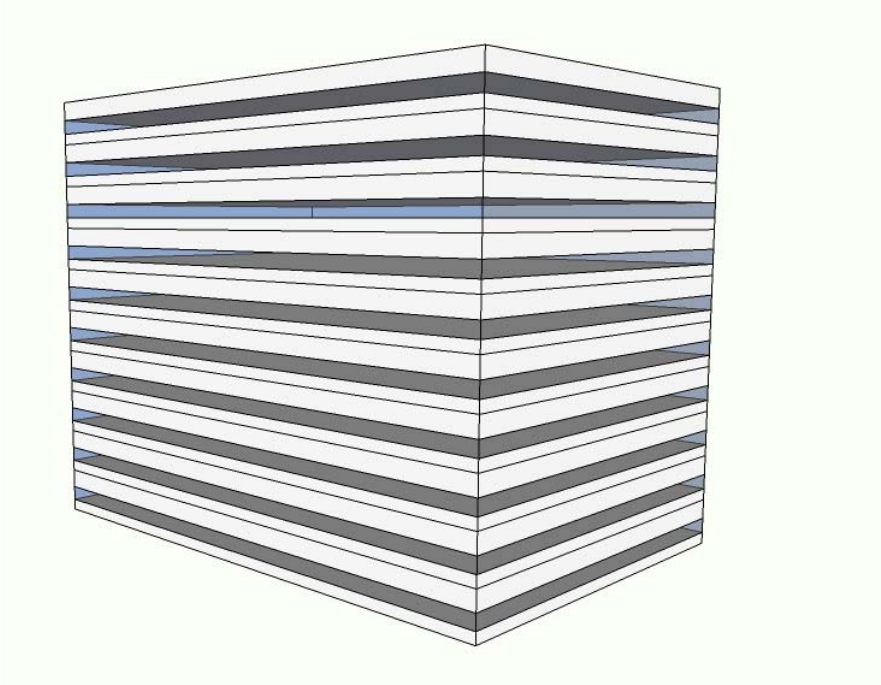
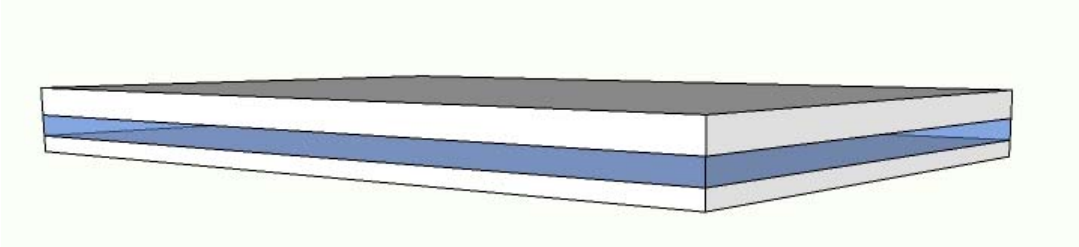
5. THE REFERENCE BUILDING OF IA-ECB ANNEX 59

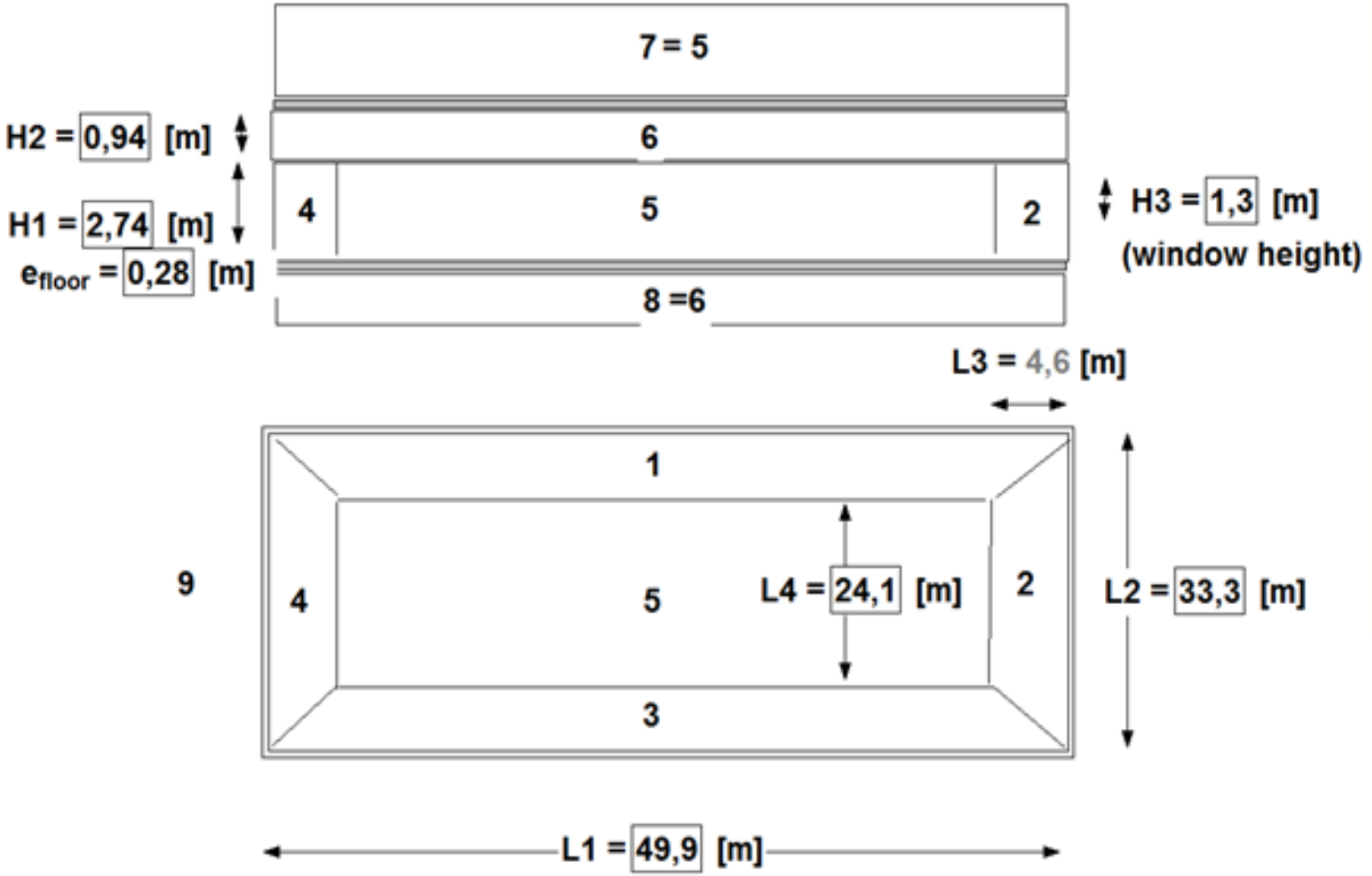
Atic
for HVAC professionals



Atic
for HVAC professionals



Atic
for HVAC professionals



Atic
for HVAC professionals

Zone sensible heat balance:

$$\Delta U_{in,01} = \int_{\tau_1}^{\tau_2} \mathrm{d}U/\mathrm{d}tau_{in,01}\ \mathrm{d}\tau$$

$$\Delta U_{in,kWh,01} = \frac{\Delta U_{in,01}}{J/kWh}$$

$$\Delta U_{in,01} = C_{in,01} \cdot (t_{a,in,01} - t_{a,in,01,1})$$

$$C_{in,01} = ICF \cdot V_{in,01} \cdot c_{p,ref}/v_{ref}$$

Atic
for HVAC professionals

Heat gains from adjacent rooms through internal walls, ceiling and floor

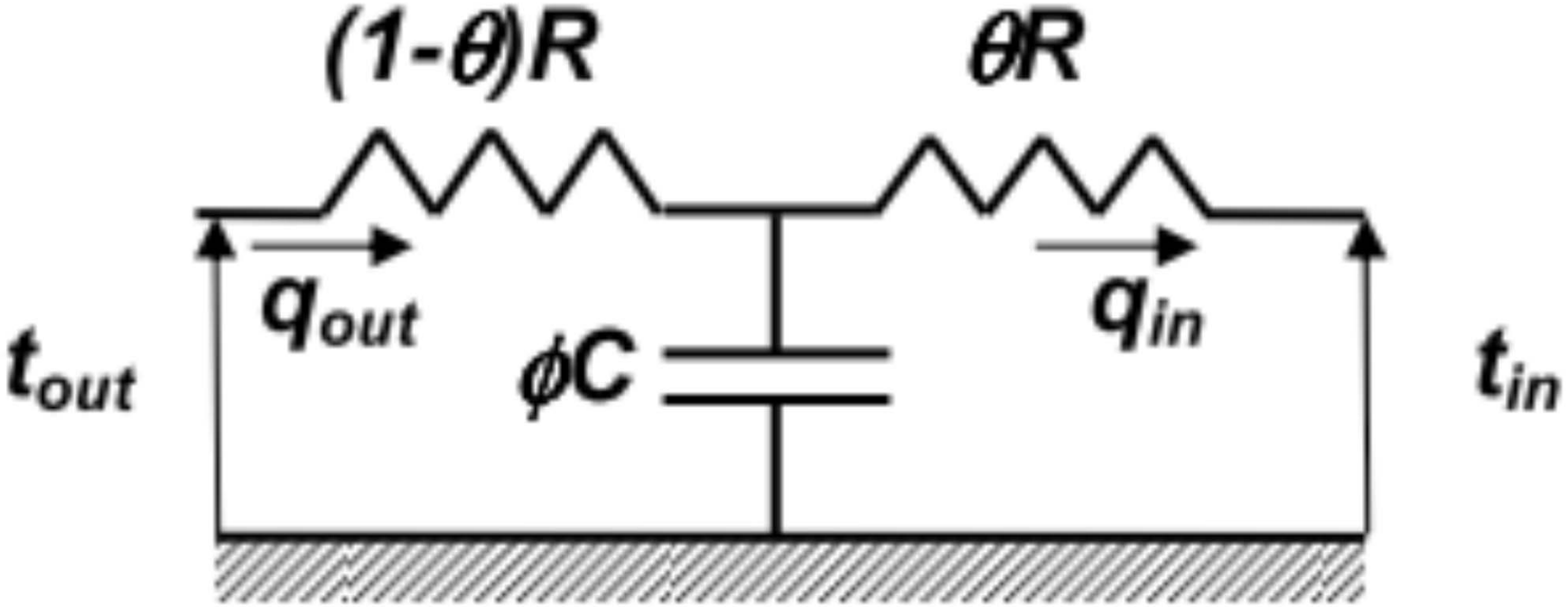
$$\dot{Q}_{s,in,intwalls,01} = \dot{Q}_{02,01} + \dot{Q}_{04,01} + \dot{Q}_{05,01} + \dot{Q}_{06,01} + \dot{Q}_{floor,01}$$

$$\dot{Q}_{02,01} = A_{1,2} \cdot U_{partition} \cdot (t_{a,in,02} - t_{a,in,01})$$

$$\dot{Q}_{floor,01} = A_1 \cdot U_{floor} \cdot \frac{t_{floor,01} - t_{a,in,01}}{f_{\theta,floor}}$$

