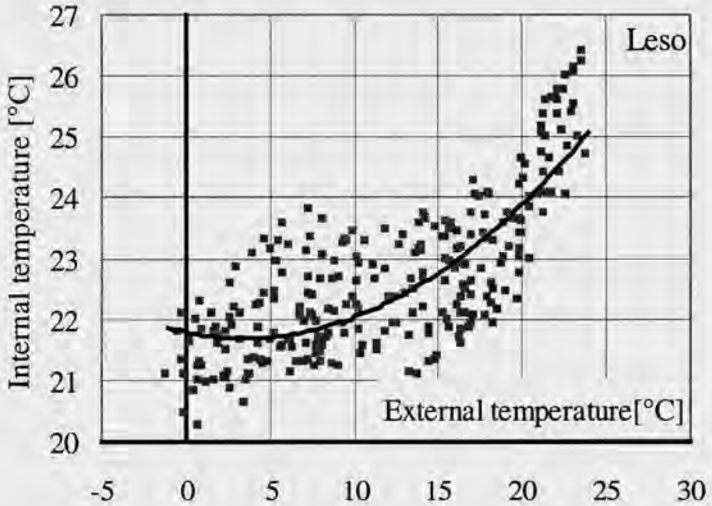


Figure 9: Daily average of indoor temperature in relation to outdoor temperature (working days only).

Internal temperature depends on external temperature, as shown in Figure 9, and this makes sense: comfort temperature is higher with summer clothing than with winter garments.

Differences between office rooms are significant (Figure 10). There is a temperature gradient from bottom to top of the building (Figure 11 to 11) the staircase being approximately at the same temperature as the office rooms at each floor. Note that the doors of office rooms to staircase are mostly open.

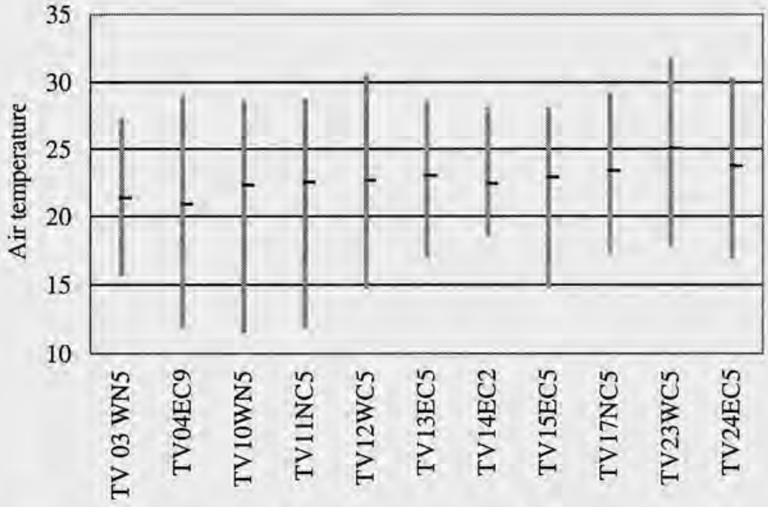


Figure 10: Yearly average of measured temperatures in office rooms, with mini-max bars. See Annex 1 for the sensor number.

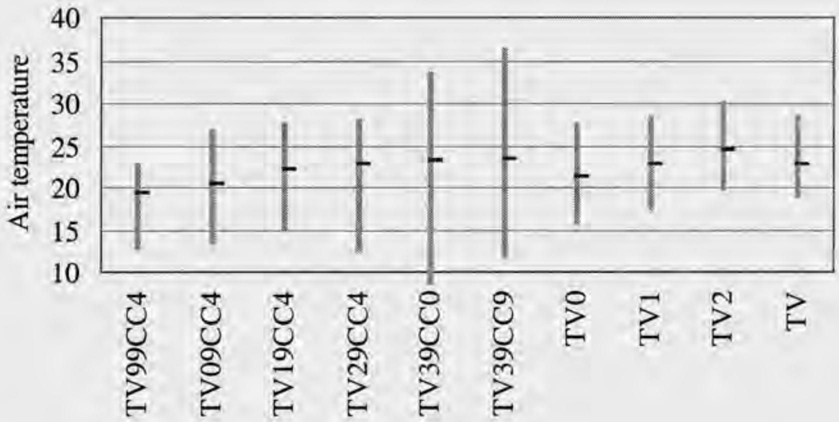


Figure 11: Yearly average of measured temperatures in staircase, with mini-max bars. To the right are averages and mini-max for each floor and for the whole building.

