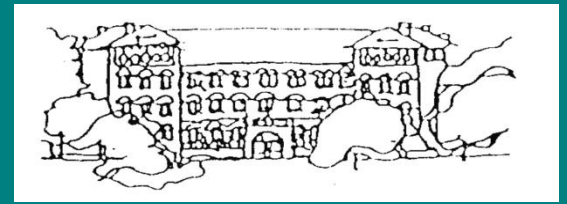




***Technical University of Civil
Engineering***



***Faculty of Building
Services***

HVAC SYSTEMS FOR A PASSIVE HOUSE – STUDY CASE

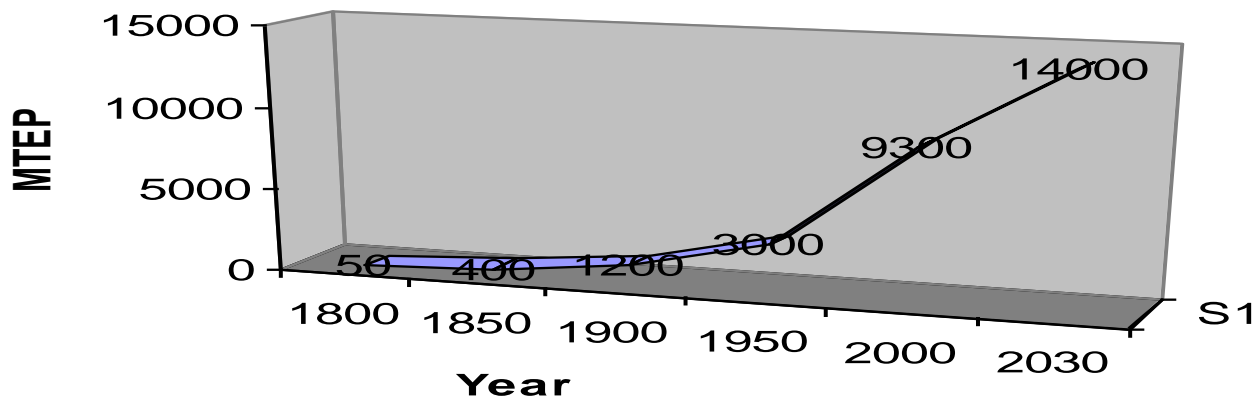
被动房中的暖通空调系统——案例研究

L. Drughean, Ph-D;

Tianjing, 28 - 30 october 2014

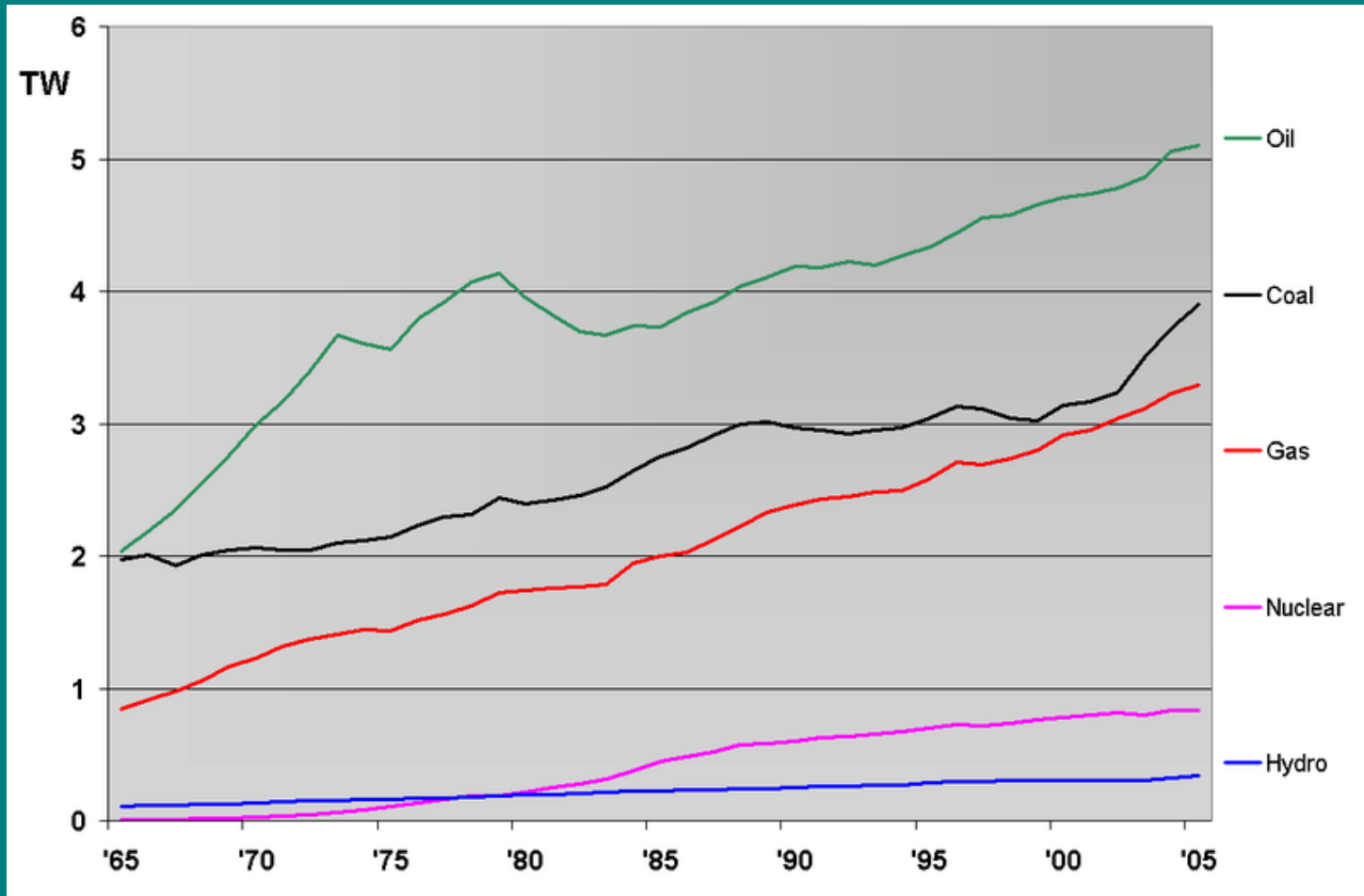
Energy Consumption (Primary Energy)