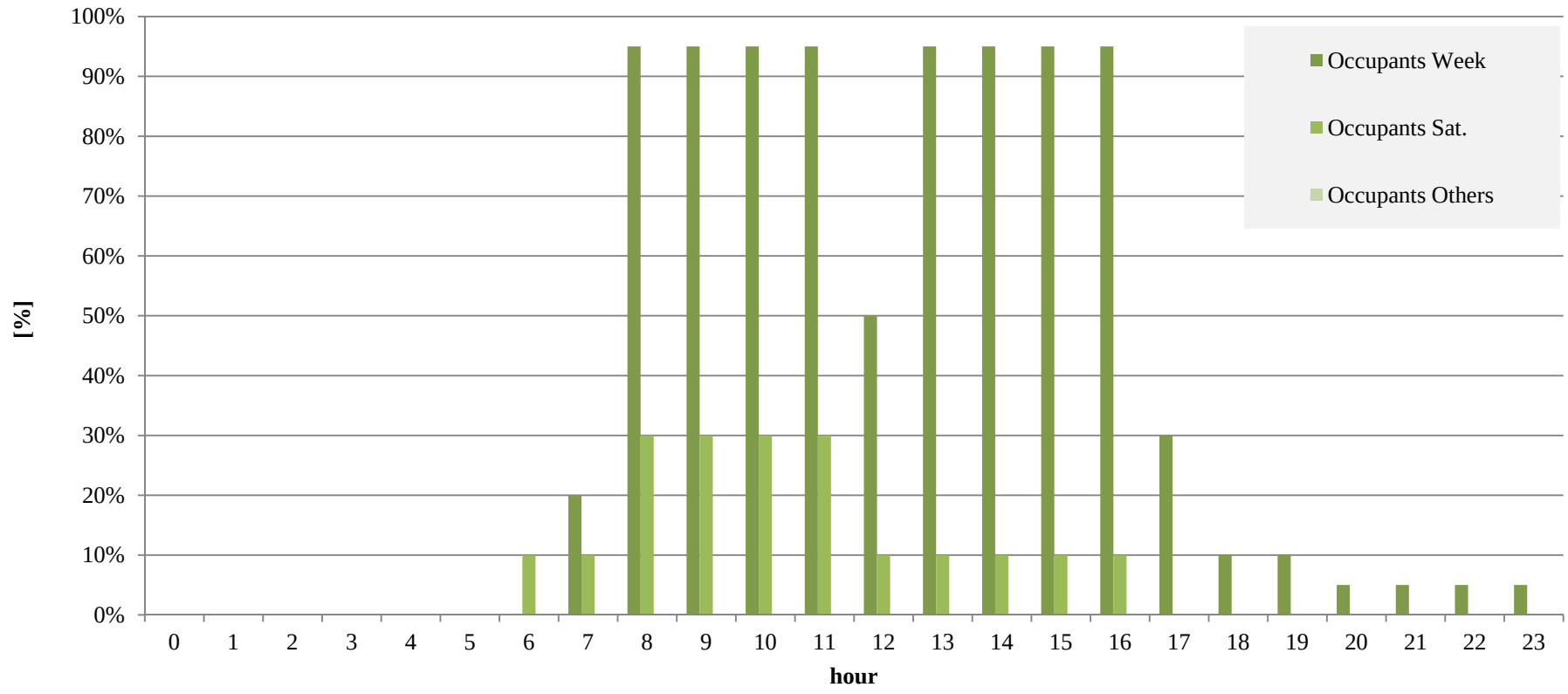
$$\dot{Q}_{08,floor,01} = A_1 \cdot U_{floor} \cdot \frac{t_{a,in,08} - t_{floor,01}}{1 - f_{\theta,floor}}$$

$$Q_{storage,floor,01} = \int_{\tau_1}^{\tau_2} \dot{Q}_{storage,floor,01} \, \mathrm{d}\tau$$