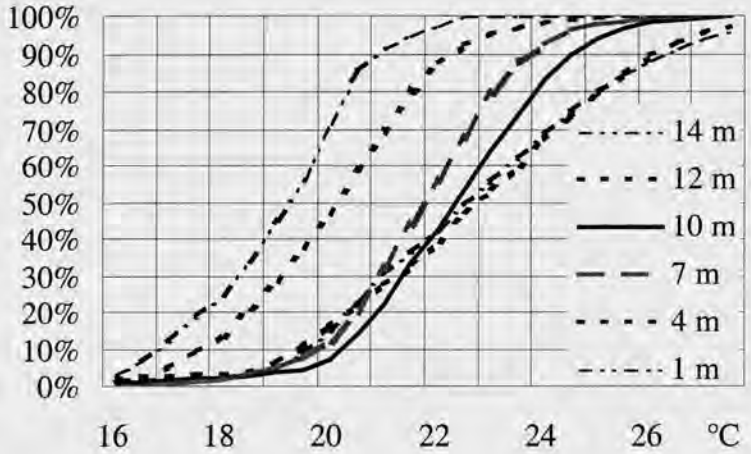


Figure 12: Cumulated frequency distribution of the internal temperature in the staircase, at various heights. Zone above 9 m is not occupied.

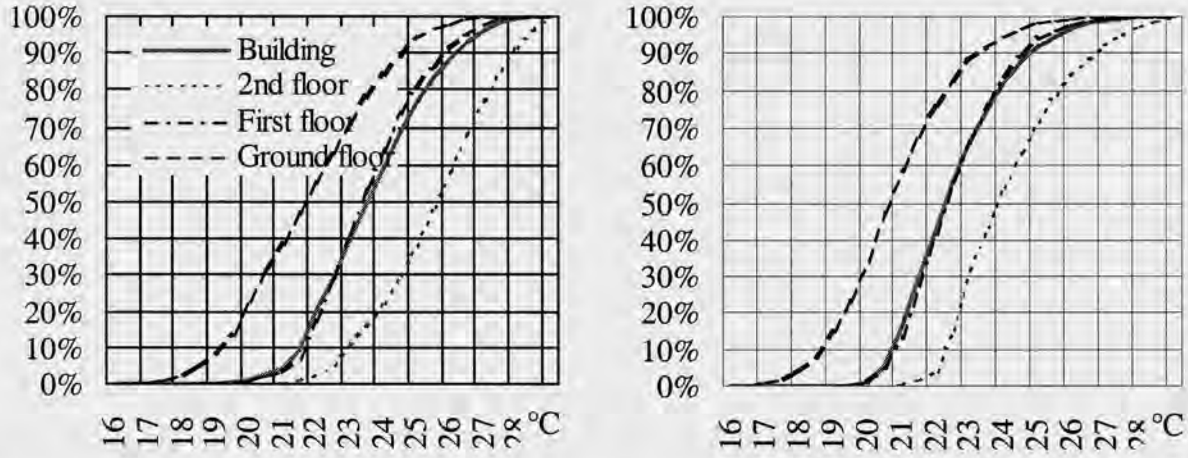


Figure 13: Cumulated frequency distribution of the average internal temperature in the three floors. Left: in winter, right, in summer.

The comfort conditions are therefore not the same at each floor. Percentage or time outside the comfort limits (according to EN ISO 7730 for office work) are listed in Table 1.

Table 1: Percentage of time outside comfort limits for office work (according to ISO 7730)

		Ground	First	Second
In Winter	Below 20	38%	1%	0%
	Above 24	1%	6%	29%
In Summer	Below 23	71%	41%	11%
	Above 26	1%	2%	32%

The most comfortable level is the first floor, which is neither cold in winter nor overheated in summer. Ground floor is a bit cold, especially in winter. This results from cold air flowing through the untight entrance door. Second floor overheats rather often, but is only 6% of the time warmer than 28°C in summer. Such temperatures arise during holidays, when nobody action the solar protections.

Energy use

Each office has two electricity meters: one for heating, and one for light and other appliances. In order to assess separately the energy use for light and other appliances, computers and office machines were, as far as possible, connected to the heating meter. So, this meter measures the energy for office appliances outside the heating season. During the heating season, it is assumed to be the average use outside the heating season.

However, some occupants connected plugged additional electric heaters into plugs connected to the lighting electricity meter, as shown on Figure 14. The maximum line shows 2 kW steady consumption during the night, which cannot be lighting.

The staircase is heated by district hot water heating. The heat meter was connected to the data acquisition system but no data was recorded. Therefore, the heat use for the staircase is estimated from records of preceding years.