能源消耗（一次能源）



Energy Production

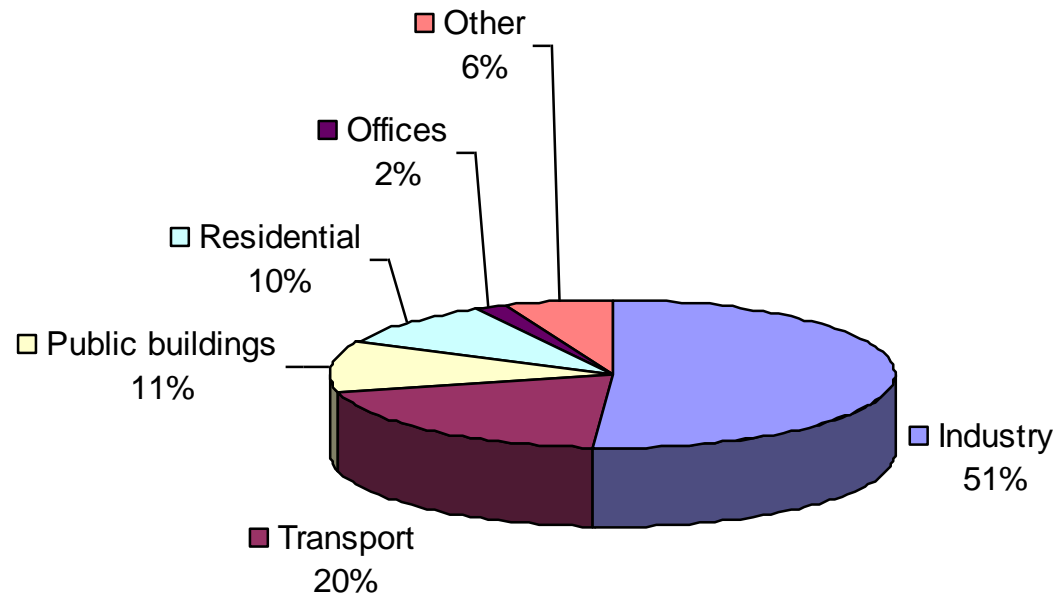
能源产出



Domain of Energy Consumption

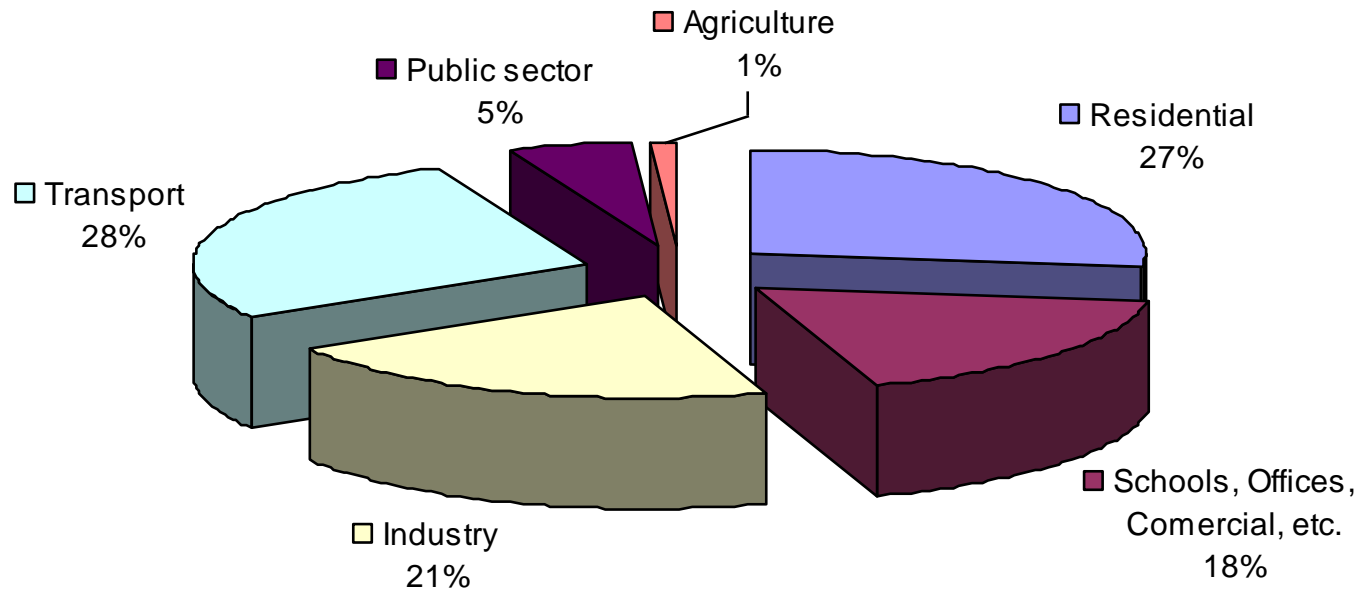
能耗分布

Possible domain to reduce energy consumption



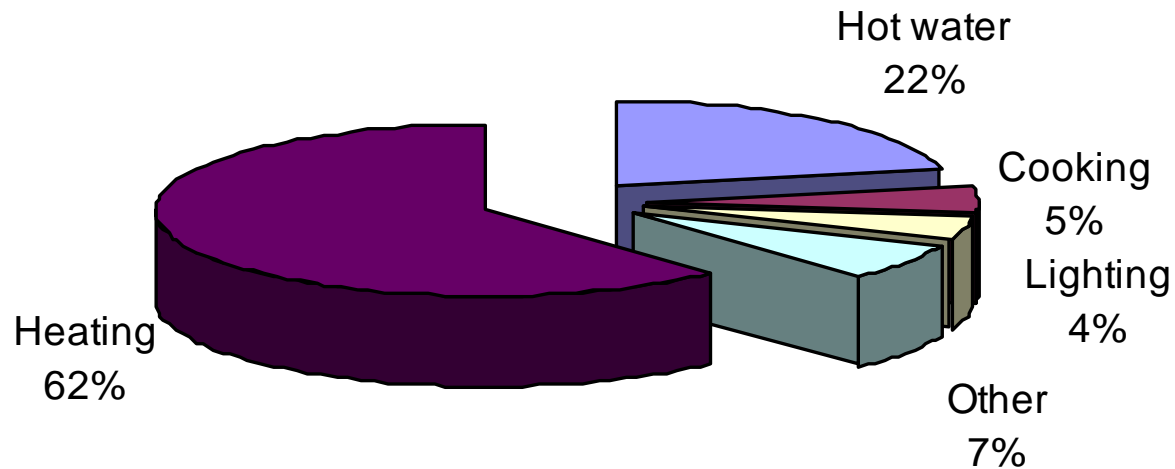
Emissions of CO₂

Emissions of CO₂
二氧化碳排放量的分布



Energy Consumption in Residential Sector

居住建筑中能耗分布



Principles for build up a P.H.

设计被动房的原则

- Volume/surface coefficient (1- single house, 0,65 – single house with a couple of floors, 0,4 block of flats, etc.); 体形系数
- Orientation; 建筑朝向
- Good insulation (limitation of thermal bridges); 好的维护结构隔热性能
- Sealed envelope; 围护结构密封
- Smart shading. 智能的遮阳

Specific coefficient for P.H. (after P.H. Institute – Dusseldorf Germany)

被动房在性能上的优势

- Final Energy

- » 15 kWh/(m² year) – heating energy

最终能耗：供热能耗为15千瓦时每平方米每年。

- Primary Energy

- » 120 kWh/(m² year) – total energy (heating, cooling, lighting, cooking, etc.)

一次能源消耗：供热、供冷、照明等总能耗为120千瓦时每平方米每年。

Designed P.H.

被动房的设计参数

General data: 总体数据

- Height: Ground+3 Floors+Attic; 高度: 三层+阁楼
- Ground surface: 500 sq.m; 占地面积: 500平方米
- Total surface: 2,500 sq.m; 建筑总表面积: 2500平方米
- Total volume: 8,000 c.m. 总体积: 8000立方米
- Destination: G+3 Flors (open offices), Attic (residential) 用途: 三层用于开放式办公室, 阁楼用于居住

View of the P.H.

建筑概览



结构 Construction

The external walls have the following structure :

- external coating :

$\delta = 0.015 \text{ m}$; $\lambda = 0.93 \text{ W/m.K}$;

- thermal insulation layer made of expanded polystyrene :

$\delta = 0.20 \text{ m}$; $\lambda = 0.04 \text{ W/m.K}$;

- neopor layer :

$\delta = 0.063 \text{ m}$; $\lambda = 0.027 \text{ W/m.K}$;

- concrete steel layer :

$\delta = 0.20 \text{ m}$; $\lambda = 1.74 \text{ W/m.K}$;

- neopor layer :

$\delta = 0.063 \text{ m}$; $\lambda = 0.027 \text{ W/m.K}$;

- thermal insulation layer made of mineral cotton :

$\delta = 0.05 \text{ m}$; $\lambda = 0.04 \text{ W/m.K}$;

- Rigips layer : $\delta = 0.012 \text{ m}$; $\lambda = 0.50 \text{ W/m.K}$;

The windows : double thermopan window ;

The roof of the house that is wood fireproofed rigid frame, with cellulose insulation of de 40 cm total thickness, with Lindab profiled plate.