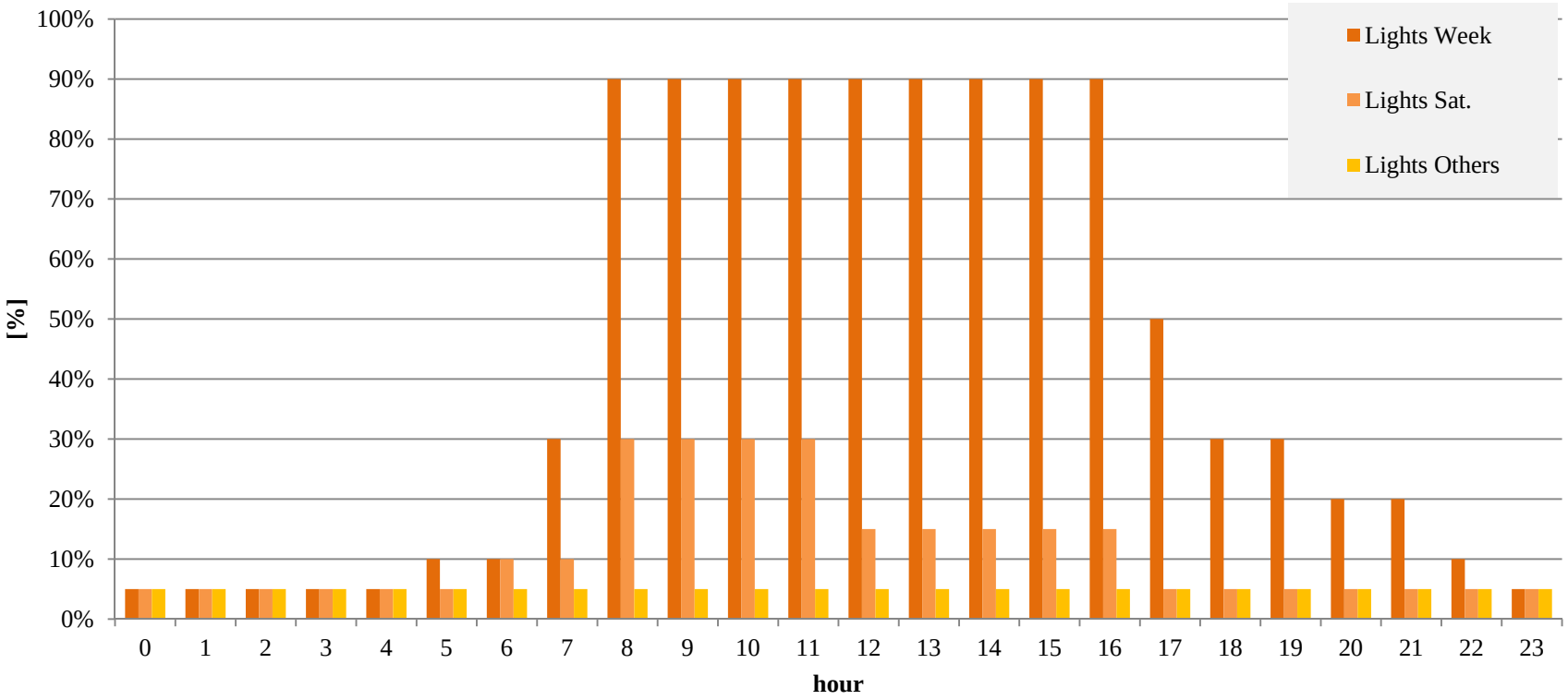
Atic
for HVAC professionals

Occupancy schedule



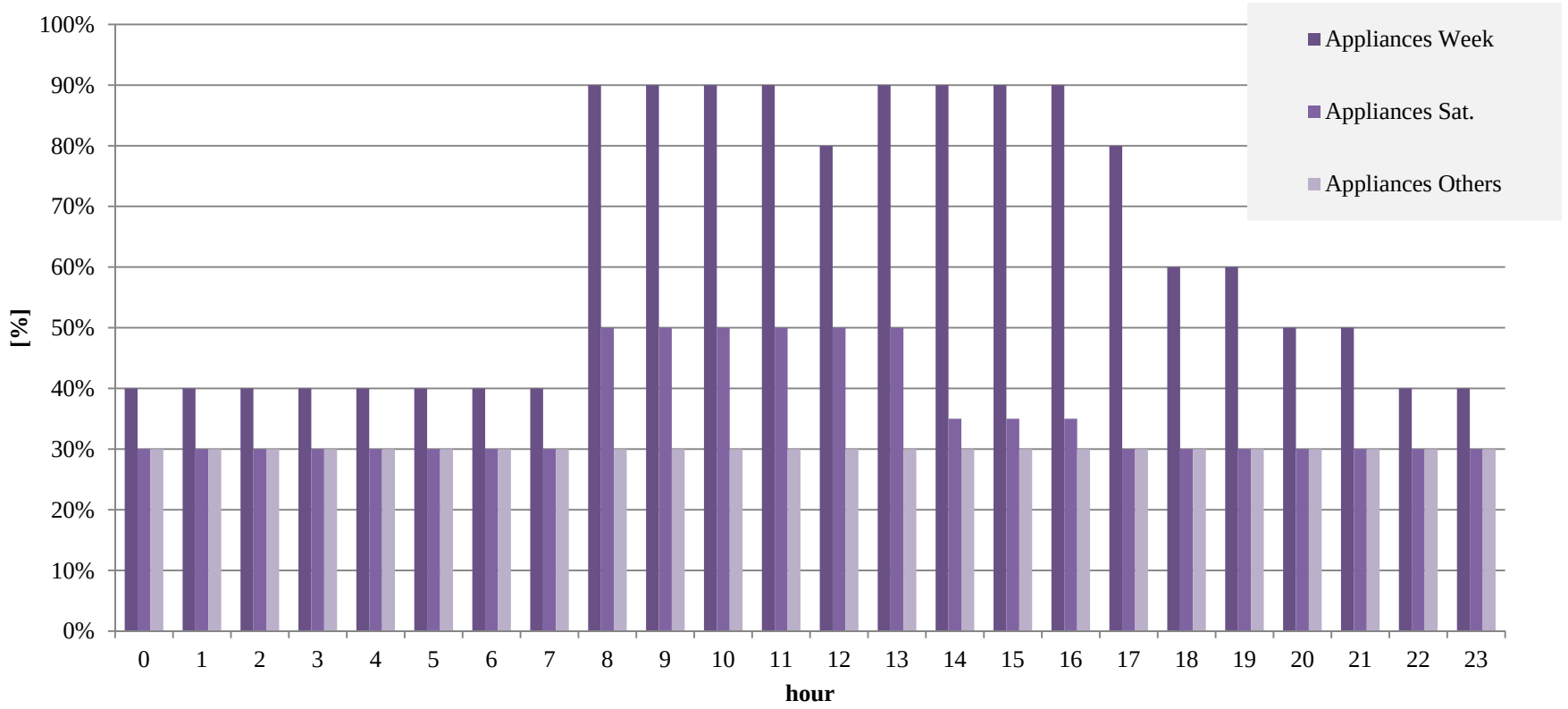
Atic
for HVAC professionals

Lighting schedule



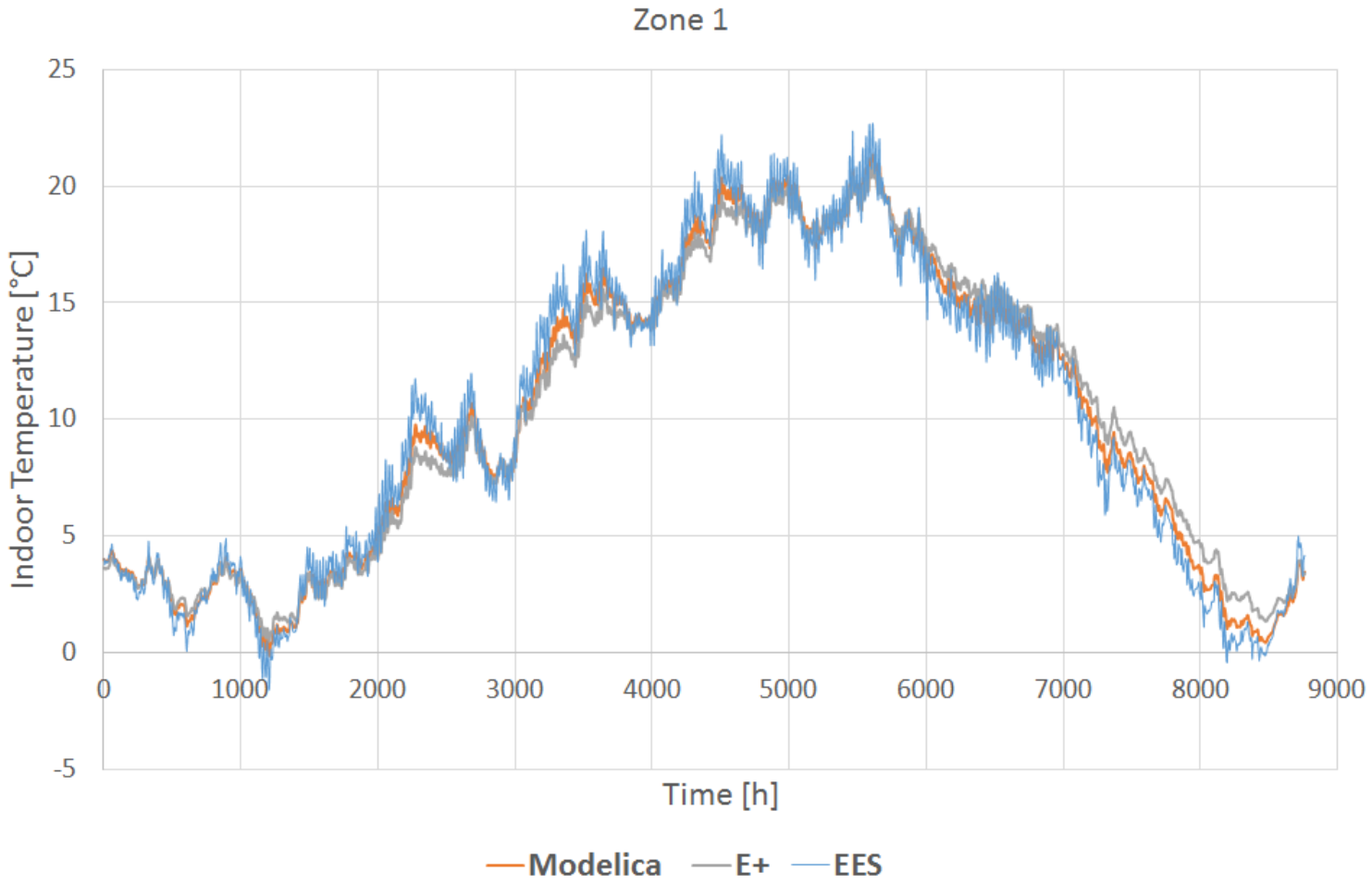
Atic
for HVAC professionals

Appliances schedule

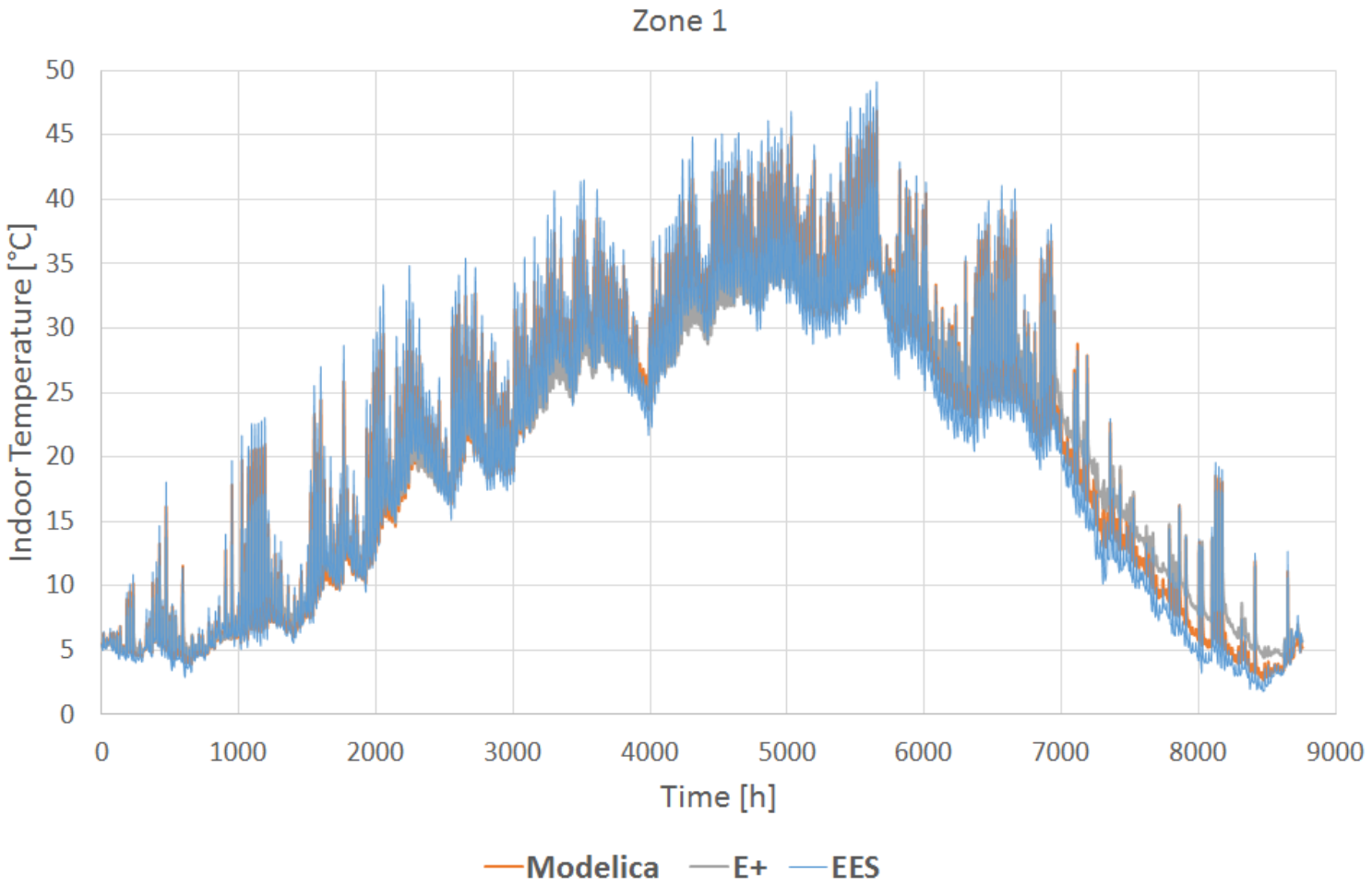


Atic
for HVAC professionals

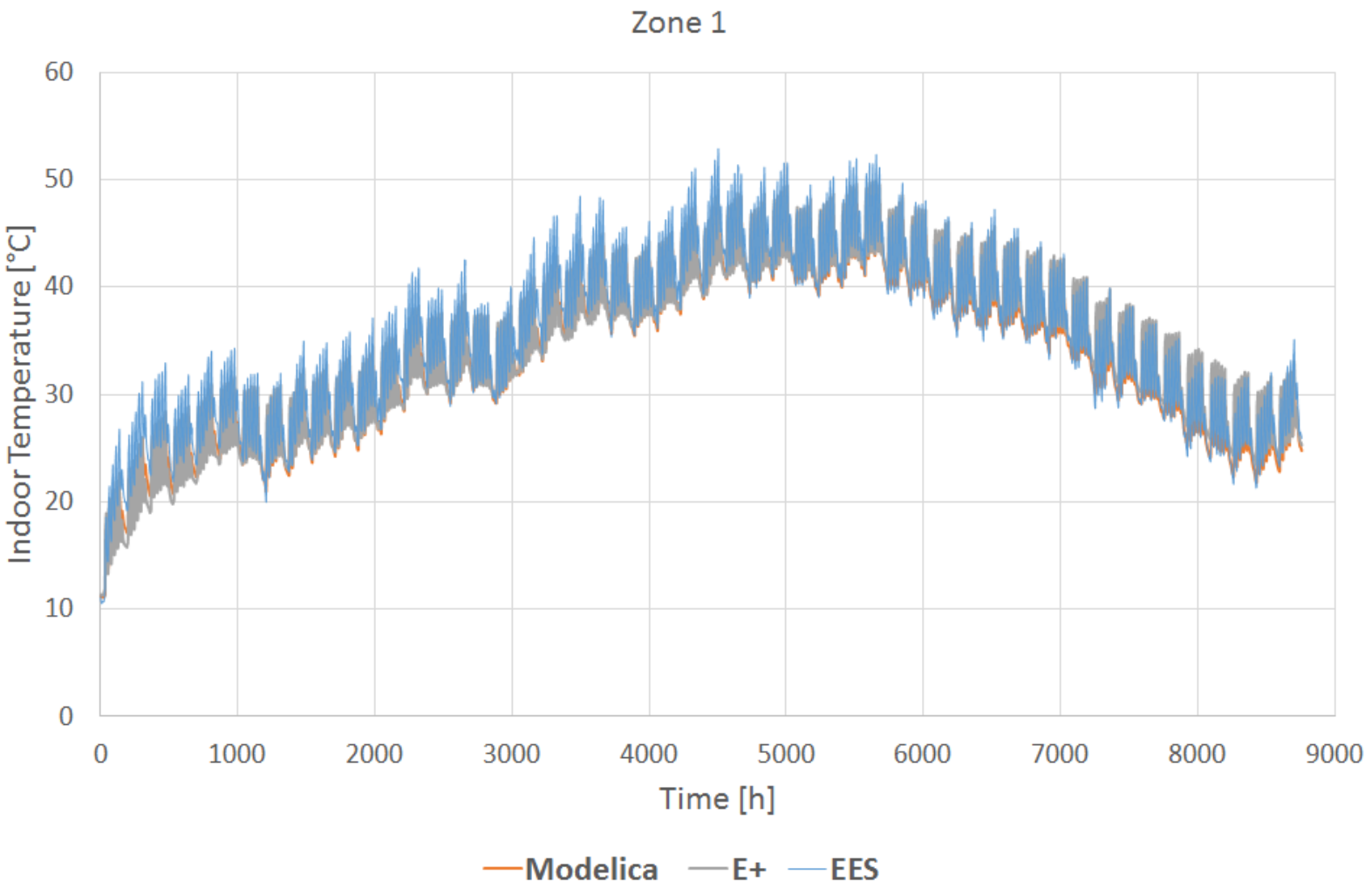
Floating temperature with external temperature as only one thermal force