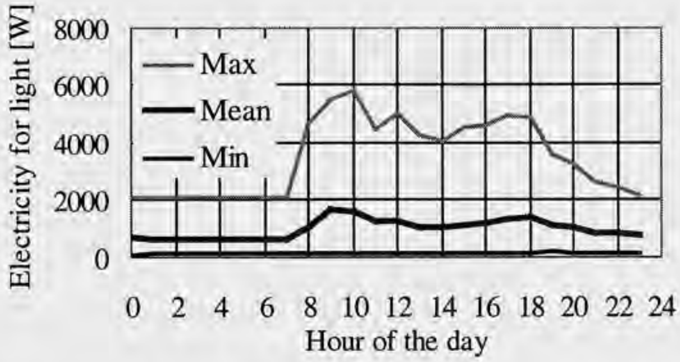


Figure 14: Daily schedule of electricity use for lighting. Maximum, average and minimum over the whole year of electricity use for each hour of the day are represented.

The monthly energy use for the whole building is shown in Figure 15. It can readily be seen that the largest part is for heating.

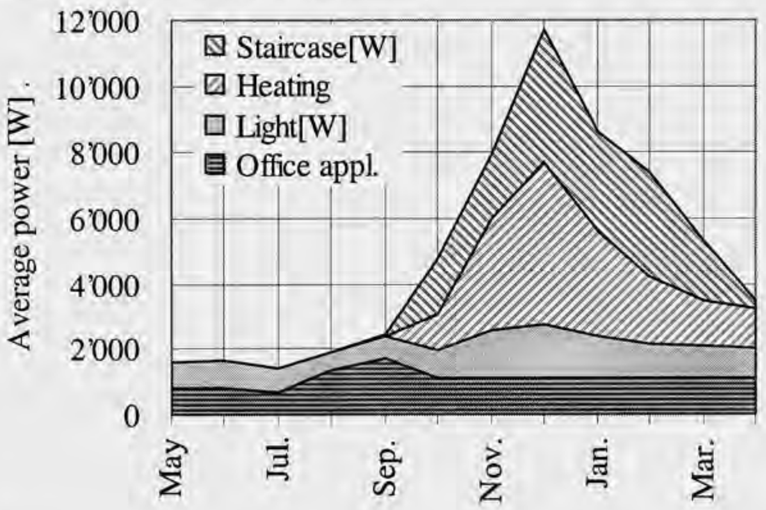


Figure 15: Monthly electricity use for the LESO building.

Partition of energy among the various uses is in Table 2 and Figure 16. Most of the energy use is for heating office rooms and staircase, but lighting and other appliances use together 43% of the total, and nearly 60% of electricity. This is typical of a passive solar building, in which the heating requirement is very small, as can be seen from the energy index in kWh/m² heated floor area.

Table 2: Partition of energy uses.

	Energy [kWh]	En.Index kWh/m²	Part
Appliances	9'658	12.3	23%
Light	8'521	10.8	20%
Heating offices	12'671	16.1	30%
Staircase	11'737	14.9	28%
Total	42'588	54.2	100%

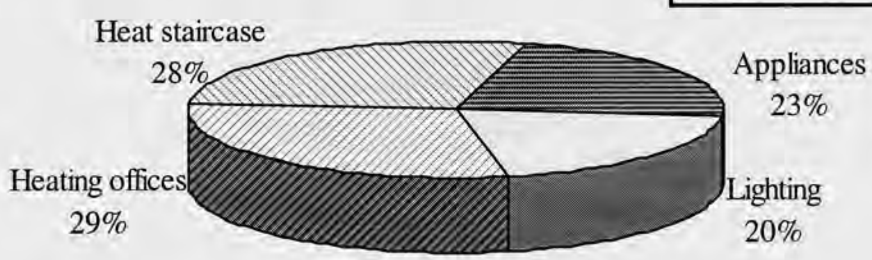


Figure 16: Partition of energy uses.

Energy signature

Energy signature is the relationship between heating power, averaged over a given period of time, and external temperature, averaged over the same period of time.

Monthly basis

Heating and cooling energy signatures on a monthly basis are given in Figure 17. Note the large dispersion of measured points around the regression line. This is typical of a passive solar building.