Utilitys

夏季工况

环境温度

总制冷量

冬季工况

环境温度

总供热量

SUMMER				
Te [°C]	25	30	35	40
Q _{Totalcool} [W]	- 415	1284	3040	4766
WINTER				
Te [°C]	-15	-10	-5	0
Q _{Total heat} [W]	12818	11065	9311	7557

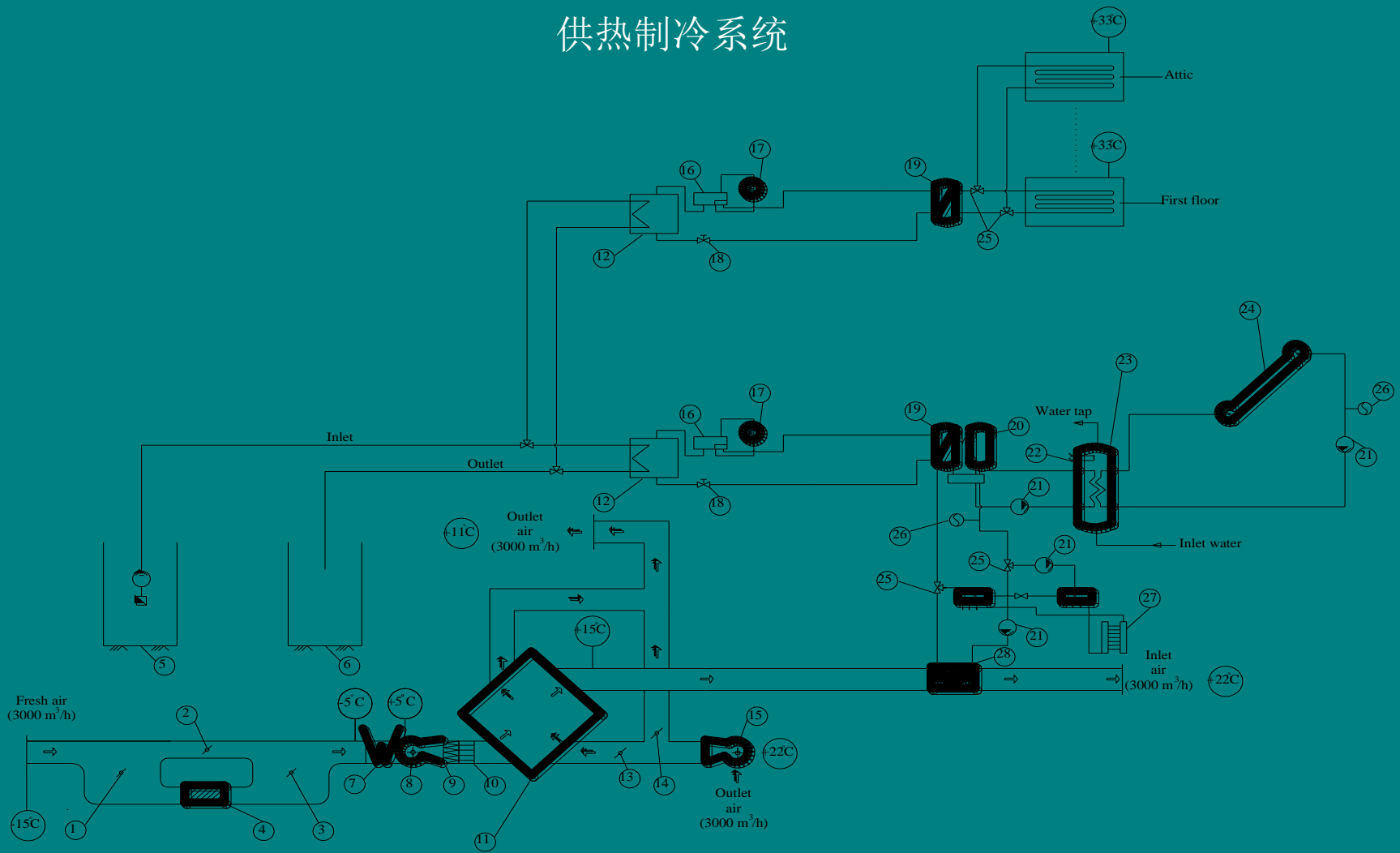
The specific consumptions

分项能耗

- Specific consumption for heating: $q_{\text{heat}} = 9.56$ kWh/m².year; 用于供热的能耗
- Specific consumption for preparing hot water: $q_{\text{hw}} = 11.86$ kWh/m².year; 用于制备热水的能耗
- Specific consumption for lighting: $q_{\text{lighting}} = 9.40$ kWh/m².year; 照明能耗
- Specific consumption for air-conditioning: $q_{\text{ac}} = 9.23$ kWh/m².year; 空调能耗
- Total specific consumption resulted: $q_{\text{total}} = 40.06$ kWh/m².year. 总能耗

