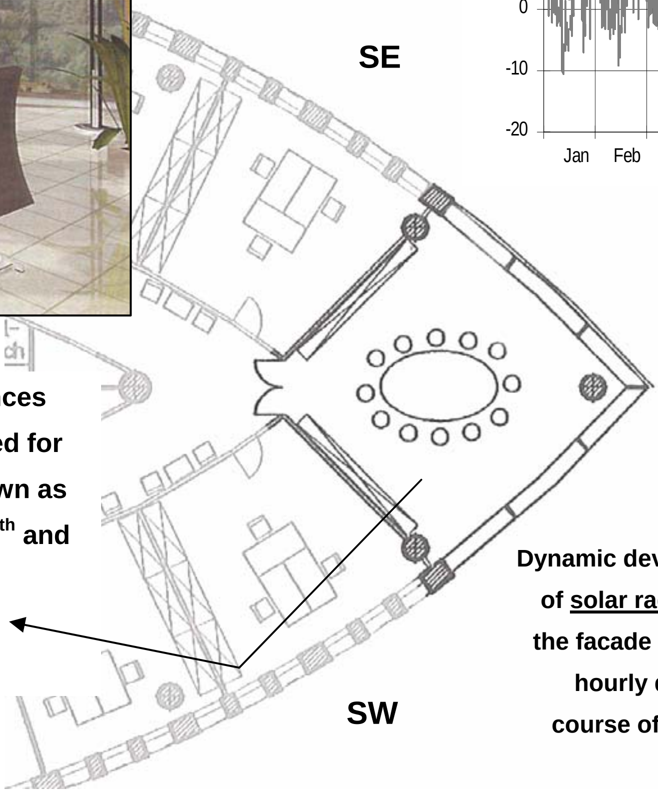
ABC-Tower - Cologne

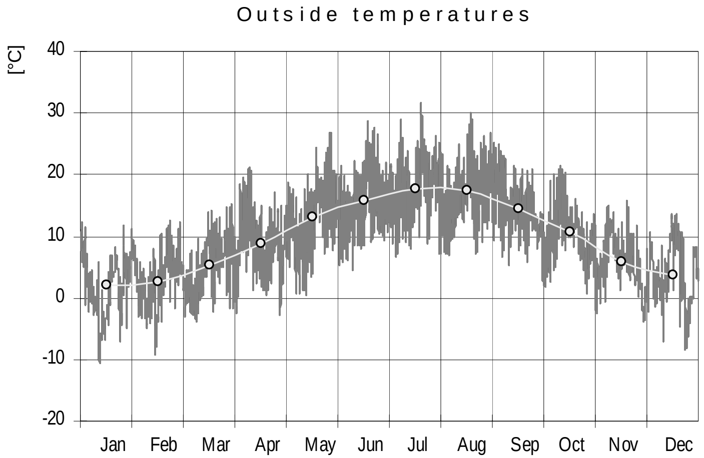
Thermodynamic Building simulations

Presentation of thermodynamic influences on the building simulation by means of a structural physical analysis for two building levels

General

Local surrounding climate

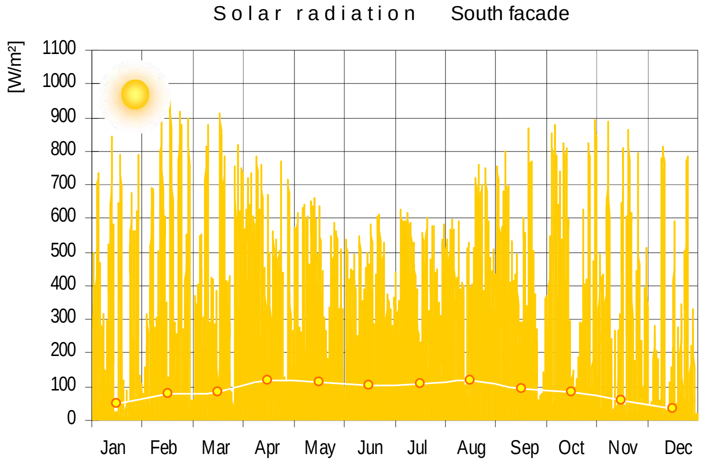




Dynamic development of the outside air temperature measured hourly during the course of one year.