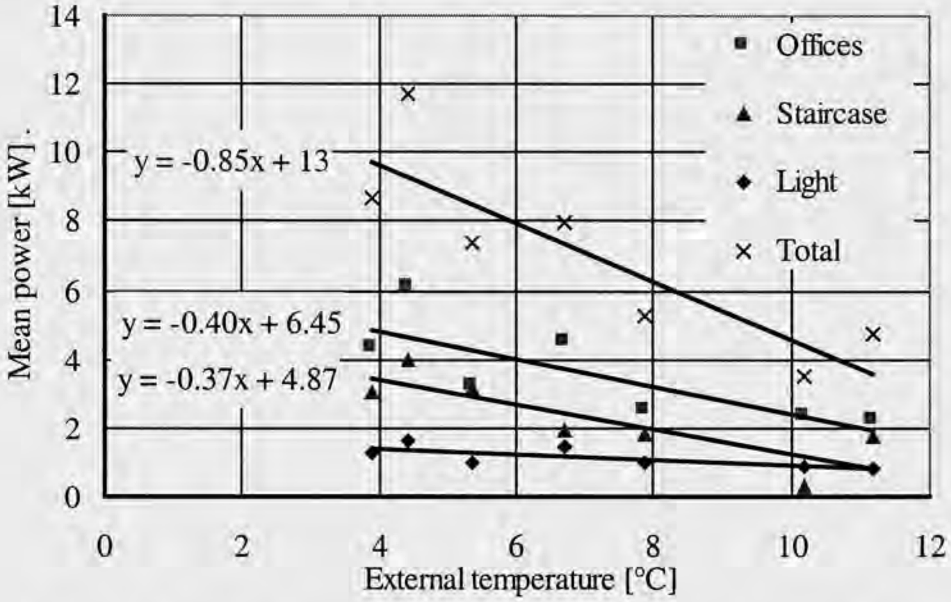


Figure 17: Heating and lighting energy signatures on a monthly basis

Total energy signature has the following parameters:

Heating power à 0°C	13 kW
Slope	850 W/K
No heating above	13 °C, assuming 2 kW base power (lighting and appliances).

The slope can be compared to the heat loss coefficient of the LESO building - calculated according to prEN 832 - which is about 1 kW/K (570 W/K by transmission and 480 W/K by ventilation). The difference may come from uncertainties of input data for calculations and of measurements.

It is by chance that he staircase and offices heating energy signature have the same slope, since there is no special reason for this.

The lighting energy is slightly correlated to temperature. There are two reasons for this: a) the parasitic electric heaters mentioned above and 2) artificial lighting needs are larger during cold days.

Theoretical heat requirement at design minimum temperature (i.e. –9 °C) would be 22 kW. For office rooms only, it would be 10 kW. This figure can be compared with the nominal power of the installed heating power: 1 kW per office room, that is 22 kW. Nominal power of district heating is not known. The main reason for oversizing is that it is difficult to find electric heaters smaller than 1 kW.

Daily basis

The energy signature of electricity can also be drawn on a daily, or even a hourly basis (Figure 18.). This figures shows that:

1. The cloud of points is widely dispersed, because energy use of this building does not strongly depends on temperature, but on many other uses, and conditions (see Figure 16)
2. There is no dependence on temperature above 13°C, which is the no-heating temperature of that building. Up top 2500 W (hourly average) is used in this building for lighting and other non-heating appliances.
3. Lighting electricity power does not depend strongly with temperature.

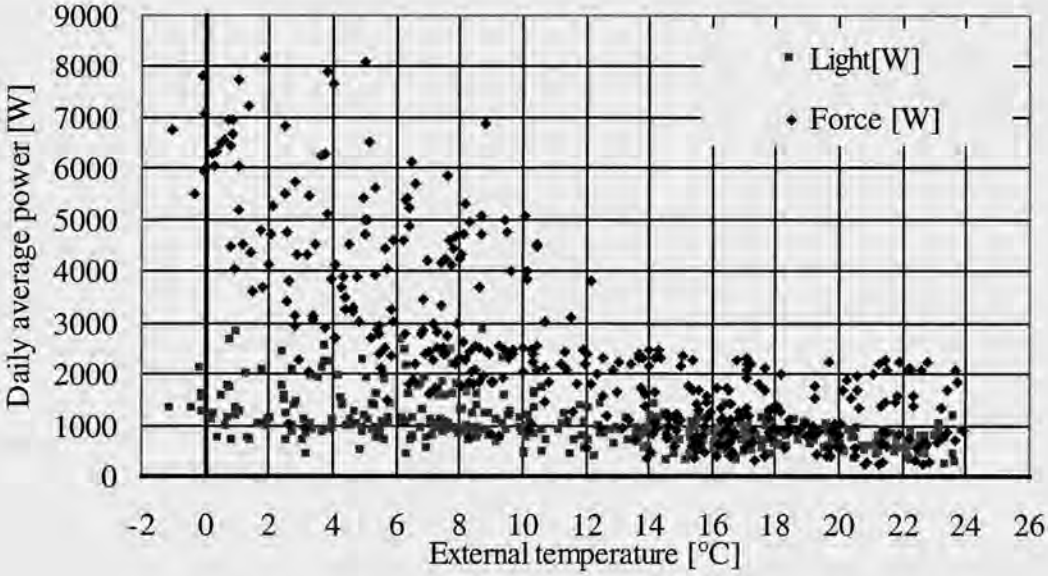


Figure 18: Heating energy signatures on daily basis

The H-m method *[Gay et al, 1995]* is useful to identify the sensitivity of the building to solar radiation, or its ability to make use of solar gains. It is an identification method taking account of both external temperature and solar radiation:

$$H = \frac{P - P_b}{\theta_i - \theta_e} = H_0 - \eta A_e \frac{q_s}{\theta_i - \theta_e} = H_0 - \eta A_e \, m \qquad (1)$$

where:

H is an apparent heat loss coefficient, which varies with solar radiation.
P is the heating power, averaged, in watts,
P_b is a base power corresponding mainly to other heat consumers such as hot water, and heat loss of the heating system, taken as 40 kW from average during summer months,
θ_i is the internal set-point temperature, in °C
θ_e is the external temperature, averaged over the same time period than that for P
H_0 is the heat loss coefficient,
η is the utilisation factor for heat gains
A_e is the effective solar collecting area, and
q_s is the solar radiation on a reference (e.g. horizontal) plane in W/m²
m is a variable depending mainly on meteorological conditions:

$$m = \frac{q_s}{\theta_i - \theta_e} \qquad (2)$$

This relationship, considering office rooms heating only, is shown on Figure 19. The parameters H_0 and ηA_e of the H-m equation are identified using a linear least square fit. These are:

H_0 = 300 W/K, smaller, but nevertheless close to the slope of the signature of office rooms

ηA_e = 27 m², effective solar radiation collecting area, to be compared to 133 m² windows, or 72 m² equivalent area calculated according to prEN 832. Note that ηA_e is related to global solar irradiance on a horizontal plane, while prEN 832 looks at each orientation separately. This, together with the fact that utilisation factor (0,65 for this building) is included in ηA_e explains the difference between ηA_e and 72 m².

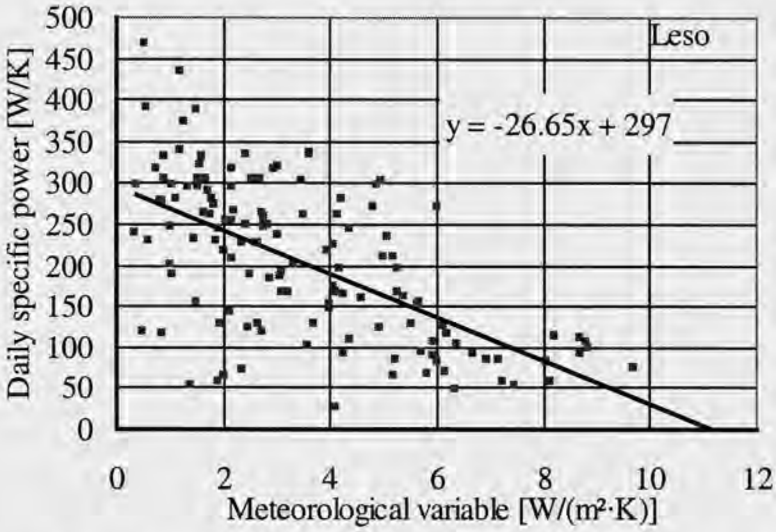


Figure 19: H-m diagram of the LESO building, heating season.

Note that heating is no more necessary when m = 11 W/(m²·K), or in other words, when the global solar radiation intensity on an horizontal plane, in W/m² is 11 times the indoor-outdoor temperature difference. This shows that the LESO building makes a large use of the passive solar gains, which cover 50% of the heating requirement.

IMPROVING THE SUNSPACE

The staircase is topped by a glazed wall and roof, which provides light in the staircase and allows its airing. This piece of ironwork was poorly manufactured. It was not watertight, and presented many thermal bridges. It was therefore changed by a new one in November 1997. The old standard double glazing was replaced by a low-emissivity double glazing, thus doubling thermal insulation. The solar protections were also changed at this time.

Figure 20 shows the relationship between indoor and outdoor temperatures in that sunspace, before and after retrofit. It can easily be seen that the internal temperature raised significantly.

Unfortunately, we have no records of the heating use. We know however that the heating power and set points were not changed during and after retrofit.

