

Sample calculations

The energy saving potential of over 40 % can be demonstrated and determined more precisely in accordance with DIN V 18599, recently updated to ENEC2007.

Providing a method of calculating the primary, net and final energy demand for non-residential buildings with regards to its usage of heating, cooling, ventilation and lighting, this directive was issued by the European Parliament and the Council on the Energy Performance of Buildings in 2005.

As an example we will use a comparison between the Zehnder ZBN radiant ceiling panels and air heaters.

Boundary conditions

Hall height 20 m, room temperature regulation for both systems via PI regulators, air distribution at a normal induction ratio, lateral air outlet

	f_{hydr}	f_{int}	$f_{Radiant}$	η_L	η_C	η_B
Zehnder ZBN	1,00	1,00	0,85	0,89	0,97	1,00
Air heating system	1,00	1,00	1,00	0,63	0,97	1,00

Basic information

Calculation formula under DIN V 18599

$$\eta_{h,ce} = \frac{1}{4 - (\eta_L + \eta_C + \eta_B)} \quad Q_{h,ce,mth} = \left[\frac{f_{Radiant} \cdot f_{int} \cdot f_{hydr}}{\eta_{h,ce}} - 1 \right] Q_{h,mth}$$

$Q_{h,ce,mth}$ additional monthly expenditure of heat transfer, in kWh/mth

$Q_{h,mth}$ monthly heat required, in kWh/mth

f_{hydr} hydraulic balancing factor

f_{int} intermittent operation factor

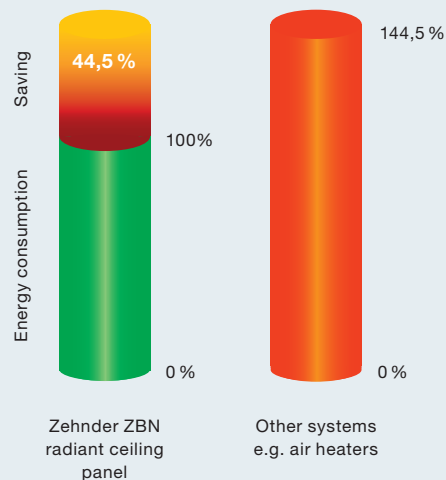
$f_{Radiant}$ factor for effect of radiance

$\eta_{h,ce}$ overall efficiency of heat transfer in room

η_L partial efficiency for vertical air temperature profile

η_C partial efficiency for room temperature regulation

η_B partial efficiency for specific losses from external structures



Energy consumption with radiant ceiling panels

$$\eta_{h,ce} = \frac{1}{4 - (\eta_L + \eta_C + \eta_B)} \quad Q_{h,ce,mth} = \left[\frac{f_{Radiant} \cdot f_{int} \cdot f_{hydr}}{\eta_{h,ce}} - 1 \right] Q_{h,mth}$$

$$\eta_{h,ce} = \frac{1}{4 - (0,89 + 0,97 + 1)} = 0,877$$

$$Q_{h,ce,mth} = \left[\frac{1 \cdot 1 \cdot 0,85}{0,877} - 1 \right] Q_{h,mth} = -0,031 Q_{h,mth}$$

$$Q_{h,ce,mth} = -0,031 Q_{h,mth} = -0,031 \cdot 10000 = -310 \text{ kWh}$$

$$10000 \text{ kWh} - 310 \text{ kWh} = 9690 \text{ kWh} \rightarrow \mathbf{100 \%}$$

Energy consumption with air heaters

$$\eta_{h,ce} = \frac{1}{4 - (\eta_L + \eta_C + \eta_B)} \quad Q_{h,ce,mth} = \left[\frac{f_{Radiant} \cdot f_{int} \cdot f_{hydr}}{\eta_{h,ce}} - 1 \right] Q_{h,mth}$$

$$\eta_{h,ce} = \frac{1}{4 - (0,63 + 0,97 + 1)} = 0,714$$

$$Q_{h,ce,mth} = \left[\frac{1 \cdot 1 \cdot 1}{0,714} - 1 \right] Q_{h,mth} = 0,4 Q_{h,mth}$$

$$Q_{h,ce,mth} = 0,4 Q_{h,mth} = 0,4 \cdot 10000 = 4000 \text{ kWh}$$

$$10000 \text{ kWh} + 4000 \text{ kWh} = 14000 \text{ kWh} \quad \frac{14000 \cdot 100 \%}{9690} = \mathbf{144,5 \%}$$

Result

Energy saving with Zehnder radiant ceiling panels = 44.5 %

Due to radiant ceiling panels heating surfaces and objects rather than the air, energy consumption is greatly reduced.

