Simulation based energy consumption calculation of an office building using solar-assisted air conditioning

S. Thomas*; P. André
Environmental Sciences and Management Department
Avenue de Longwy 185, 6700 Arlon, Belgium
*Corresponding author : sebastien.thomas@ulg.ac.be
Université de Liège

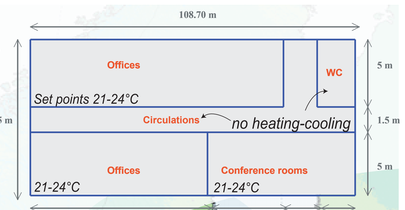
Objective : Evaluate **solar energy potential** in office building air-conditioning

At 3 locations

Stockholm - Paris - Lisbon

Building layout

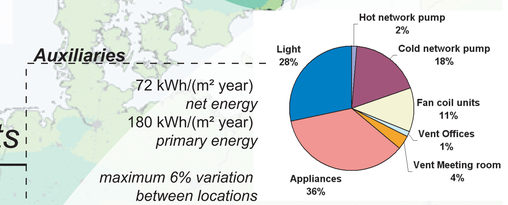
-Typical European office building
(Case study IEA ECBCS 48)
- 1250m² / floor (81% is heated)
- 12 identical floors
- High internal loads
- North-South largely glazed
- U value = 0.80 W/(m².K)



3 Heating/Cooling systems, 5 cases

Case	Heating		Cooling	
	Energy source	*Equipment*	*Energy source*	*Equipment*
1	Gas	Boiler	Electricity	Vapour compression system
2 .A .B	Gas	Boiler	Sun, Electricity grid as back-up	Vapour compression system, PV panels
3 .A .B	Gas, Sun	Boiler, solar thermal panels	Sun, Gas as back-up	Absorption chiller, solar thermal panels

Available space for solar pannels : building roof.
Case 2.A ; 3.A : 3 floor building
Case 2.B ; 3.B : 12 floor building

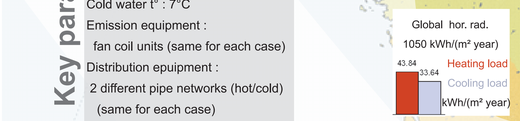


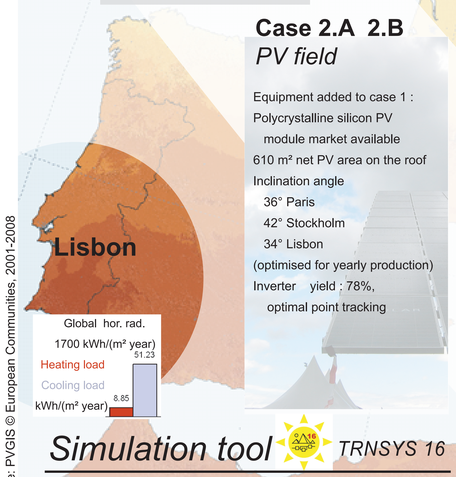
Results

Auxiliaries

72 kWh/(m² year)
net energy
180 kWh/(m² year)
primary energy

maximum 6% variation between locations





Key parameters

Case 1
Classical A-C

Boiler efficiency = 88.2 to 89.2 %
Chiller COP :
3.5 at rating point
4.5 (yearly mean value Lisbon)
Hot water t° : 90°C to 45°C
Cold water t° : 7°C
Emission equipment :
fan coil units (same for each case)
Distribution epuipment :
2 different pipe networks (hot/cold)
(same for each case)

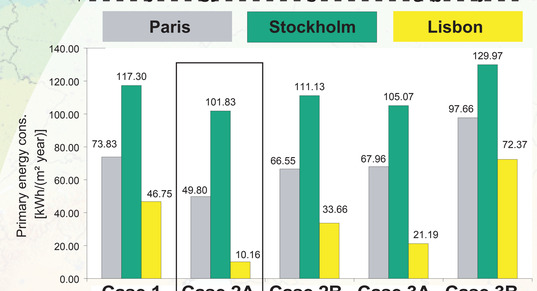
Case 2.A 2.B
PV field

Equipment added to case 1 :
Polycrystalline silicon PV module market available
610 m² net PV area on the roof
Inclination angle
36° Paris
42° Stockholm
34° Lisbon
(optimised for yearly production)
Inverter yield : 78%,
optimal point tracking

Case 3.A 3.B
Thermal field
Absorption chiller

Hot water storage tank
STO 3 - PAR 7 - LISB11 m³
Evacuated tube collectors
427 m² net area on the roof
Inclination angle
STO, PAR 15° - LISB 25°
Absorption chiller
thermal COP rated : 0.695
yearly mean value : 0.64-0.67

Primary energy for *heating and cooling* (yearly basis)



Case 1	Case 2A	Case 2B	Case 3A	Case 3B
26.32	0.00	17.42	10.74	5.71
9.18	0.00	3.89	5.02	2.94
73.60	0.00	59.98	57.16	12.37

% dedicated to vapour compression chiller

% dedicated to new auxiliaries equipments

Elec net energy to primary energy : X 2.5
(Belgian value)

Simulation tool

TRNSYS 16

Complete building modeling (type 56)
Dynamic simulation for each case as well as for building load and appliances consumption.

For case 3, model of absorption chiller (type 107) has been updated.

Parameters definition based on real equipments.

Conclusions

Whatever the location, case 2 (PV panels) seems to be the most efficient case from a primary and net energy consumption point of view.

Auxiliaries consumption is a key field for energy savings.