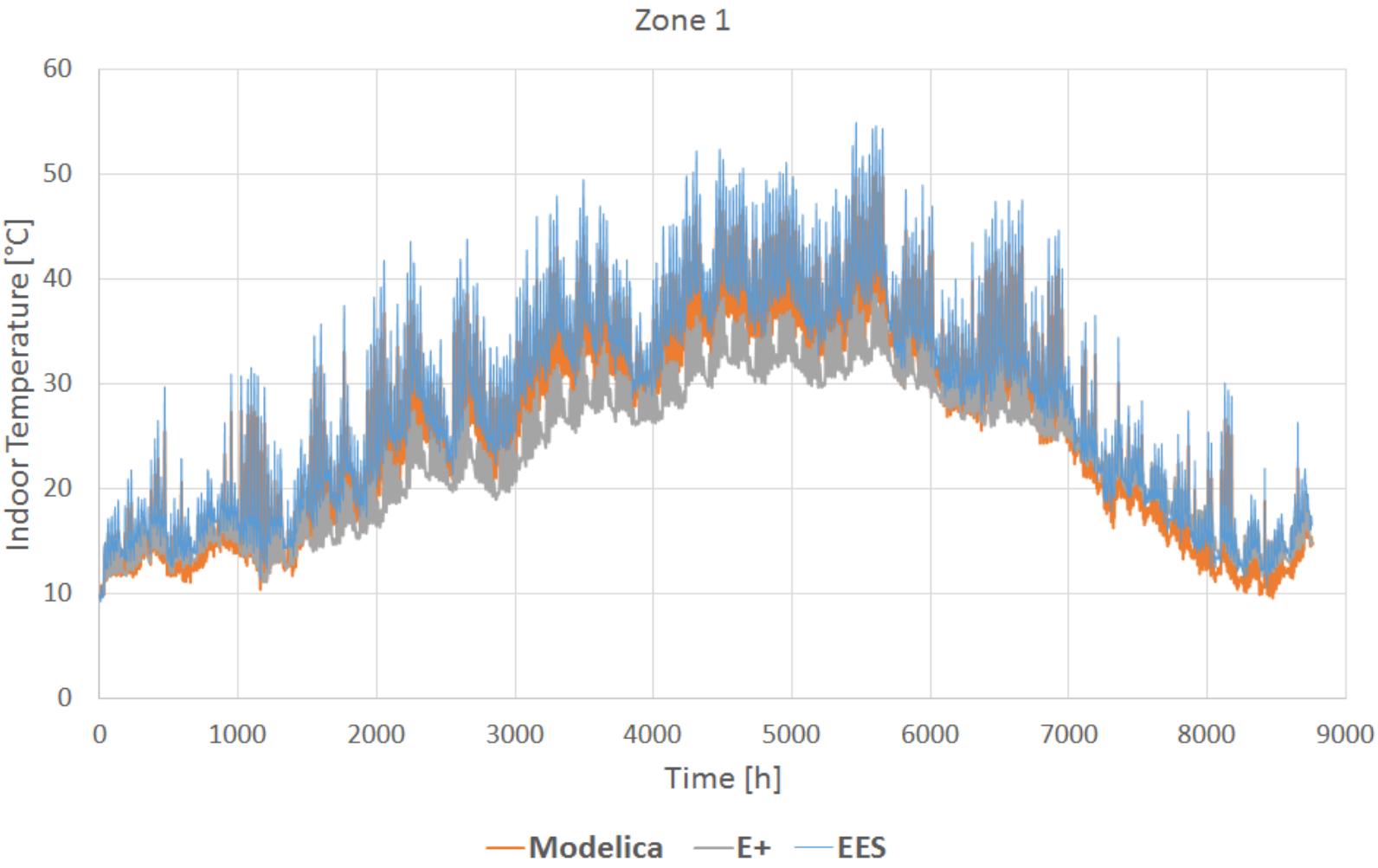
with also solar radiation



with also internal gains



With also ventilation and infiltration



Zone water gain:

$$\dot{M}_{w,zone,01} = (1 - \epsilon_{occdispl}) \cdot \dot{M}_{w,occ,01}$$

$$M_{w,zone,01} = \int_{\tau_1}^{\tau_2} \dot{M}_{w,zone,01} \, \mathrm{d}\tau$$

Atic
for HVAC professionals

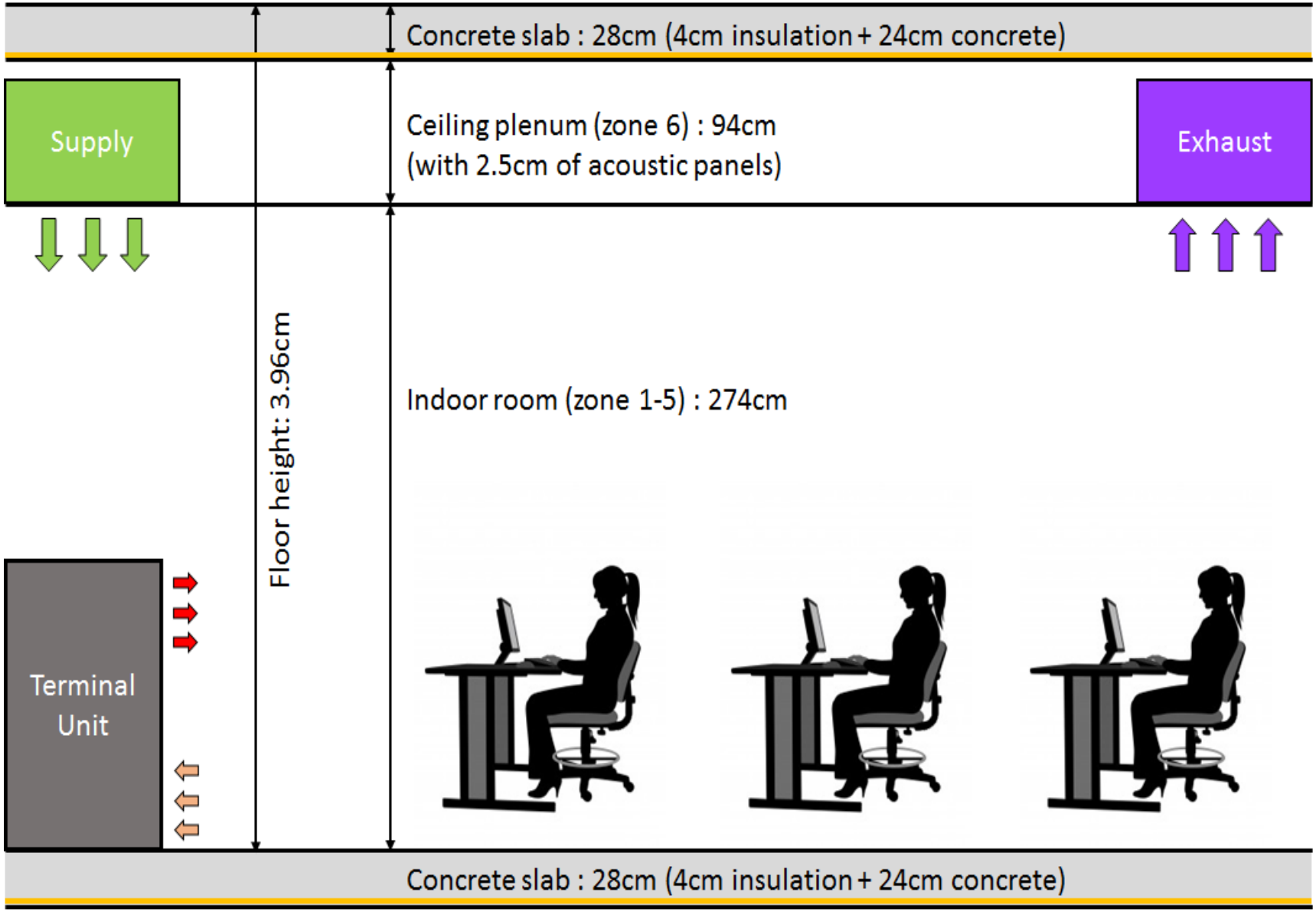
Zone CO2 balance

$$\Delta M_{CO2,in,01} = \int_{\tau_1}^{\tau_2} \mathrm{d}MCO2in/\mathrm{d}tau_{01}\ \mathrm{d}\tau$$

$$\Delta M_{CO2,in,01} = C_{CO2,in,01} \cdot (X_{CO2,in,01} - X_{CO2,in,01,1})$$

$$C_{CO2,in,01} = MM_{CO2} \cdot \frac{V_{in,01}}{v_a \cdot MM_{dryair}}$$

Atic
for HVAC professionals


Concrete slab : 28cm (4cm insulation + 24cm concrete)
Supply
Ceiling plenum (zone 6) : 94cm
(with 2.5cm of acoustic panels)
Exhaust
Floor height: 3.96cm
Indoor room (zone 1-5) : 274cm
Terminal Unit
Concrete slab : 28cm (4cm insulation + 24cm concrete)

[1]RETURN AIR DUCT and RETURN FAN

$$\Delta p_{returnfan} = \Delta p_{returnduct} + \Delta p_{return,econo} + \Delta p_{return,recovery}$$

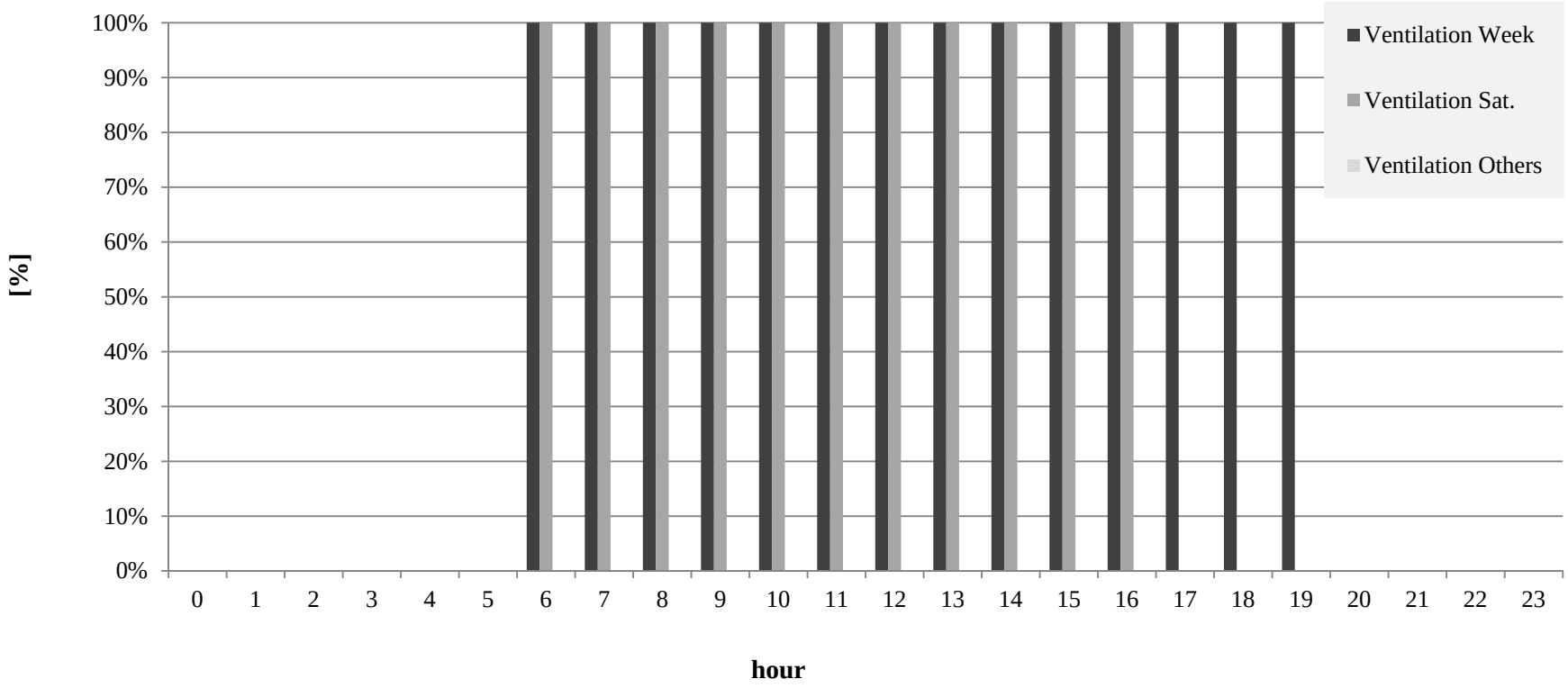
$$\epsilon_{s,returnfan} = \epsilon_{s,returnfan,n}$$

(might be also identified from fan characteristics)

$$\dot{W}_{returnfan} = f_{returnfan} \cdot \dot{V}_{a,returnfan} \cdot \frac{\Delta p_{returnfan}}{\epsilon_{s,returnfan}}$$

