ARE HEAT RECOVERY SYSTEMS NECESSARY FOR NEARLY ZERO ENERGY BUILDINGS IN MILD CLIMATES?

Flourentzos Flourentzou[1], Samuel Pantet

1 Estia SA
Parc Scientifique EPFL
1015 Lausanne, Switzerland
**flou@estia.ch*

ABSTRACT

Heat recovery ventilation became an unavoidable element of a passive or nearly zero energy building in Northern and Central Europe countries. Airtightness standards became very tight so that the building is compatible with this ventilation system. As frosting of heat recovery unit consumes a lot of electrical energy, a buried pipe system to smooth air temperature variations became also a necessary system in order to avoid defrosting. All these systems cost a lot of money and grey energy to get the benefit of 60 to 70% global net heat recovery of ventilation losses and some freshness in the summer. Southern countries, copying energy saving practices from the north, sometimes without a serious critical approach, adopted this practice and some of them even impose it for low energy consumption buildings.

This article presents the results of a life cycle assessment, taking into account all the consumed primary energy of the system, integrating also the grey energy of the machines and ducts. Heat recovery becomes a questionable principle, in climates where temperature differences and heat recovery potential are low. In cases where high-energy performance heat and cooling production, is used like heat pumps of COP higher that 4, the study shows that unfortunately the system consumes more electricity, than the electricity needed to produce the recovered heat or coolness. The study shows also the limited potential of the buried pipe technique compared to natural ventilation.

The analysis shows that heat recovery in mild climates can be considered as an energy saving measure only where mechanical ventilation is imposed for other reasons (very high external noise pollution, special uses needing high standard controlled ventilation, etc).

KEYWORDS

Ventilation, heat recovery, nearly zero energy buildings.

1 INTRODUCTION

Nearly zero energy buildings bring a new fundamental change in building energy behaviour in southern climates: Energy for heating is reduced to extremely low levers and the main energy needs are for cooling. Table 1 shows that in an almost zero energy building in Nicosia, energy demand for heating is 8 kWh/m^{2}y while energy demand for cooling is 34 kWh/m^{2}y. These values are without any ventilation heat recovery. In old, non-insulated, buildings these values where 149 kWh/m^{2}y for heating and 43 kWh/m^{2}y for cooling. The ratio heating energy demand/cooling energy demand passes from 8/10 in non-insulated buildings to 2/10 in almost zero energy buildings (Flourentzou 2012 - 1).

Insulation	Heating demand	Cooling demand	Total demand
A. 0 cm, single glazing	149 (78%)	43 (22%)	192
B. 4 cm, double glazing - 3.5 W/m^2k	21 (25%)	64 (75%)	85
C. 10 cm, double glazing - 1.3 W/m^2k	8 (19%)	34 (81%)	42

Table 1. Heat and cooling demand of 3 building scenarios for an office building in Lefkosia – Cyprus, simulated dynamically with DIA+.

This means that the effort in well-insulated and well-shaded buildings in the south should be concentrated on low primary energy cooling technics. The most efficient low energy cooling technic is night ventilation. This means that half of the year, the building should be open or ventilated with high airflow rates, and this is a very significant difference between building thermal behaviour in southern and northern climates (Flourentzou 2012 -2). Designers attitude towards infiltration level and heat recover should be re-examined with the new reality.

To aboard this question, we take a real simple office building which is under construction, and we simulate heating and cooling demand, and we evaluate ventilation heat recovery and buried pipe energy savings. Simulations are performed with DIAL+, 2013 version (Paule, 2013).

2 TECHNICAL CHARACTERISTICS OF THE BUILDING

2.1 Typology and dimensions

We choose as typical office space a typical floor of a high-rise building under construction in Lefkosia. The floor total height is 3.84m, while the clear internal height is The building is well insulated and well shaded. East and west façades are equipped with a combination of fixed and movable solar protection and south façade is equipped with a 1.5m overhangs and internal solar protection. East, South and West facades are 50% glazed (glazing height = 1.8 m). North façade has 4 windows of 2X2.5m.

The total rough surface area is 486 m^2. The useful area without the external walls and the staircase is 479xx