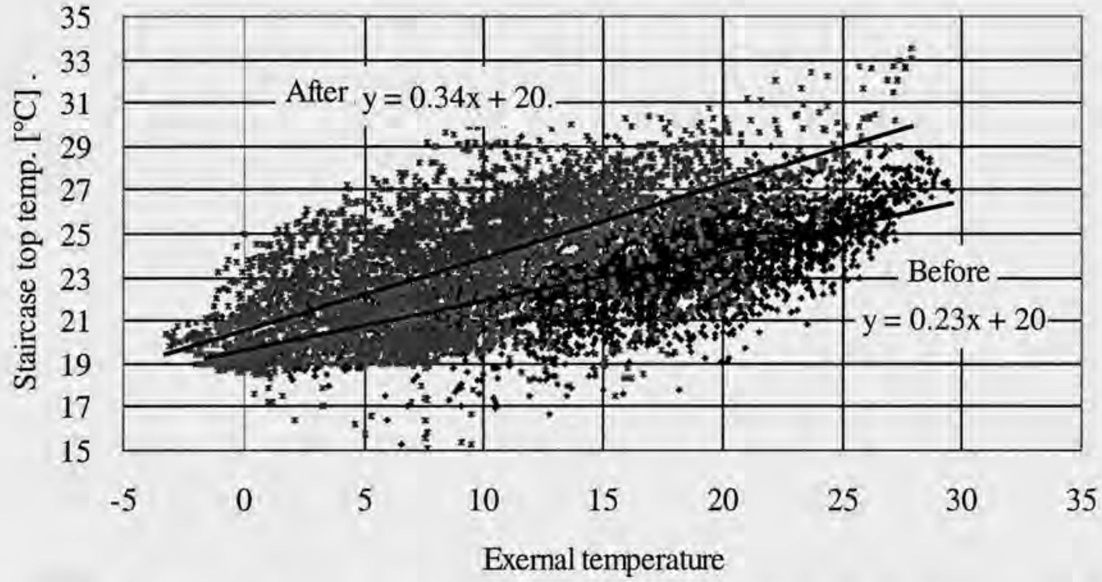


Figure 20: Relationship between indoor and outdoor temperatures in the sunspace on the top of the staircase, before and after retrofit.

CONCLUSIONS

Monitoring of internal temperatures has shown that there is a temperature gradient from bottom to top of the building. The most comfortable level is the first floor, which is neither cold in winter nor overheated in summer. Ground floor is a bit cold, especially in winter, while the second floor overheats rather often, but seldom above 28°C.

The building has a very low annual energy consumption, only 54 kWh/m² heated floor area for all uses. Most of the energy use is for heating office rooms and staircase, but lighting and other appliances use together 43% of the total, and nearly 60% of electricity. This is typical of a passive solar building. The no-heating temperature is also rather low: only 13°C.

REFERENCES

Gay, J.-B.; Eggimann,, J.-P., Faist, A., Francelet, P.-A., Scartezzini, J.-L.: Comparaison de six systèmes solaires passifs dans des conditions climatiques identiques. *Cinquième Symposium Solaire, EPFL, Lausanne, 1995*

Roulet, C.-A. LESO building - Heat loss of protruding elements, *Office report,LESO-EPFL, Feb, 1997*

ANNEX 1: INFORMATION ON MONITORED DATA FILES

Monitored data are provided for the OFFICE monitoring year, that is from June 1st, 1997 to May 31, 1998. Monitoring actually began by the end of April 1997 and ended at the beginning of June 1998.

Monitored data are stored in an ACCESS format file (LESO_OFFCICE.mdb), which is organised in five tables:

• Door	Doors opening sensors and occupants counters
• Force & Light	Electricity metersr
• Internal temperature	Air and globe temperatures
• Meteorology	All meteorological data
• Shadings & Windows	Position of solar shadings and windows

In this format, each line corresponds to a given time. The first line contains the variable names, listed further below with explanations.

How to handle the ACCESS database

For those not knowing ACCESS, a few hints are given below.

To see a chart

It is possible to draw a chart in Access. To draw a chart for a given channel between 2 dates:

1. Go in the *Forms* windows.
2. Select the button "*New*"
3. Select "*Chart Wizard*" and the table where the data come from and press "OK". Then follow the instructions

To export Access data to Excel worksheet

1. In the Database window, click the name of the table or query you want to export, and then on the File menu, click Save As/Export.
2. In the Save As dialog box, click To an External File or Database, and then click OK.
3. In the Save As Type box, click the spreadsheet format you want.
4. Click the arrow to the right of the Save In box and select the drive or folder to export to.
5. Double-click an existing spreadsheet, or enter a new name in the File Name box.

   Caution. With three exceptions, if you export to an existing spreadsheet file, Microsoft Access deletes and replaces the data in that spreadsheet. The exceptions occur when you export to a Microsoft Excel version 5.0, 7.0/95, or 8.0/97 workbook, where the data is copied to the next available worksheet.

   If you selected Microsoft Excel 5-7 or Microsoft Excel 97 in step 3 and you want to preserve fonts, preserve the displayed data from Lookup fields, and preserve field widths, select the Save Formatted check box. Saving will be slower.

6. Click Export.

   Microsoft Access creates the spreadsheet file containing the data from your table or query. Field names from the table or query are placed in the first row of the spreadsheet.