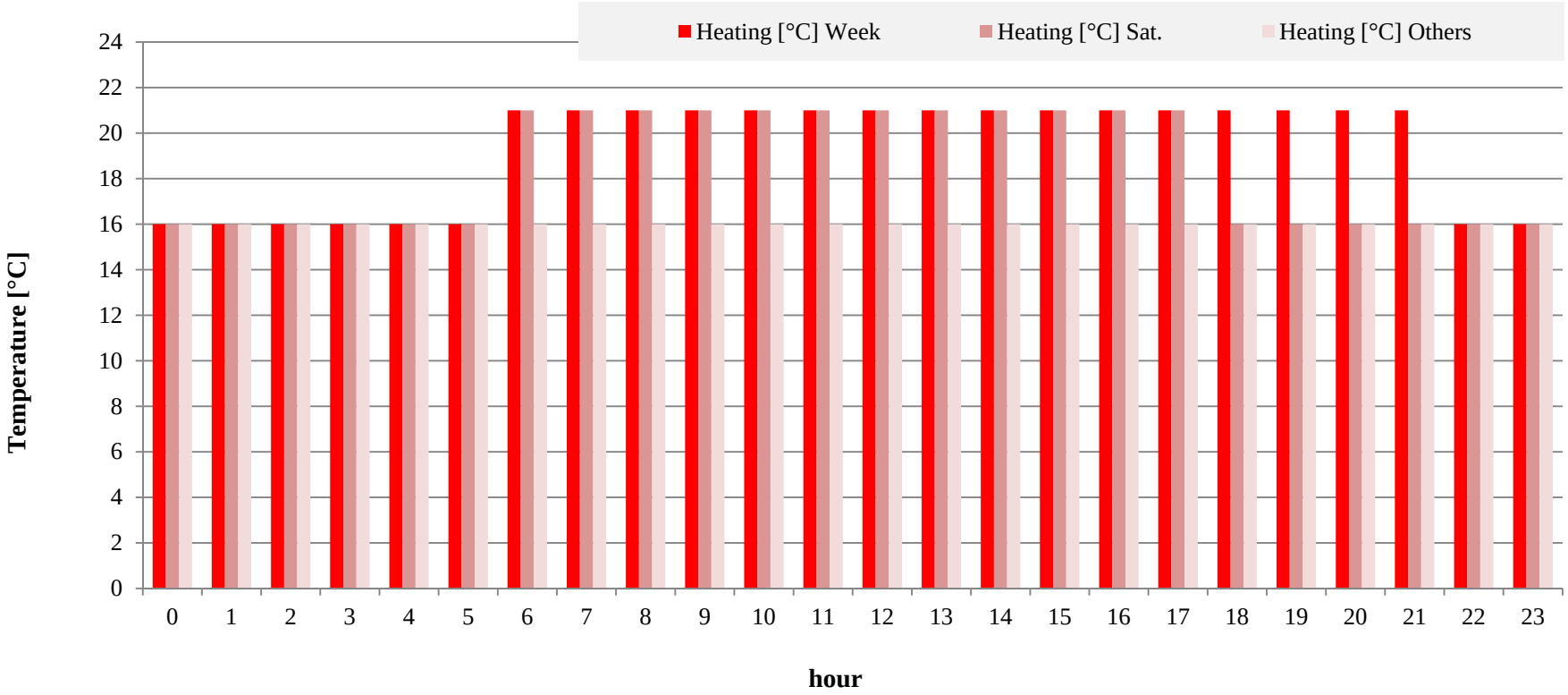
Atic
for HVAC professionals

Ventilation schedule



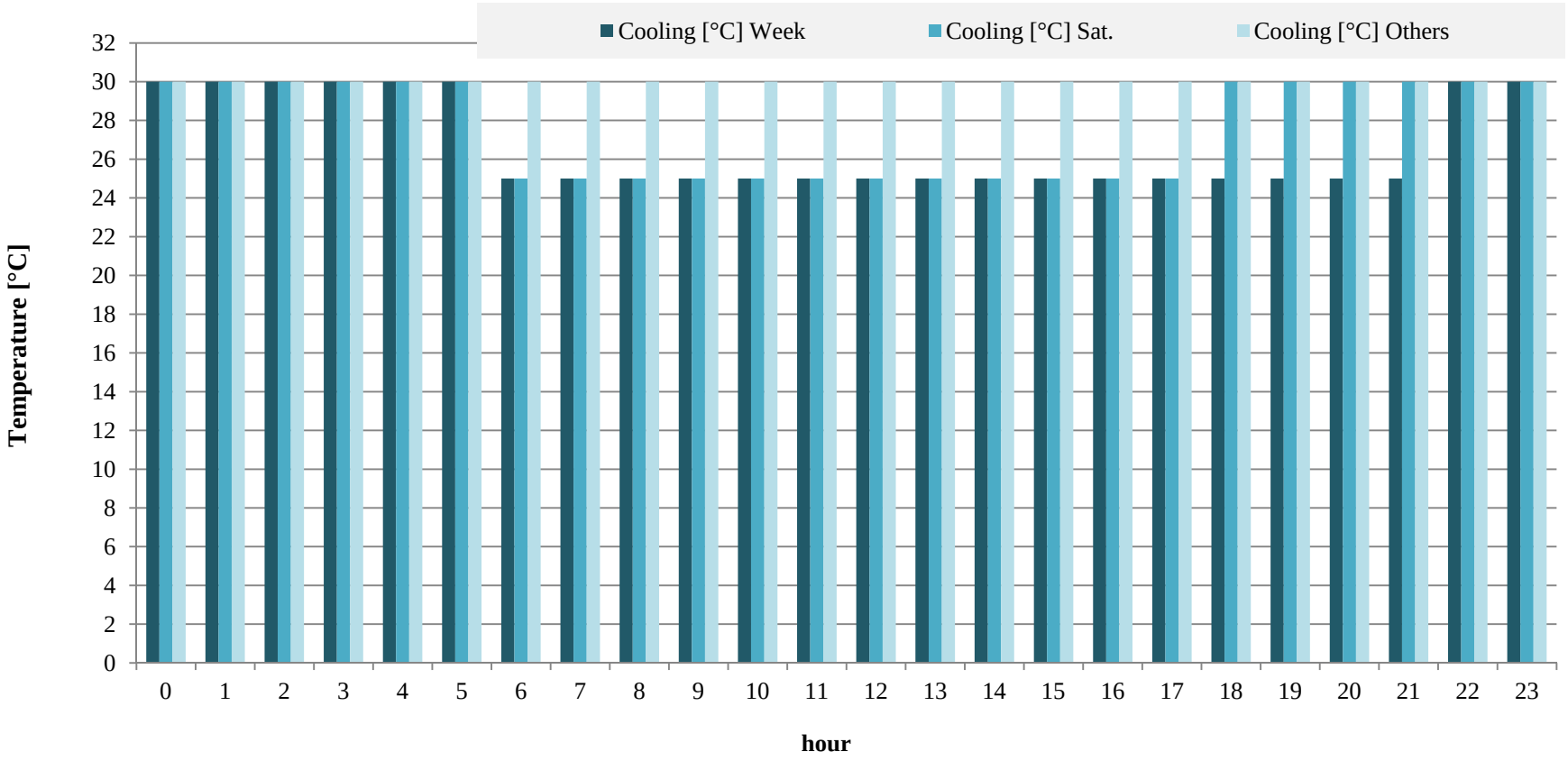
Atic
for HVAC professionals

Heating set points

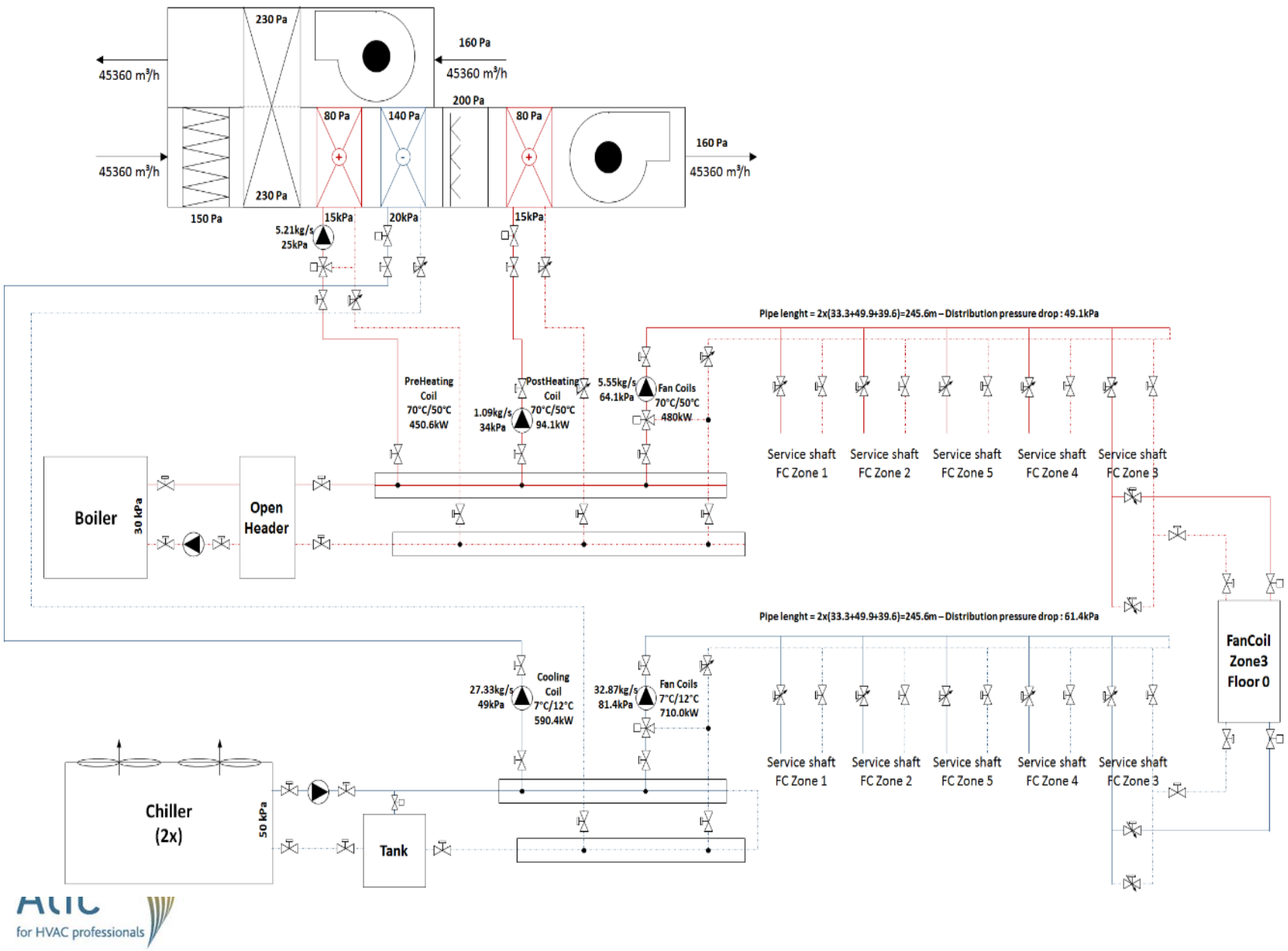


Atic
for HVAC professionals

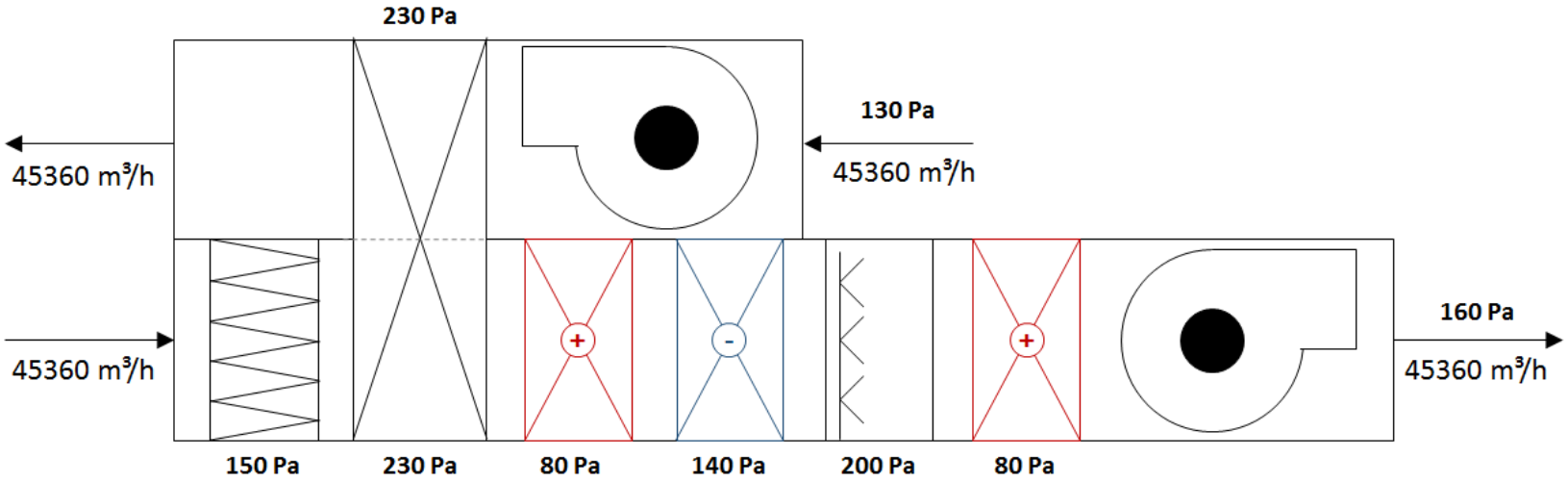
Cooling set points

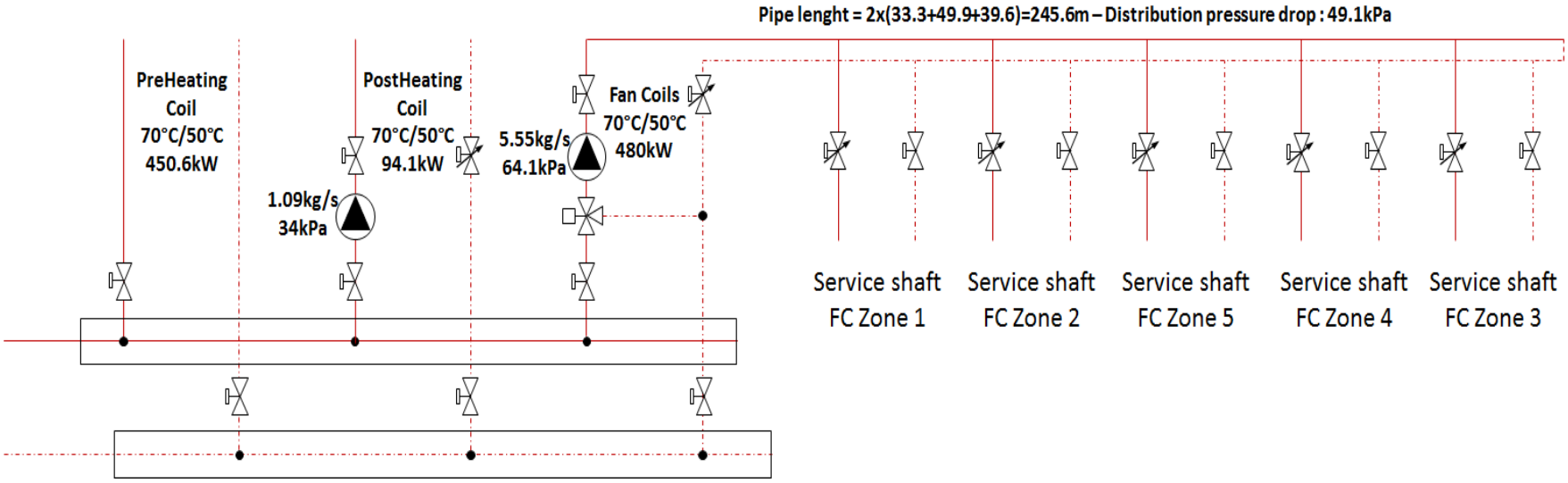


Atic
for HVAC professionals

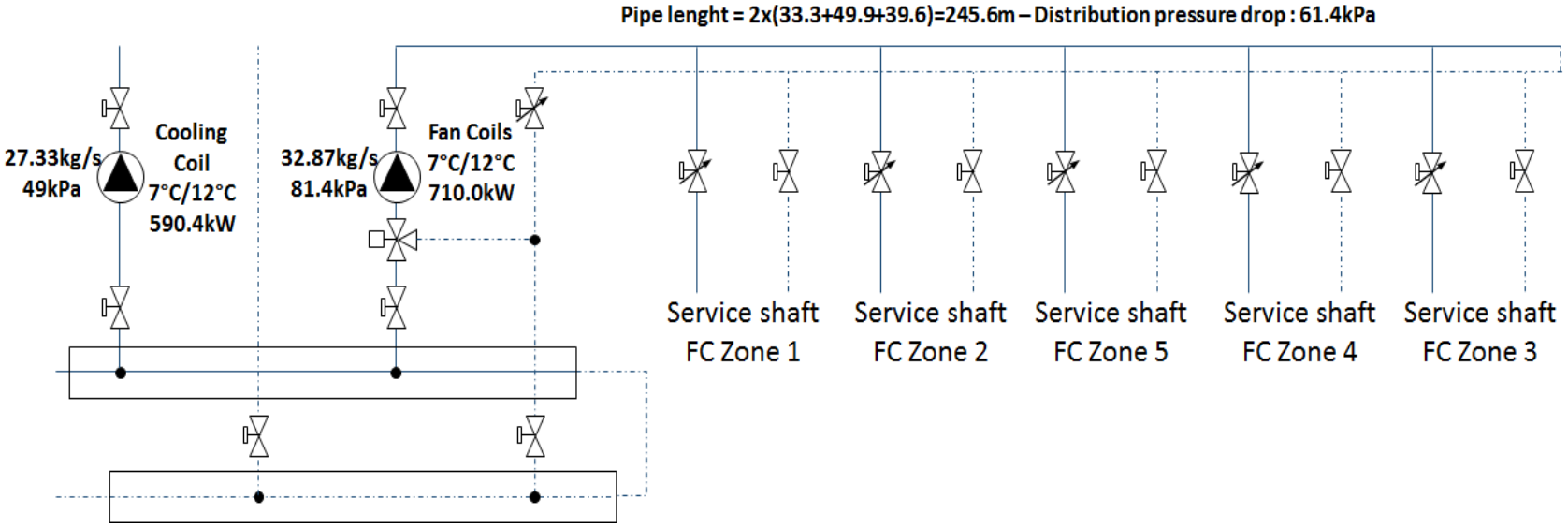


for HVAC professionals

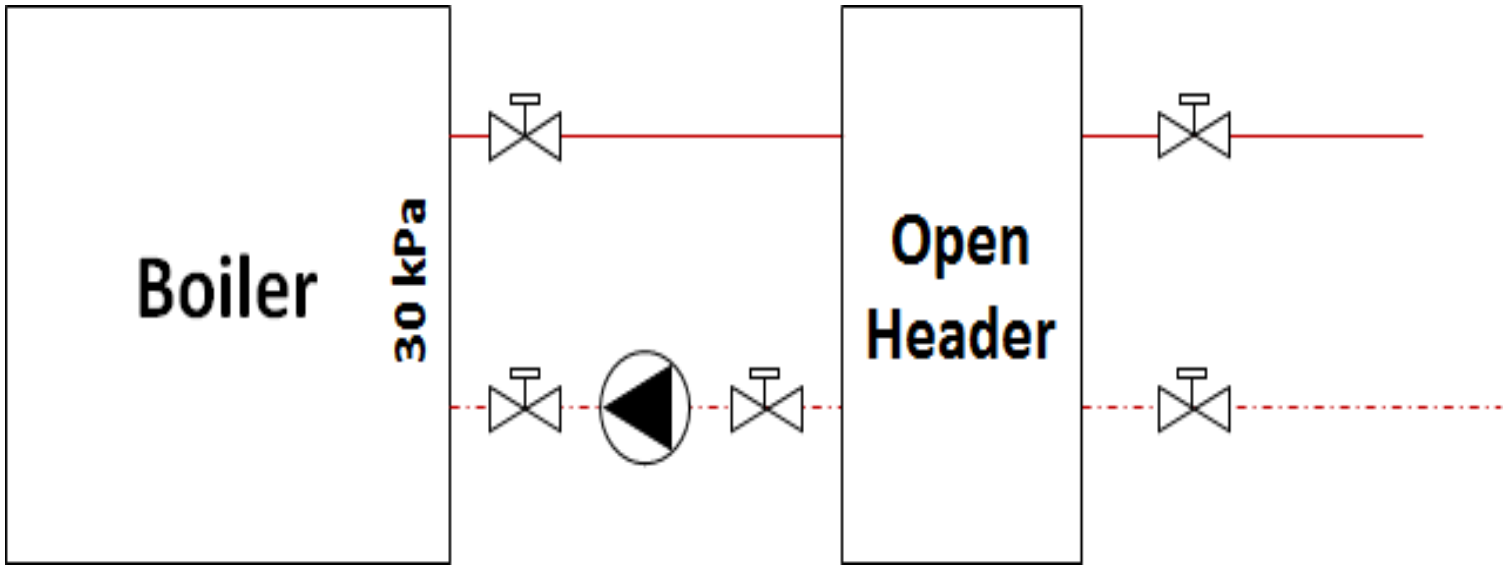

230 Pa
130 Pa
45360 m³/h
45360 m³/h
45360 m³/h
160 Pa
45360 m³/h
+
-
+
150 Pa
230 Pa
80 Pa
140 Pa
200 Pa
80 Pa