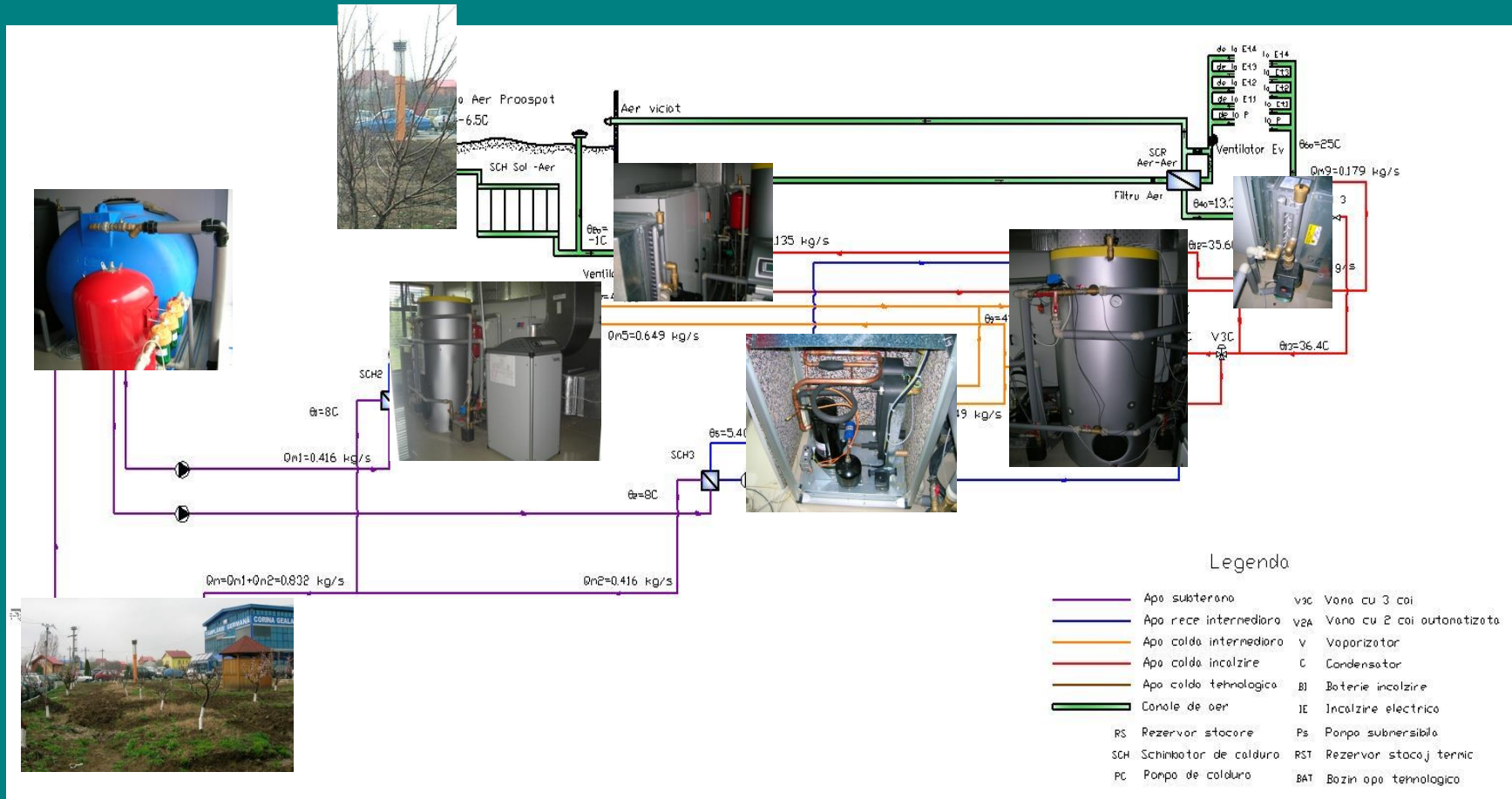
Heating/Cooling air system

供热制冷系统



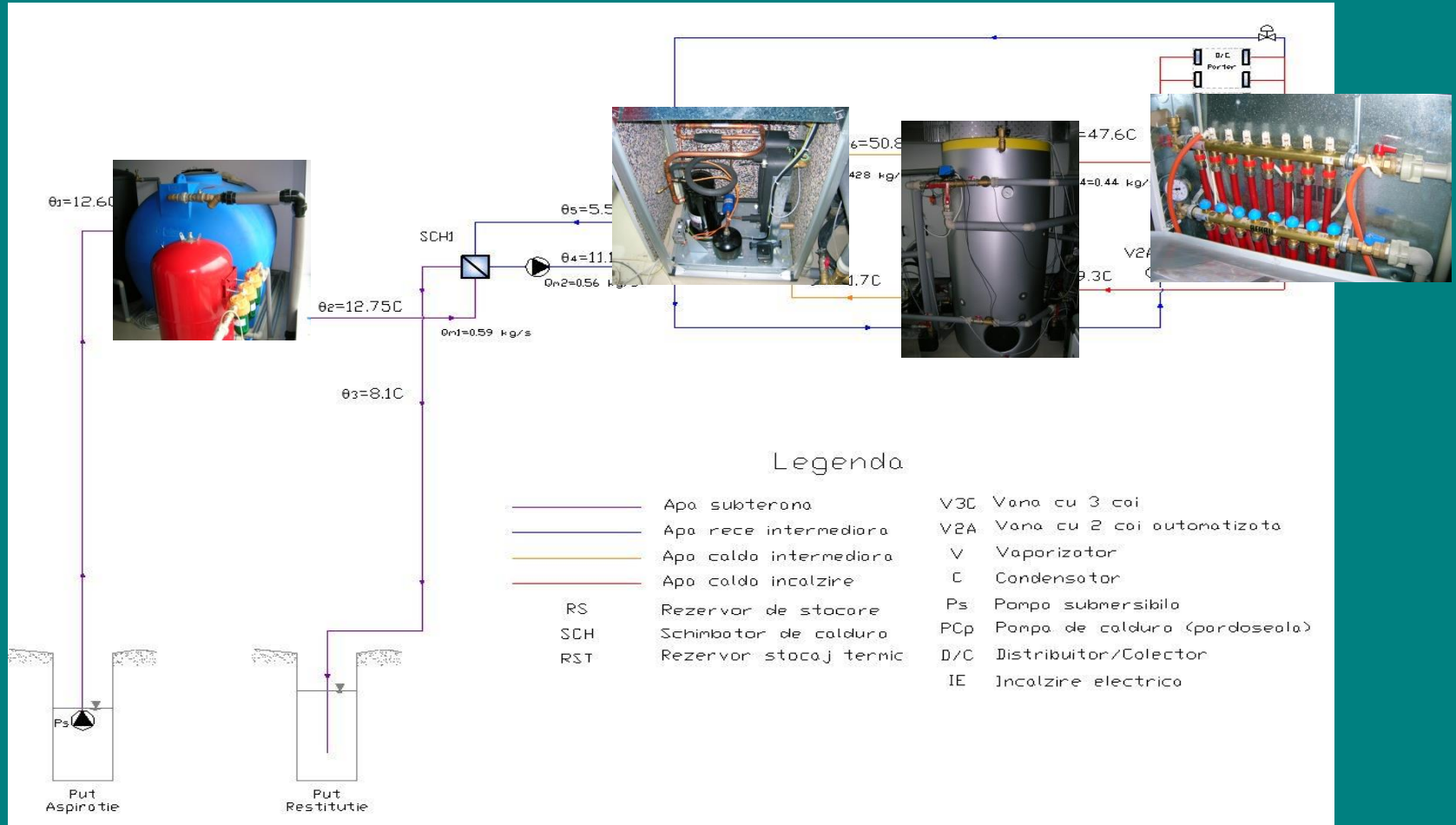
Heating or Cooling plant using the mechanic ventilation system