Detailed list of monitored channels

Sensor types

Type	Short description	Detailed description
TV	Temperature - Ventilated	Platinum 100 Ω resistor, four wires, located in a chrome plated 1 cm Ψ tube, ventilated with small electric fan.
TA	Temperature - Air	Platinum 100 Ω resistor, four wires, located in a chrome plated 1 cm Ø tube
TS	Temperature - Surface	Platinum 100 Ω resistor glued on the surface
TG	Temperature - Globe	Platinum 100 Ω resistor in a 15 cm Ψ black sphere
TF	Temperature - Floor	Platinum 100 Ω resistor embedded in the floor
TW	Temperature - Walls	Platinum 100 Ω resistor embedded in the wall
Px	Potentiometer	Precision 50 kΩ potentiometer monitoring door (PD) or window (PW) opening angle, or sunscreen (PS) position
Bx	Binary	Switch monitoring door (SD) or window (SW) opening
Cx	Counter/consumption	Counter for electricity (CF, CL), heat counter (CH) or occupants passing the door (CD)
xF	Postfix for counters	Heating and other appliances
xL	Postfix for counters	Measures light only

Most sensors were developed at the LESO. Exception are:

Electricity counters: Landis and Gyr MK 4 modified to get a pulse at each disc rotation through an opto-electronic device.

Heat counter: Chlorius combimeter

In the following tables is a complete list of channels. Listed are:

Standard name:	Abbreviated name according to the "Sensor names" sheet in annex
Data column	Name of the columns in EXCEL files containing the measured data
VNR name	Name of the channel in the data logging system (purchased from VNR company)
Correction	Calibration data, when required
Calibration date	Date when calibration data was measured
Remarks	Comments

OFFICE 003& 004

Standard name	data column	VNR name	Correction	Calibration date	Remarks
TV 03 WN5	B	T802	0.1	04.02.97	
TG 03 RCC	C	T833	0.2	04.02.97	
CD 03	D	V843R3			
CF 03	E	C803	X8.33=wh		
CL 03	F	C804	X2.08=wh		
PD 03 NE	G	V832R3			
PW 03 SE	H	V830R3			
PS 03	I	V840R3			0.3V Open 5V Closed
BW03	J	O831			
BD03	K	O827			VNR name = 827 or 727 ?
TV 04 EC9	L	T801	-0.2	04.02.97	
TG 04 RCC	M	T804	0.2	04.02.97	
CD 04	N	V843R3			
CF 04	O	C801	X8.33=wh		
CL 04	P	C802	X2.08=wh		
PD 04 NW	Q	V827R3			
PW 04 SW	R	V852R3			
PS 04	S	V823R3			
BW 04	T	O829			
BD 04	U	O810			

OFFICE 100, 101, 102

Standard name	data column	VNR name	Correction	Calibration date	Remarks
TV 10 WN5	V	T647	0	04.02.97	
TV 11 NC5	W	T607	0.4	06.02.97	
TV 12 WC5	X	T601	0.2	04.02.97	
CD 12	Y	V641R2			
CF 12	Z	C601	X8.33=wh		
CL 12	AA	C602	X2.08=wh		
CF 10	AB	C603	X8.33=wh		
CL 10	AC	C604	X2.08=wh		
PS 12		V642R3			Solar protection
BW 11 SC	CP	V636R3			
BW 12 SC	CQ	V637R3			
BW 10 ES	CO	V635R3			Windows computer rooms
BW 10 EN	CN	V634R3			

OFFICE 103, 104

Standard name	data column	VNR name	Correction	Calibration date	Remarks
TV 13 EC5	AE	T531	0.5	04.02.97	No solar protection monitoring
TG 13 RCC	AF	T530	0.5	04.02.97	
CD 13	AG	V534R3			
CF 13	AH	C503	X8.33=wh		
CL 13	AI	C504	X2.08=wh		
PD 13 NE	AJ	V608R3			
PW 13 SW	CR	V638R3			
BW 13 SE	AK	V633R2			
BD 13 NE		?			
TV 14 EC2	AL	T540	-0.1	04.02.97	
TG 14 RCC	AM	T539	0.4	04.02.97	
CD 14	AN	V533R3			
CF 14	AO	C501	X8.33=wh		
CL 14	AP	C502	X2.08=wh		
PD 14 NW	AQ	V529R3			
PW 14 SW	CS	V543R3			
BW 14 SW	AR	V509R3			Double switch, one per window
BD 14 NW	AS	V524R3			

OFFICE 105, 106, 107

Standard name	data column	VNR name	Correction	Calibration date	Remarks
TV 15 EC5	AT	T535	-0.1	04.02.97	
TV 16 WN5	AU	T402	0.2	04.02.97	
TV 17 NC5	AV	T538	-0.1	04.02.97	
CD 15		?			
CF 15	AW	C401	X8.33=wh		COMMON WITH 106&107
CL 15	AX	C402	X2.08=wh		COMMON WITH 106&108
PS 15		-			
BW 15 SE9	CU	V423R3			
BW 16 SW9	CW	V421R3			
PW 15 SE	CT	V420R3			
PW 16 SW	CV	V422R3			
BW 17 WS	CX	V418R3			