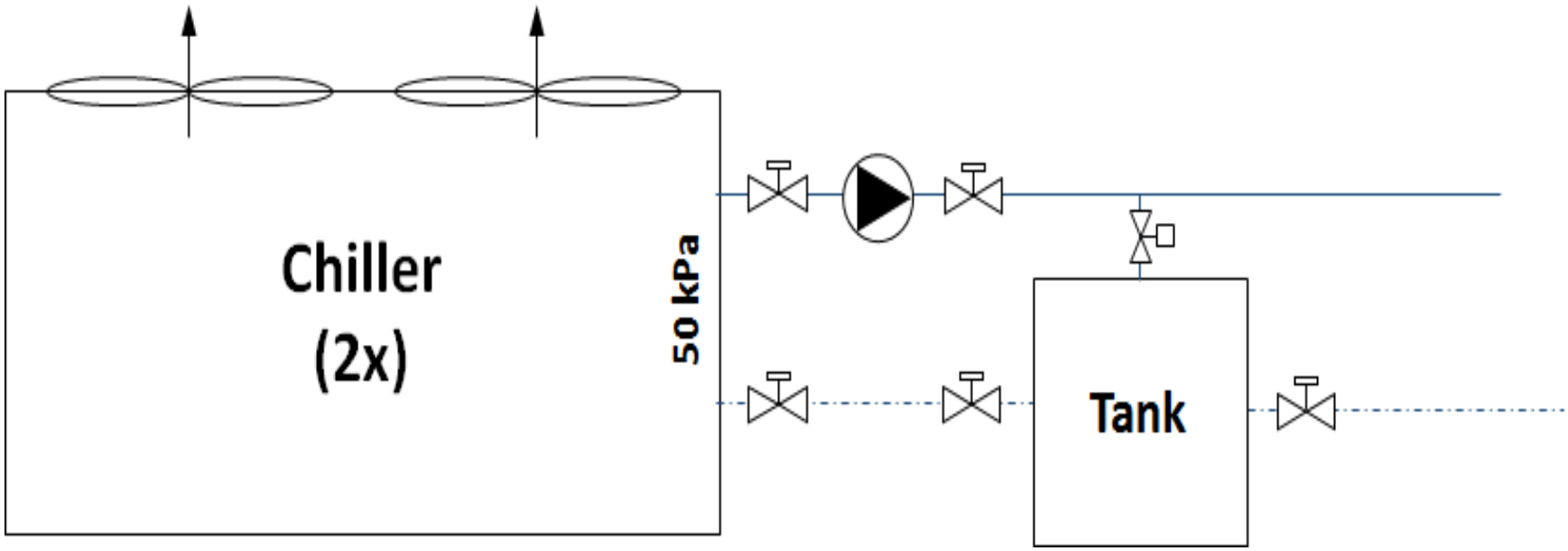
Atic
for HVAC professionals



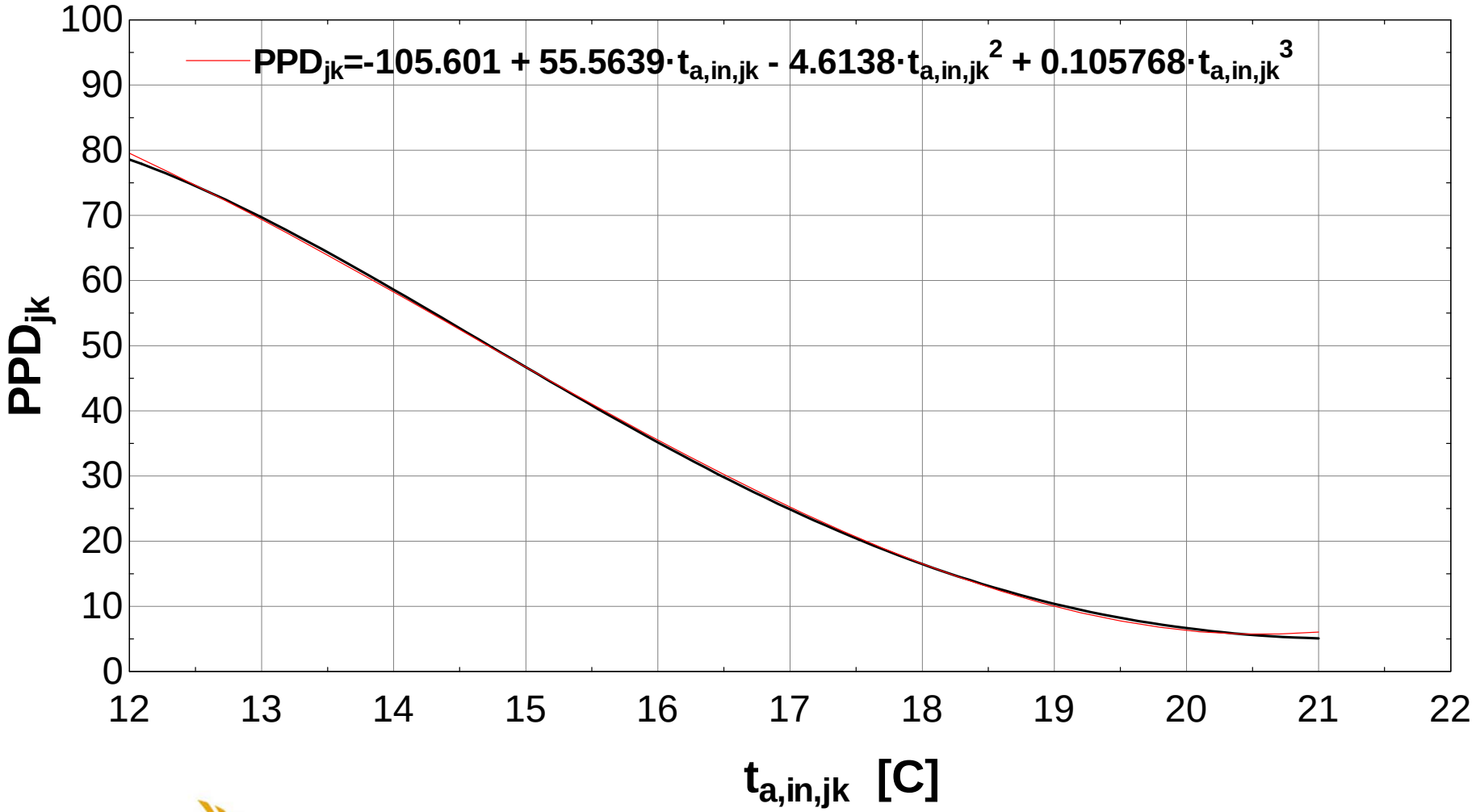
Atic
for HVAC professionals



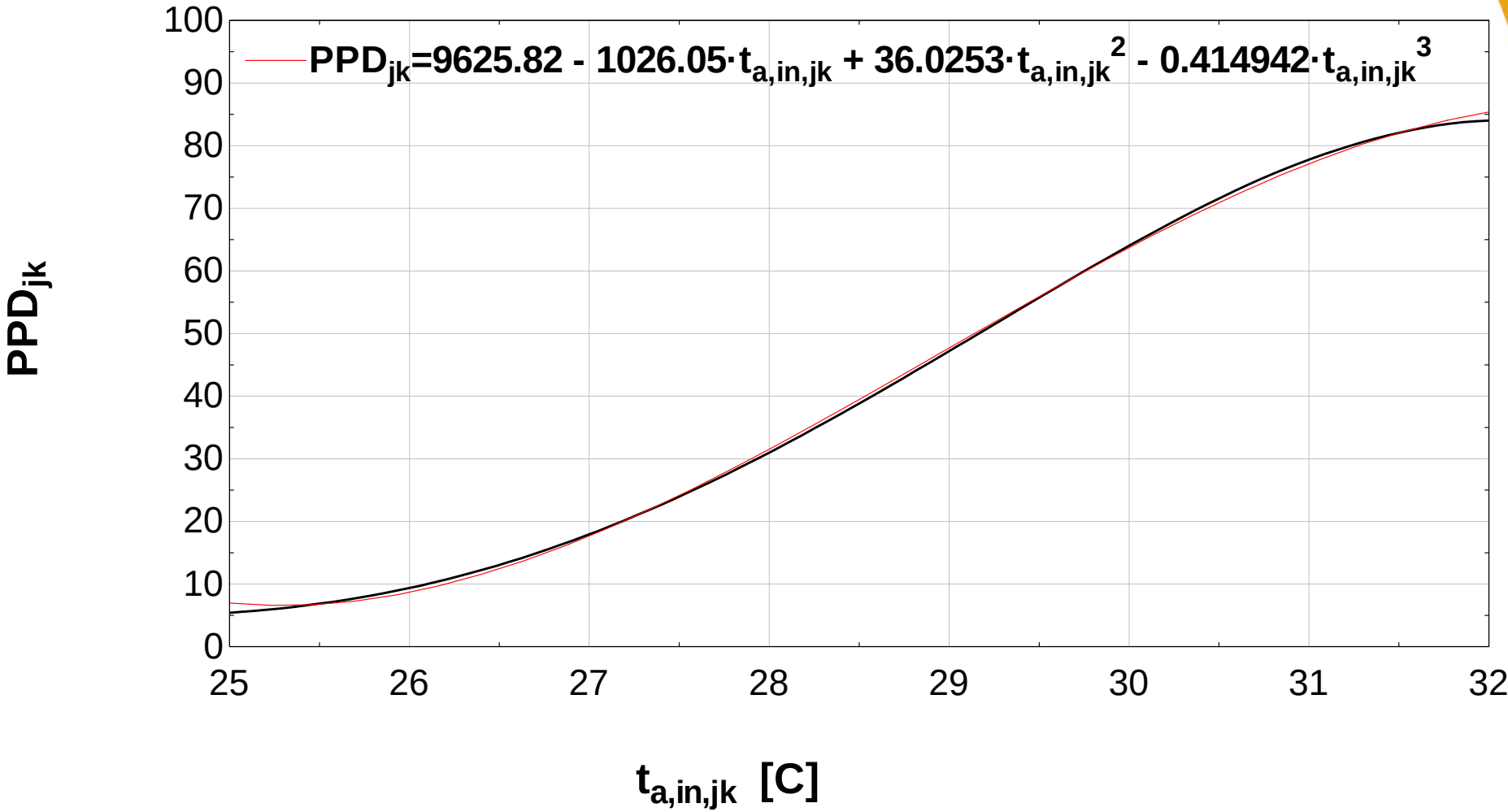
Atic
for HVAC professionals



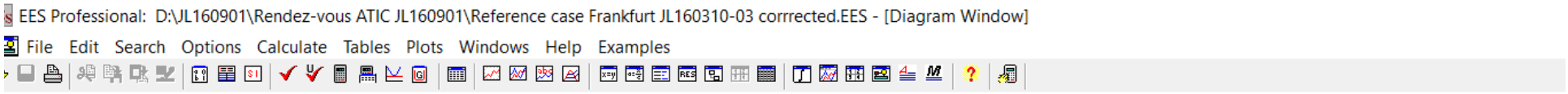
Atic
for HVAC professionals



Atic
for HVAC professionals



Atic
for HVAC professionals



Calculate

$\tau_{winter,1} = 0$ [h]

$\tau_{winter,2} = 8760$ [h]

$\Delta tau_{winter} = 0.5$ [h]

$t_0 = 20$ [C]

$Q_{preheatingcoil,kWh} = 81074$ [kWh]

$Q_{postheatingcoil,kWh} = 87315$ [kWh]

$Q_{TUheatingcoils,kWh} = 18359$ [kWh]

$Q_{boiler,kWh} = 178165$ [kWh]

$Q_{gas,consumed,kWh} = 212438$ [kWh]

$\eta_{boiler,HHV,average} = 0.8387$ [-]

$Q_{cooling,AHU,kWh} = 138171$ [kWh]

$Q_{TUcoolingcoils,kWh} = 598031$ [kWh]

$Q_{evaporators,kWh} = 813246$ [kWh]

$W_{chillers,kWh} = 290911$ [kWh]

$COP_{average} = 2.796$ [-]

$PPD_{average,01} = 6.165$ [%]

$PPD_{average,02} = 6.21$ [%]

$PPD_{average,03} = 6.406$ [%]

$PPD_{average,04} = 6.337$ [%]

$PPD_{average,05} = 9.527$ [%]

$W_{mainfan,kWh} = 63462$ [kWh]

$W_{returnfan,kWh} = 21968$ [kWh]

$W_{TUfans,kWh} = 25896$ [kWh]

$W_{heatingpumps,kWh} = 8584$ [kWh]

$W_{coolingpumps,kWh} = 77044$ [kWh]