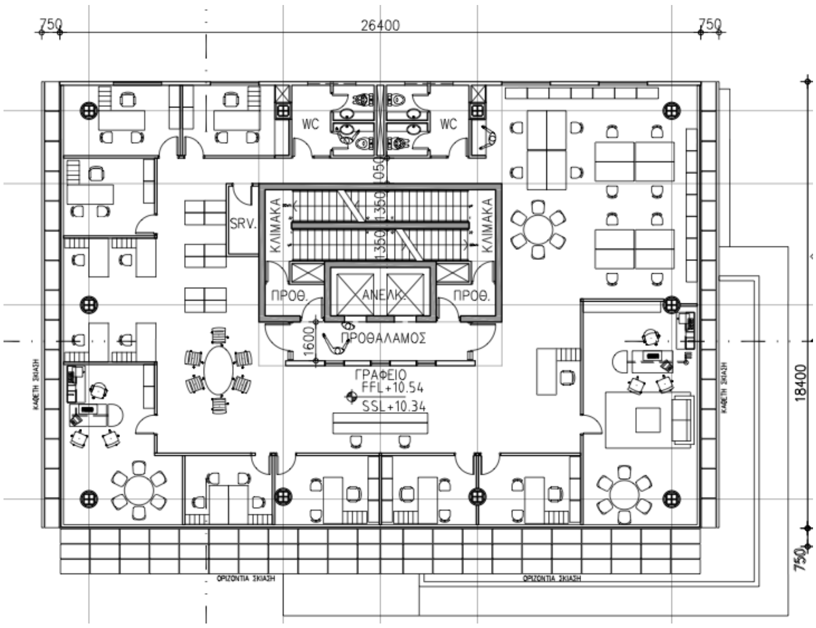

Figure 1: plan of a standard storey

2.2 Simulation parameters

The envelope characteristics are different for the cold and hot climates according to table 2. They are unchanged for all simulations.

	Cold climates	**Hot climates**
Thermal insulation position	external	external
Wall thermal insulation thickness	30 cm	10 cm
Roof thermal insulation thickness	30 cm	10 cm
Glazing g value	0.6	0.4
Window U value	0.8 W/m^2K	1.3 W/m^2K
Glazing light transmittance	O,55	0.65
Ventilation opening dimensions	1X1.8	1X1.8
Number of occupants	35	35
Ventilation airflow (30 m^3/pers)	1250/146 m^3/m^2h	1250/146 m^3/m^2h
Internal gains (7 W/m^2)	3400W	3400W
Lighting power (15.9 W/m^2)	7223W	7223W
Solar protection g value	0.15	0.15
Glazing control	Automatic if >90 W/m^2	Automatic if >90 W/m^2

Table 2. Building thermal characteristics for cold (Geneva and Copenhagen) and hot (Athens and Lefkosia) climates.

We vary climatic conditions for cold and hot climates: Stockholm - SE, Geneva - CH, Athens – GR and Lefkosia – CY. We consider DK and CH as cold climates while GR and CY hot climates. Climatic data come from a meteonorm standard file except for CY coming from real data of a standard year according the local energy department. This variation will change the building energy balance. Heating and cooling needs will be different.

We also vary the building thermal mass. We consider low thermal mass a space with suspended ceiling and raised floor and light façades with insulation within plaster boards. High thermal mass keeps the same façade but with apparent concrete floor and ceiling. This will change the dynamic behaviour of the building, especially during summer. It will change the free cooling potential and the overheating risks.

We will compare the effect of heat recovery for the 8 combinations of light and heavy buildings for the 4 climatic conditions.

3 SIMULATION RESULTS

3.1 Heating and cooling energy demand without heat recovery

Dynamic simulations are performed according to ISO EN 15791 with DIAL+ software.

Simulation	Light Building			Massive Building		
	Cooling	**Heating**	**Total**	**Cooling**	**Heating**	**Total**
CY Nicosia	42	5	47	41	2	43
GR Athens	31	8	39	30	5	35
CH Bern	9	25	34	7	22	28
SE Stockholm	9	33	42	9	31	40

Table 3. Cooling energy demand in hot climates represents 80 to 95% of the total energy demand while heating energy demand represents 70 to 80% of the total in cold climates. Light buildings consume 5 to 15% more than massive buildings depending of the meteorological conditions.

As we can see from table 3, in hot climates cooling energy demand for passive buildings is of the same order of magnitude as heating energy demand for cold climates but the total energy demand is of similar magnitude for hot and cold climates.

3.2 Effect of heat recovery in hot and cold climates

Simulation	Light Building			Massive Building		
	Cooling	**Heating**	**Total**	**Cooling**	**Heating**	**Total**
CY Nicosia	42	2	44	41	0.4	41
GR Athens	34	3	37	32	0.8	33
CH Bern	9	7	16	7	5	12
SE Stockholm	9	12	21	9	10	19

Table 4. Cooling energy demand in hot climates represents 80 to 95% of the total energy demand while heating energy demand represents 70 to 80% of the total in cold climates. Light
We choose as typical

Tables are numbered. The table caption is above the table.

Table 5: Table Caption

Column Title	Column Title	Column Title	Column Title	Column Title
Table content				

Figures are numbered. The figure caption is below the figure.

Figure 2: Figure caption

Equations are numbered:

$$A = B + C \quad (1)$$

$$D + E = F \quad (2)$$

4 CONCLUSIONS

Please refer to the main conclusions of the work.

5 ACKNOWLEDGEMENTS

Please list the individuals that provided help to this work, if any.

6 REFERENCES

Flourentzou, F., Irwin, D., Kritioti, M., Stasis, T., Zachopoulos, N., (2012). Hybrid ventilation and cooling technics for the new Nicosia Townhall, AIVC conference, Copenhagen, 2012.

Flourentzou, F., Paule, B., Pantet, S., (2012). Natural ventilation and passive cooling simulation is not any more a privilage for experts, AIVC conference, Copenhagen, 2012.

Paule, B., et al, (2012). DIAL+Suite : a new suite of tools to optimize the global energy performance of room design, Status Seminar, Zurich..