OFFICE 203, 204

Standard name	data column	VNR name	Correction	Calibration date	Remarks
TV 23 WC5	AY	T036	0.6	04.02.97	
TG 23 RCC	AZ	T004	0.9	04.02.97	
CD 23	BA	V028R2			
CF 23	BB	C003	X8.33=wh		
CL 23	BC	C004	X2.08=wh		
PD 23 NE	BD	V033R3			
PW 23 SW	BE	V034R3			switch only on window
PS 23	BF	V032R3			
BW 23 SW	CY	V309R3			
BD 23 EN		-			
TV 24 EC5	BG	T038	1.1	04.02.97	
TG 24 RCC	BH	T003	0.3	04.02.97	
CD 24	BI	V027R2			
CF 24	BJ	C001	X8.33=wh		
CL 24	BK	C002	X2.08=wh		
PD 24 NW	BL	V035R3			
PW 24 SW		-			switch only on window
PS 24	BM	V032R3			IDEM OFFICE 204
BW 24 SW	BN	V043R3			NOT PRESENT
BD 24 EN		-			

STAIRCASE

(909, 009, 109, 209, 309)

Standard name	data column	VNR name	Correction	Calibration date	Remarks
TV 99 CC4	BW	T723	0.1	04.02.97	
TV 09 CC4	BX	T722	0.1	04.02.97	
TV 19 CC4	BY	T543	-0.1	06.02.97	
TV 29 CC4	BZ	T013	0.8	04.02.97	
TV 39 CC9	CA	T148	0.2	04.02.97	
TV 39 CC0	CB	T012	0.7	06.02.97	
BW29EN0	CZ	V310R3			
BW29WN0	DA	V052R3			
BD39ES0	DB	V154R3			
BW39SC8			No switch		This window is always closed.
BW39EN0	DC	V151R3			Airing openings
BW39WN	DD	V137R3			Airing openings

METEO

Standard name	data column	VNR name	Correction	Calibration date	Remarks
Outdoor air temperature (roof)	BO	T101	0.7	06.02.97	In meteo aired cabinet
Ventilated outdoor air temperature (roof)	BP	T152	0.8	06.02.97	In meteo aired cabinet with a ventilator
Pyrheliometer 19819	BQ	V102R1	*1000/60 to get W/m²		Solar radiation on horizontal plane, sum of 60 records.
IR radiation horizontal	BR	V105R3			
Wind speed	BS	V110R2			
Wind direction	BT	V111R2			
Diffuse solar radiation	BU	V124R1	*1000/60 to get W/m²		
Atmospheric pressure	BV	V105R3			Not working properly

Others

Standard name	data column	VNR name	Correction	Calibration date	Remarks
CH 19 WN5	CC	C505	X100 =wh		Heat Counter CHLORIUS. NO DATA
CF 05	CD	C701	X8.33=wh		
CL 05	CE	C702	X2.08=wh		
CF 10	CF	C603	X8.33=wh		
CL 10	CG	C604	X2.08=wh		
CF 20	CH	C305	X8.33=wh		
CL 20	CI	C306	X2.08=wh		
CF 25	CJ	C005	X8.33=wh		
CL 25	CK	C006	X2.08=wh		
CF 26	CL	C007	X8.33=wh		
CL 26	CM	C008	X2.08=wh		

SENSOR NAMES

Sensor type		Office		Coordinates		
A	A	X	X	A	A	X

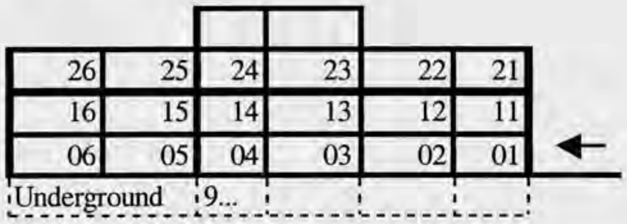
- Height for a vertical wall (1-9): 25 cm per unit. Ex.8=200cm,5=125cm
  Orientation for the roof or the floor (N-S-E-W)
- Sensor coordinates (looking the wall): N-S-E-W, C (centre)
- Wall orientation: N-S-E-W, F(floor), C(ceiling)

- Office number: 1,2,3...rooms, 8 for the corridor, 9 for the staircase, 7 outsid
- Floor: 0, 1, 2. Number 9 for the underground.

Sensor type:

TV	Temperature - Ventilated	**Px**	Potentiometer
TA	Temperature - Air	**Bx**	Binary
TS	Temperature - Surface	**Cx**	Counter/consumption
TG	Temperature - Globe	**xD**	Door
TF	Temperature - Floor	**xW**	Window
TW	Temperature - Walls	**xS**	Store
TE	Temperature Exterior	**xF**	Force
HU	Humidity	**xL**	Light

LESO Offices



Example:

TV 03 WS8 Temperature measurement, ventilated sensor
Ground floor,
office 3
West wall, Southern site of the wall, 200 cm from the ground