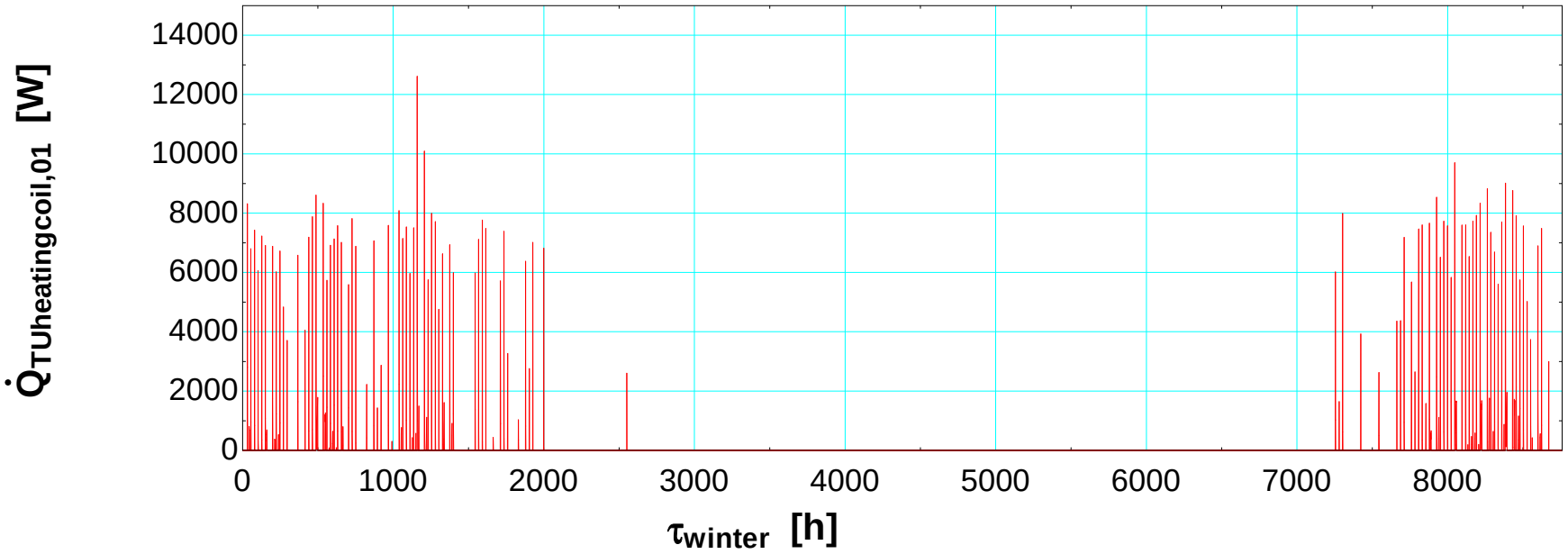
$Q_{sun,kWh} = 340658$ [kWh]

$Q_{s,occ,kWh} = 165361$ [kWh]

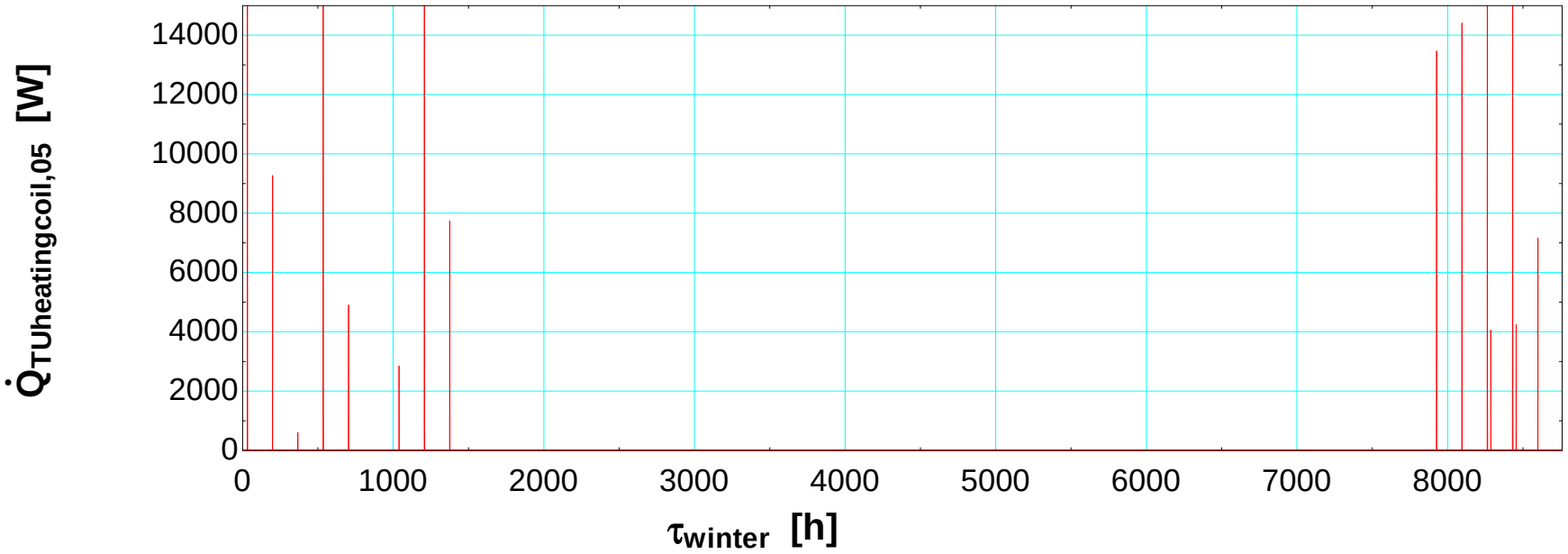
$W_{light,kWh} = 634279$ [kWh]

$W_{appl,kWh} = 599046$ [kWh]

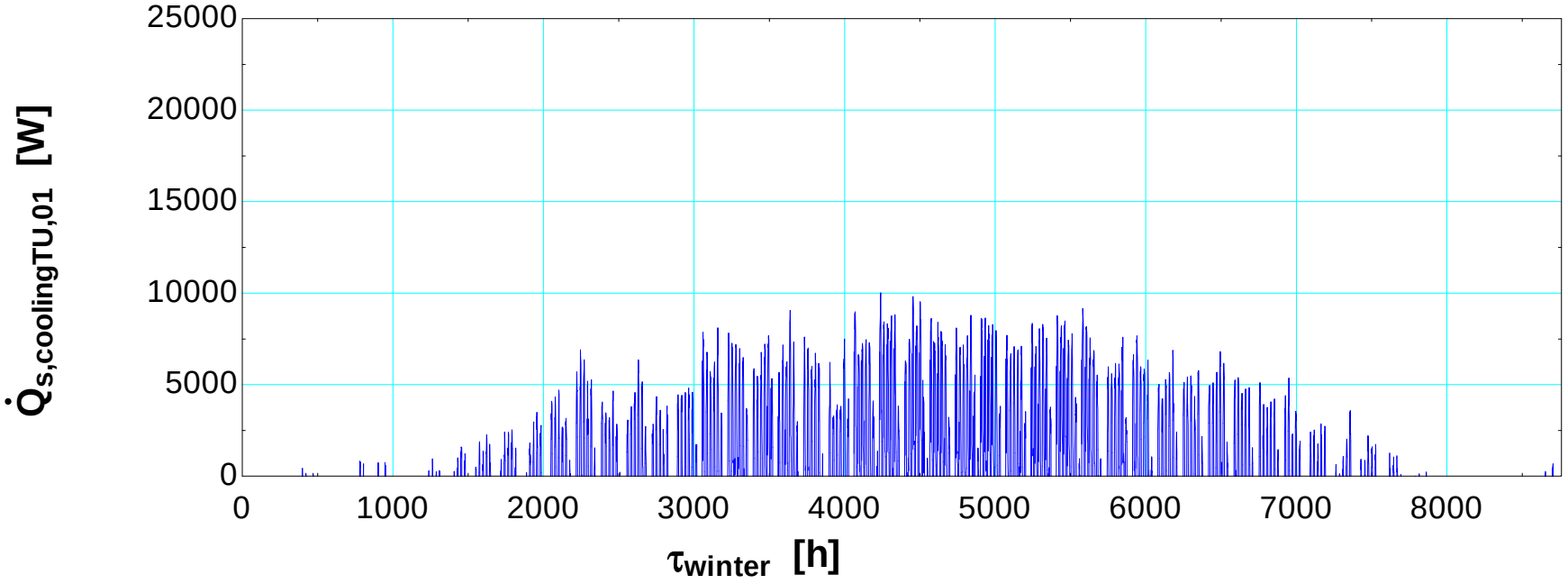
$W_{total,kWh} = 1.721E+06$ [kWh]

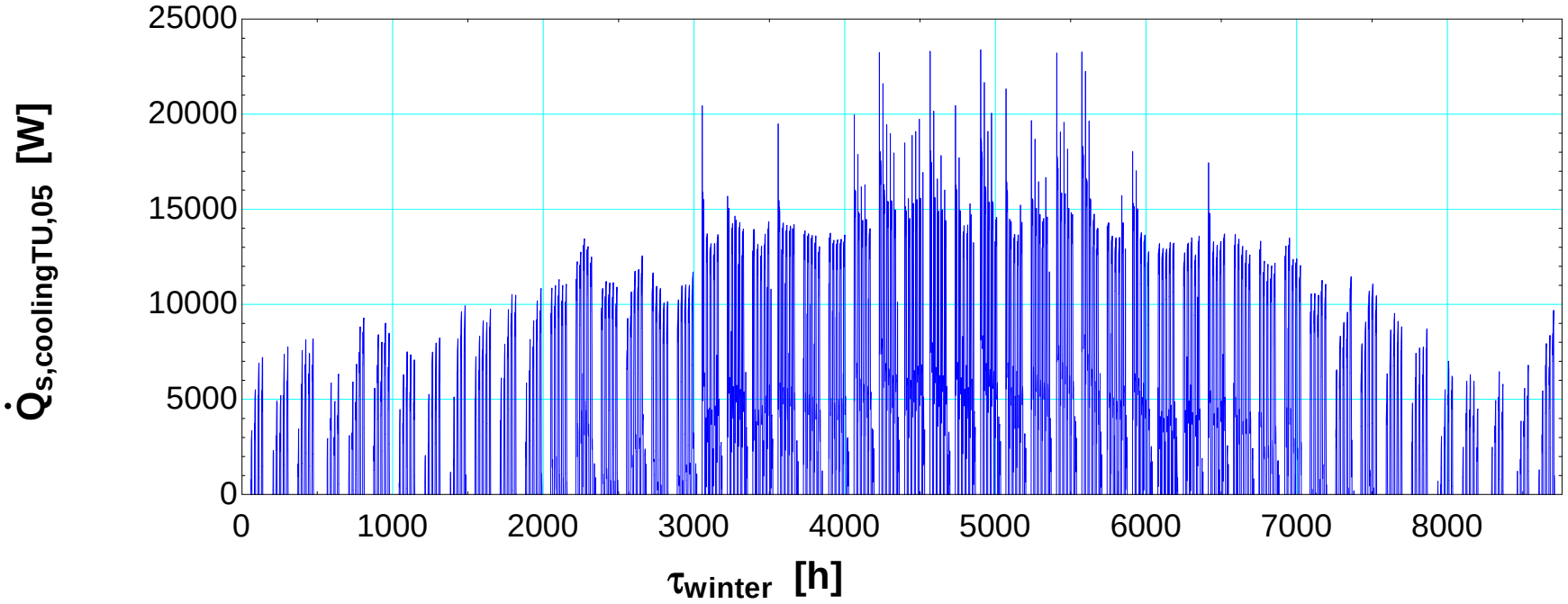


Atic
for HVAC professionals



Atic
for HVAC professionals


25000
20000
15000
10000
5000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
$\dot{Q}_{S,coolingTU,01}$ [W]
τ_{winter} [h]



Atic
for HVAC professionals