使用空气末端的制冷和供热设备



Heating or Cooling plant using the radiant floor

使用辐射地板的制冷和供热设备

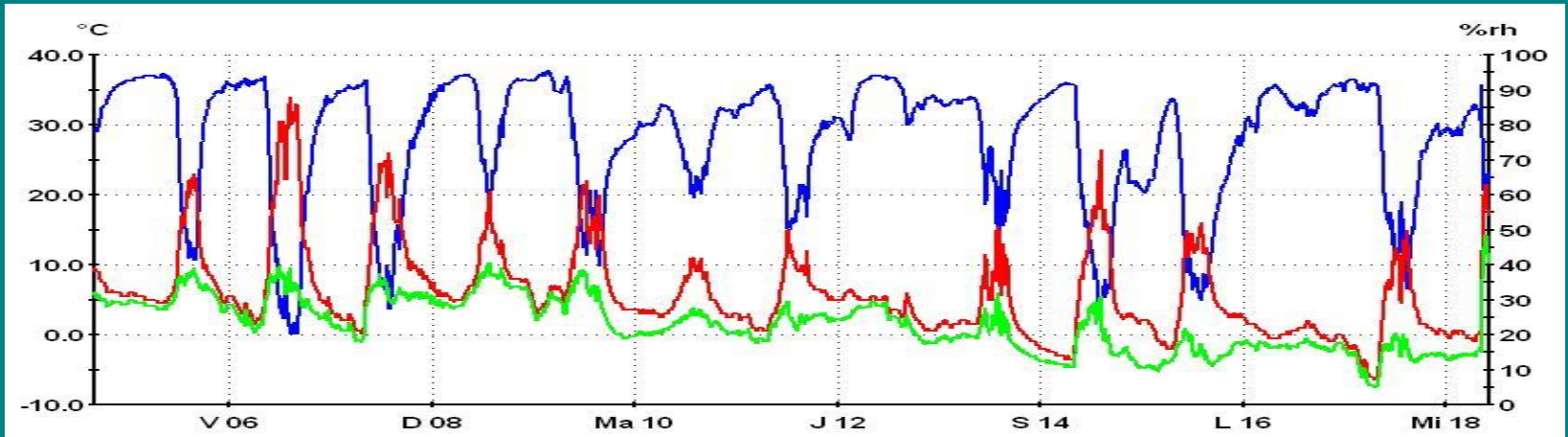


Conclusions

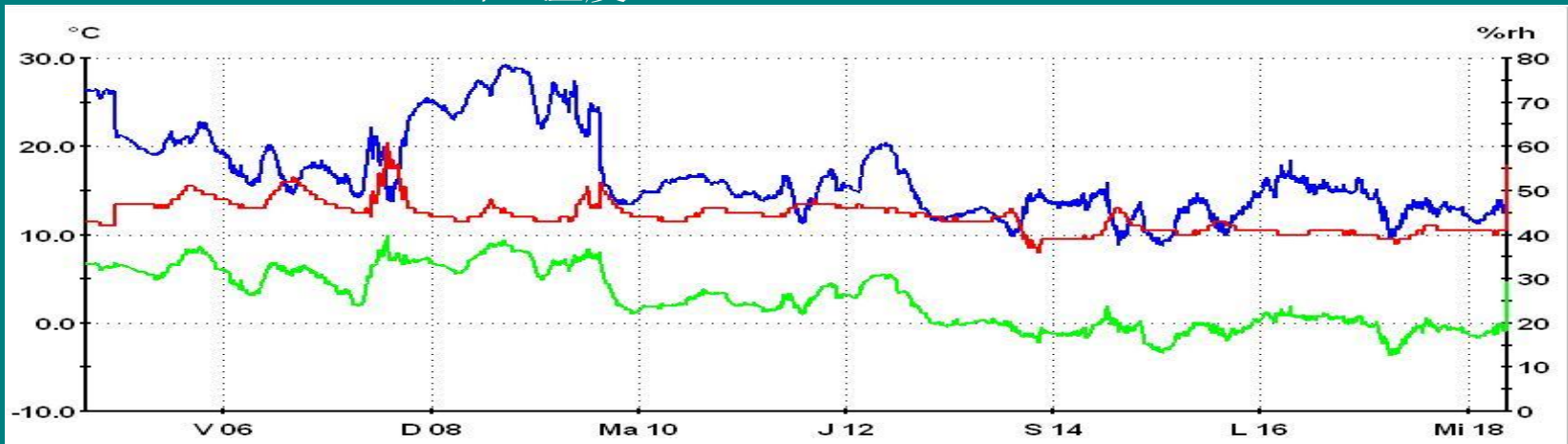
结论

Temperature variation in the ground heat exchanger 土壤换热器的温度变化

- Inlet temperature (february) 进口温度

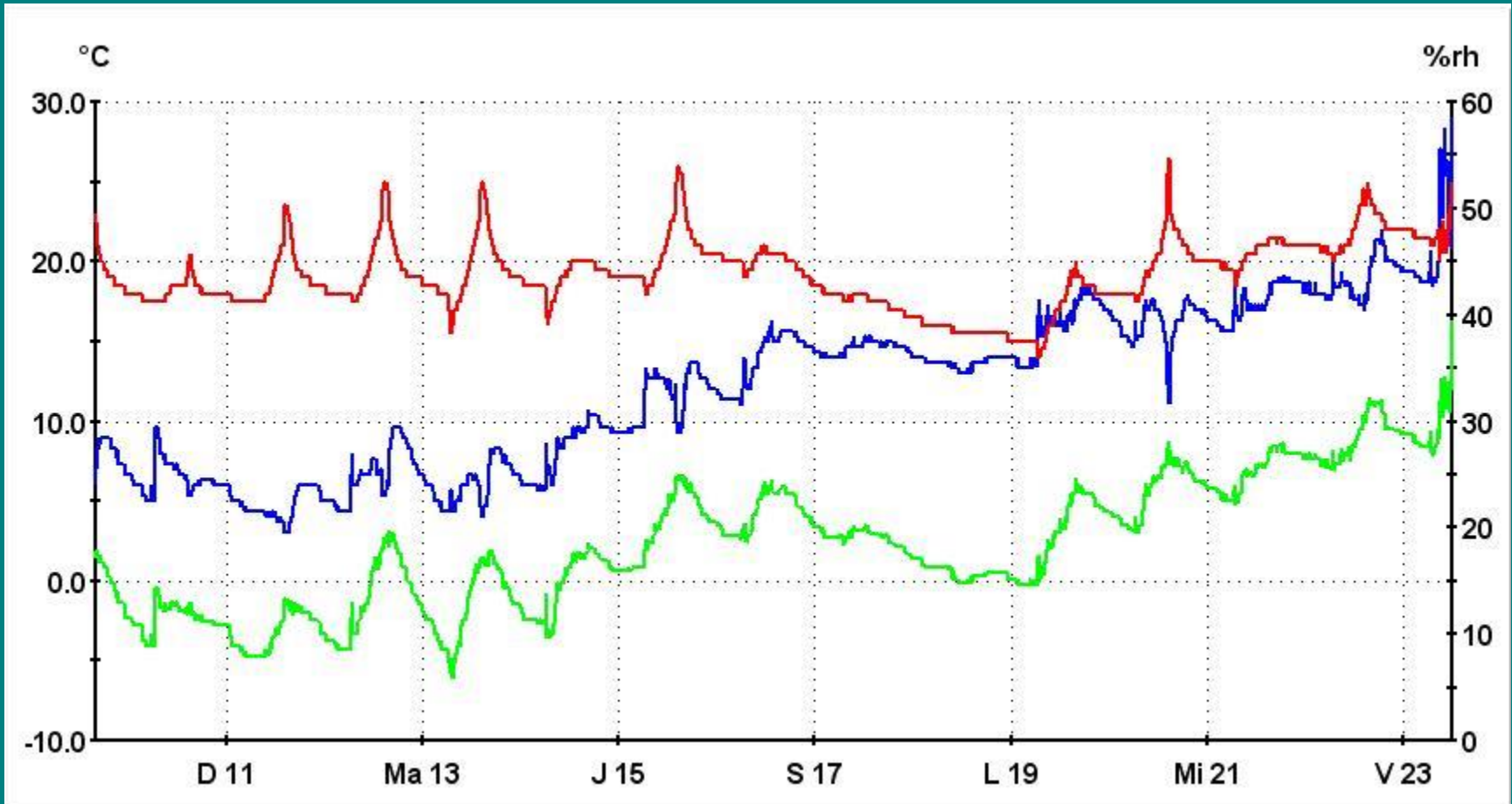


- Outlet temperature 出口温度



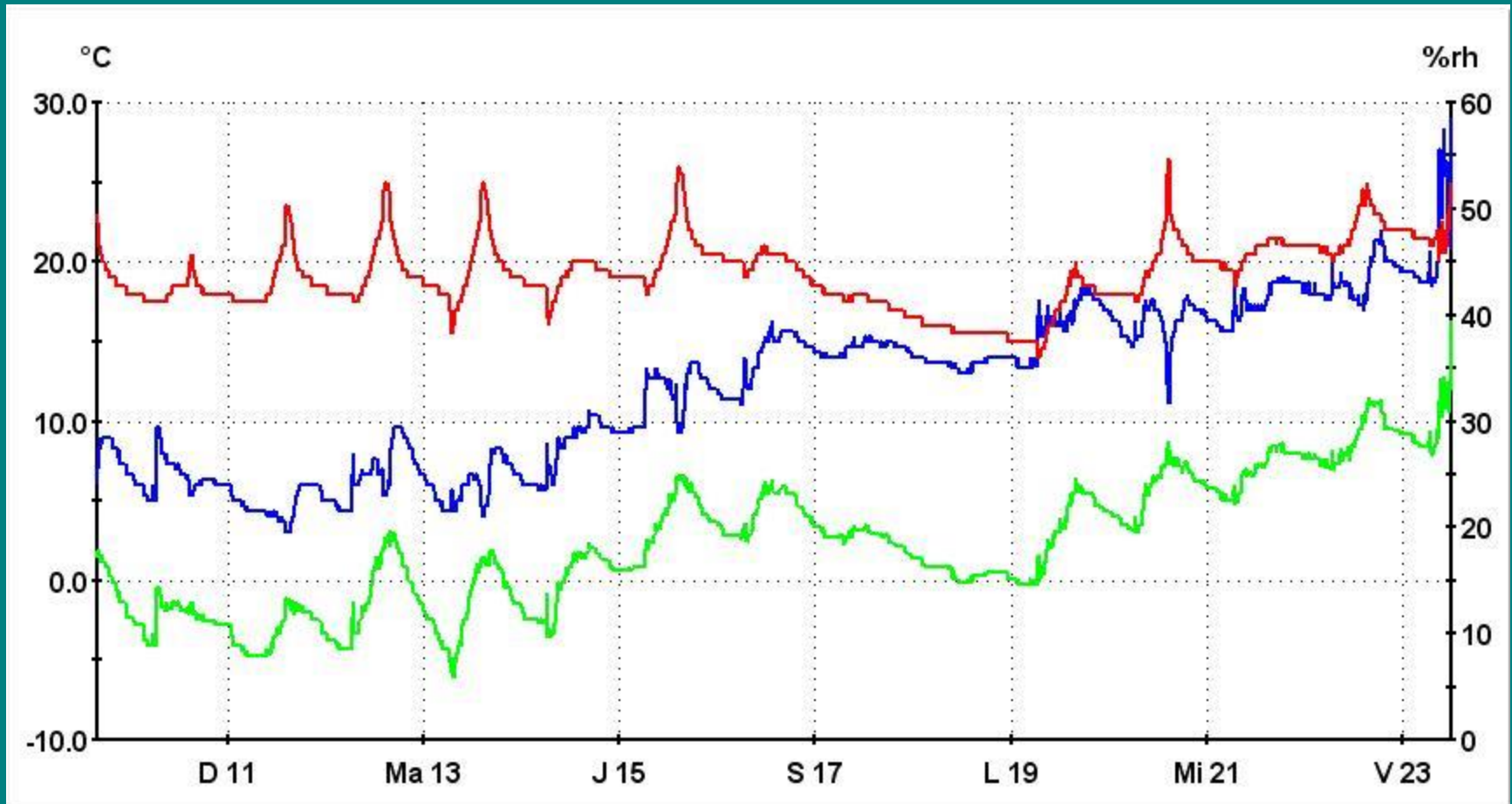
Floor heating (ground / open office)

地板采暖（首层和办公室）



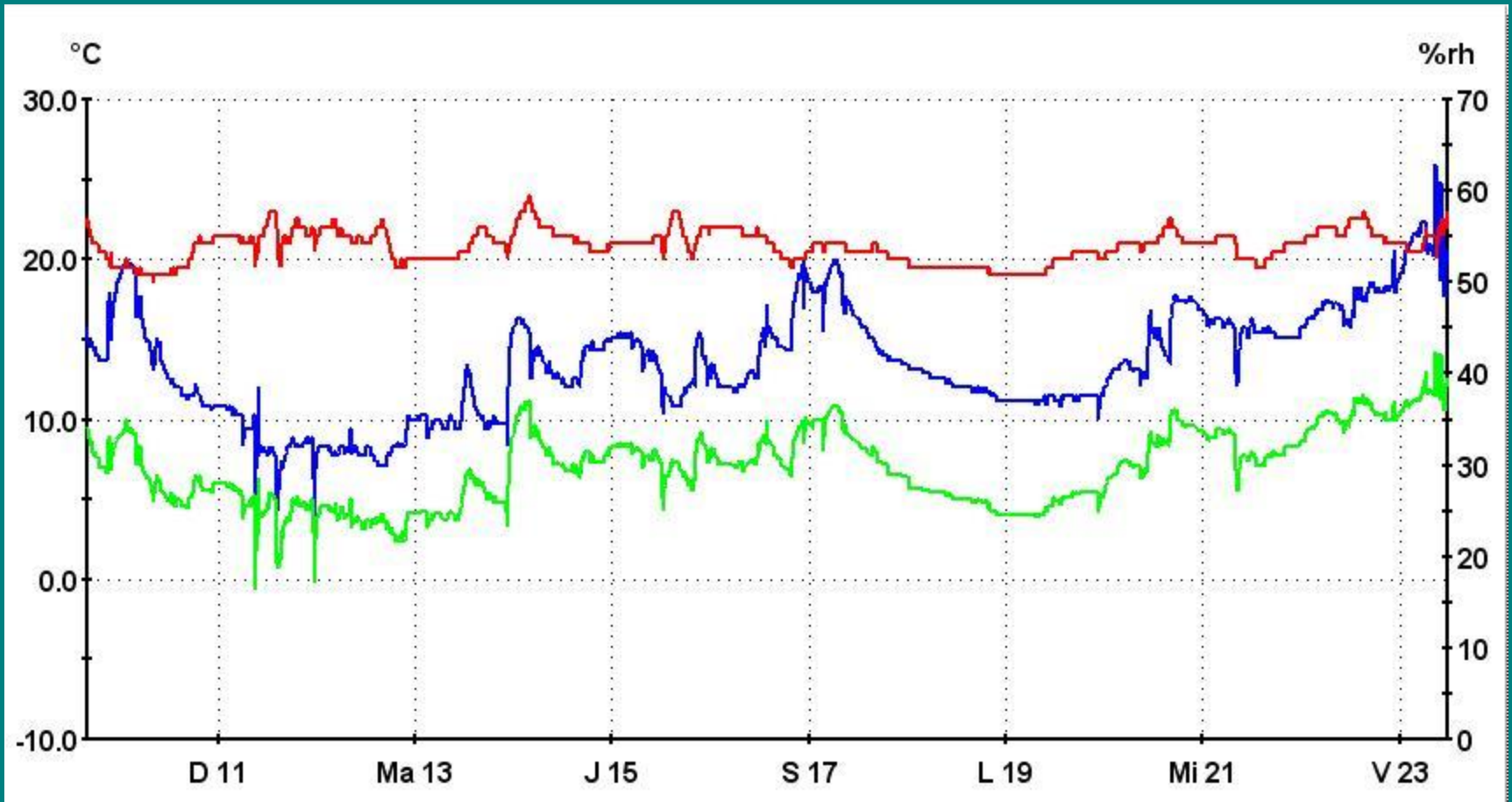
Floor heating (first floor / open office)

地板采暖（首层和办公室）



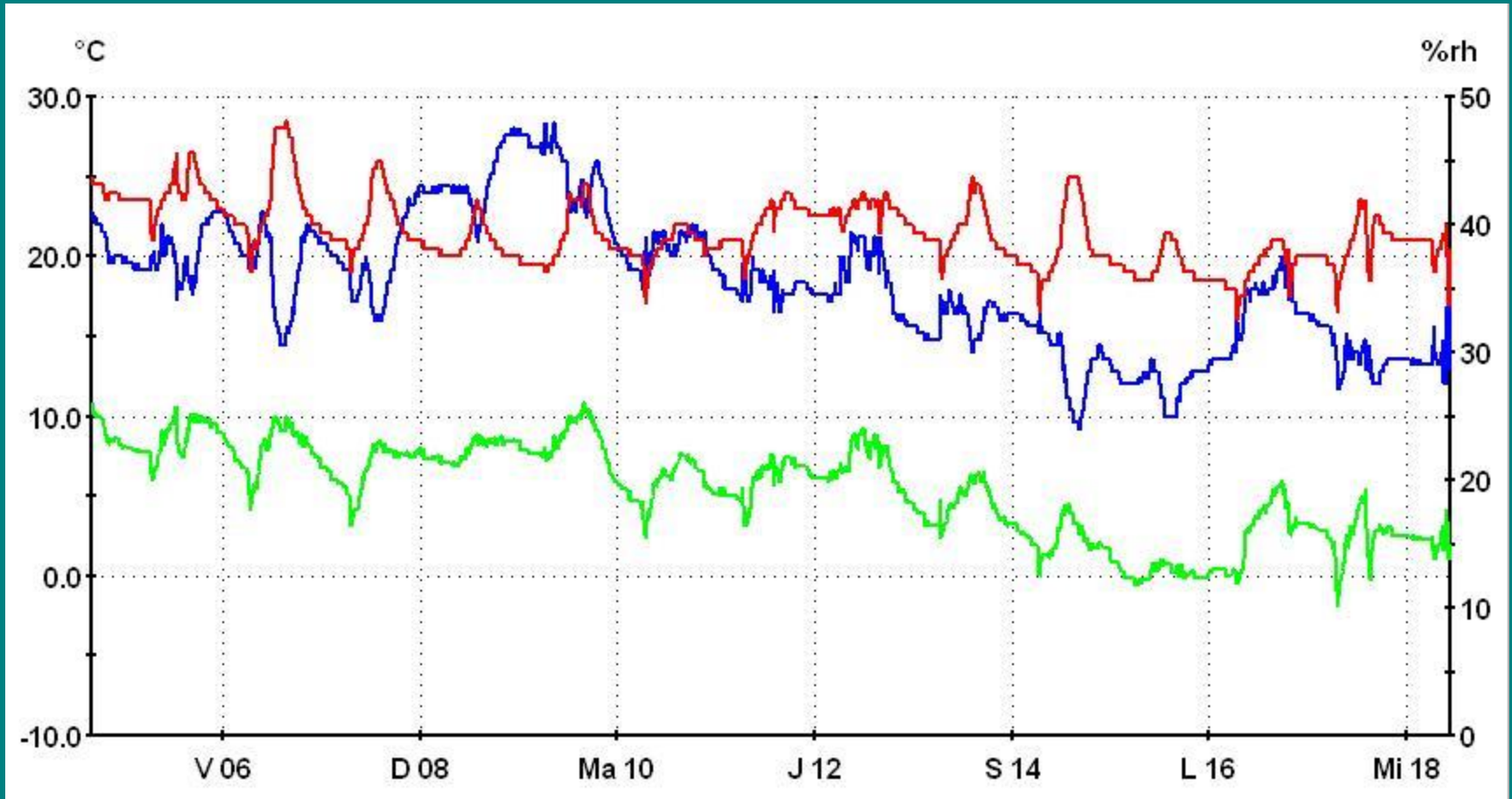
Floor heating (residential)

地板采暖（居住部分）



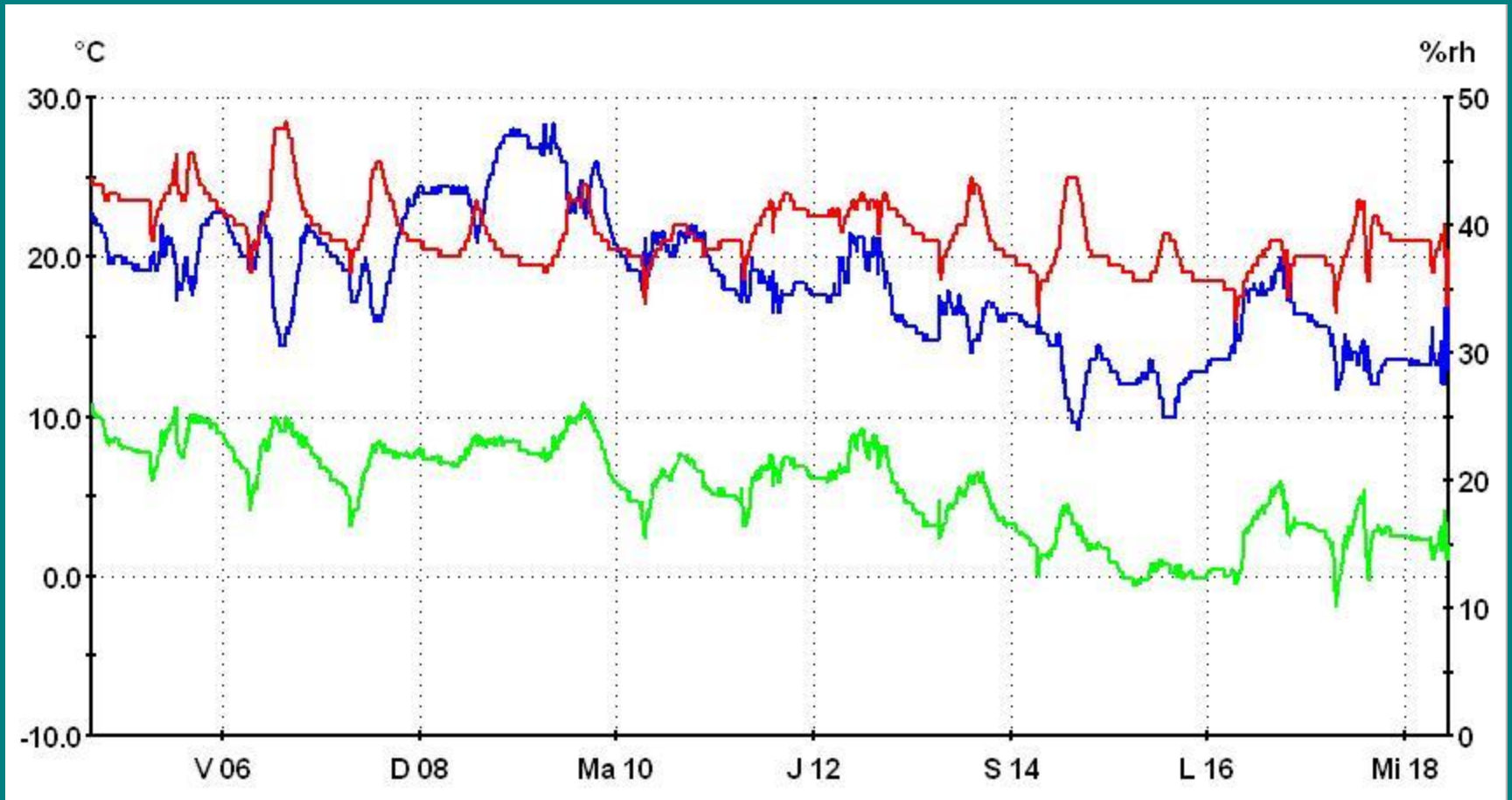
Air + Floor Heating (Ground / open office)

空气+地板采暖（首层和办公室）



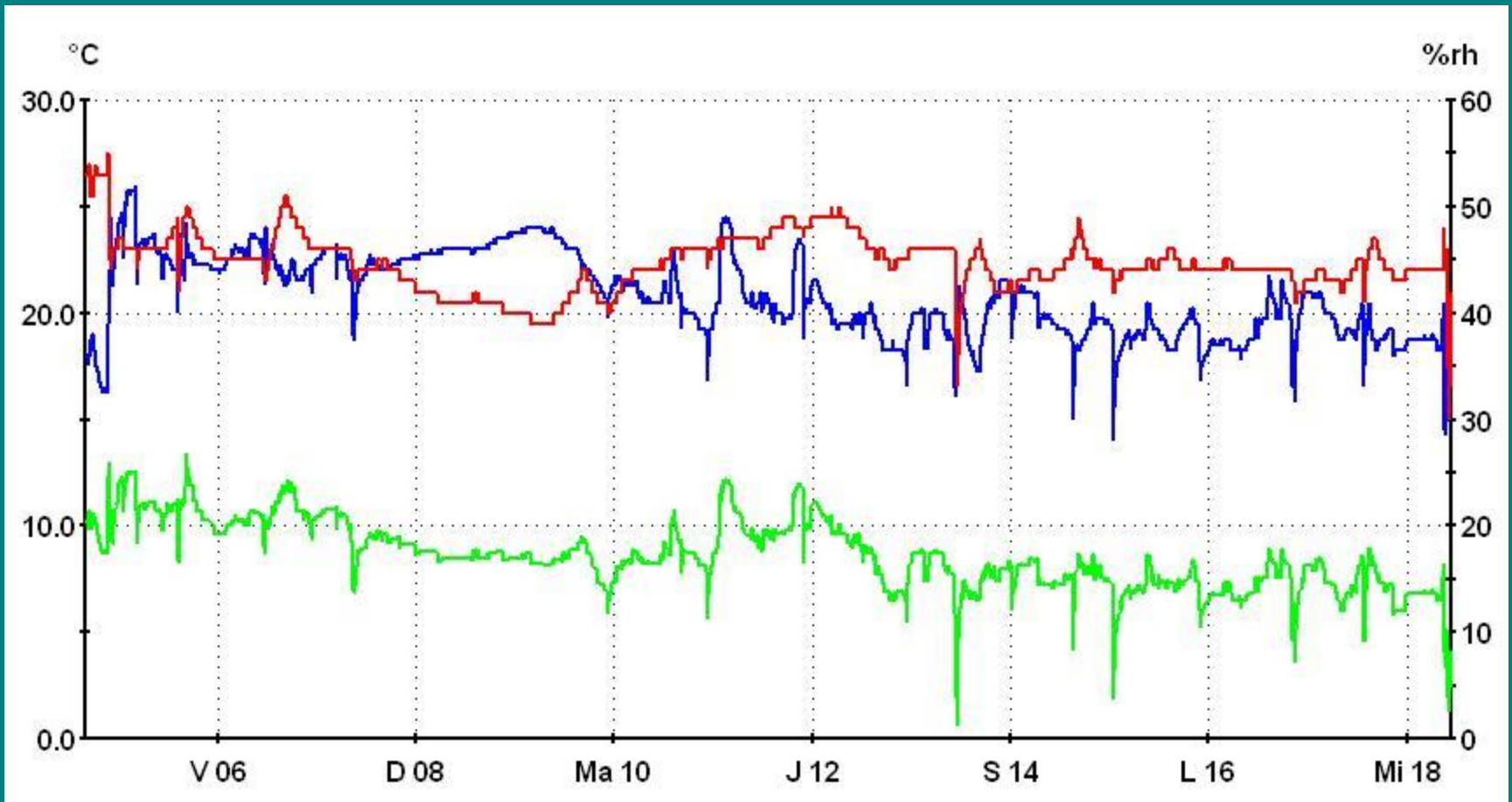
Air + Floor Heating (first floor / open office)

空气+地板采暖（首层和办公室）



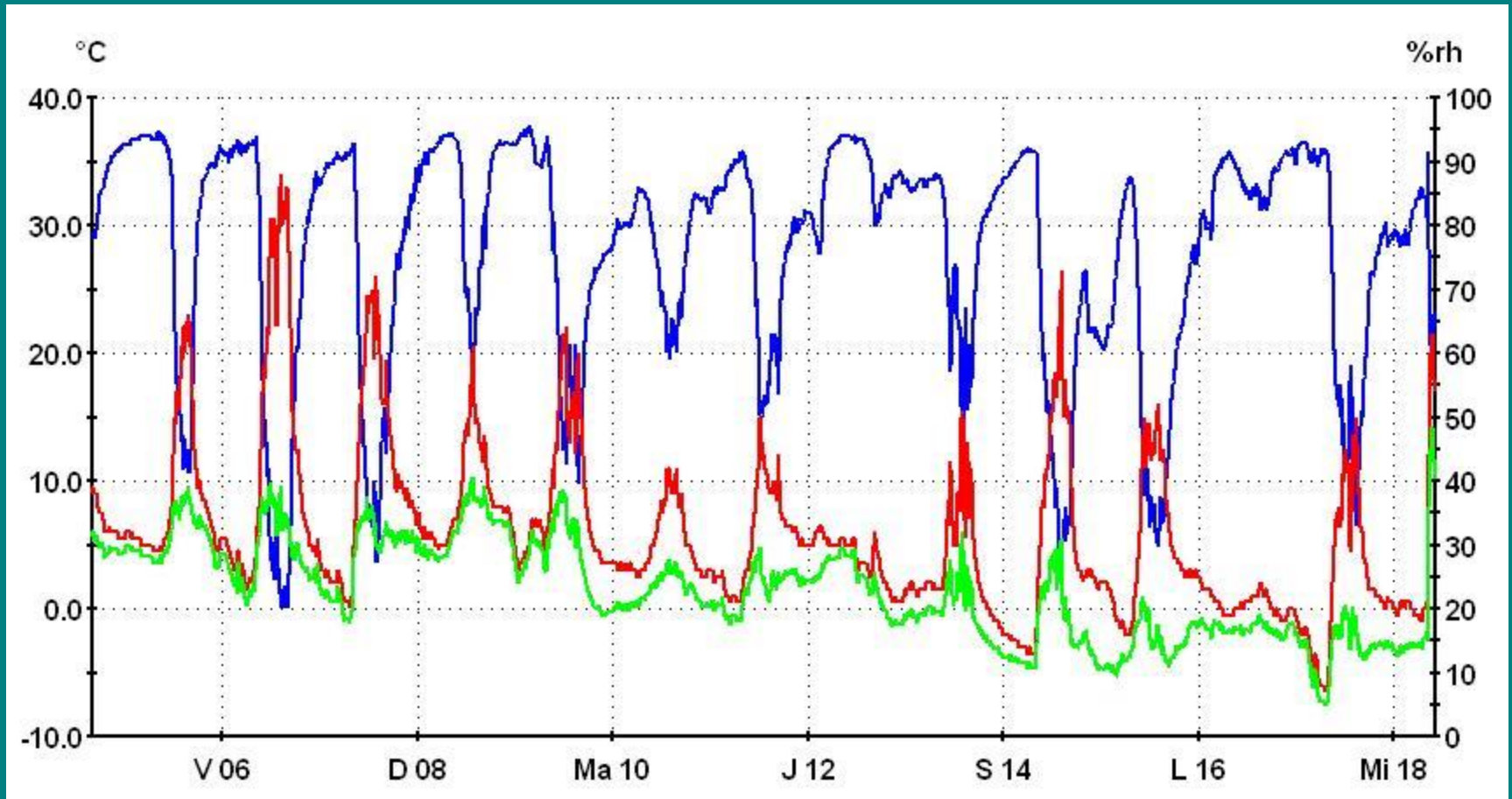
Air + Floor heating (residential)

空气+地板采暖（居住部分）



Outside temperature

室外温度



Thank you for your
attention!