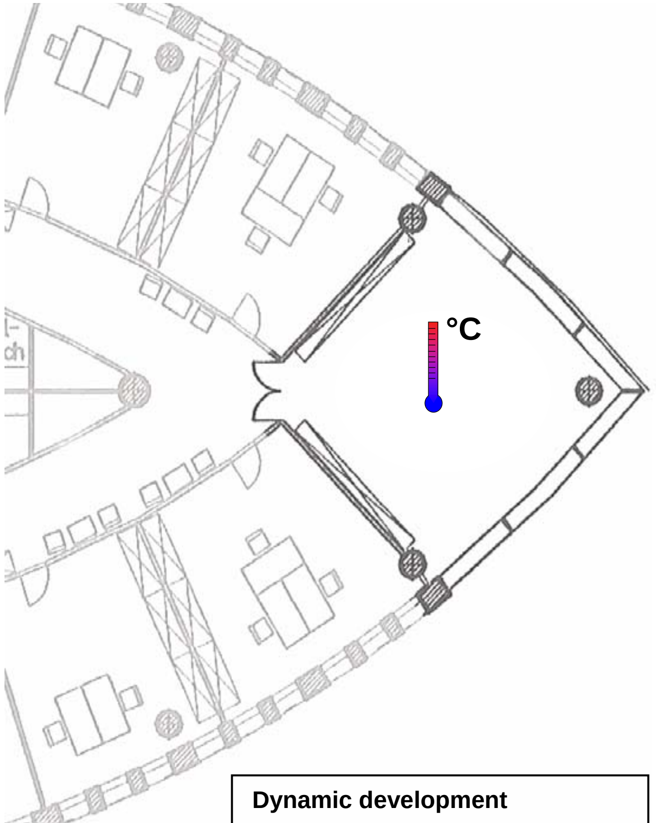
In order to illustrate transient / dynamic influences on the indoor climate and its effects on the need for heating and on thermal comfort, these are shown as an example in two conference rooms on the 15th and 16th floors.

Dynamic development of solar radiation on the facade measured hourly during the course of one year.

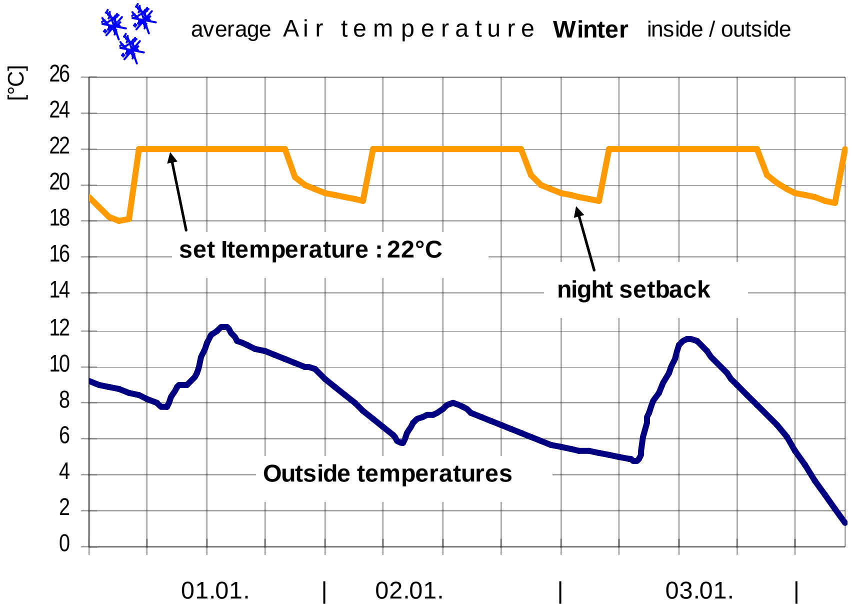


I n d o o r a i r t e m p e r a t u r e s

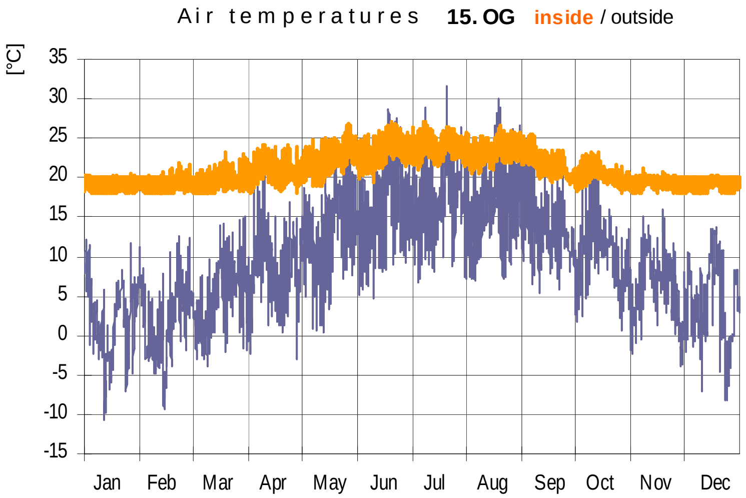
By adhering to the required temperature in the rooms, dynamically flowing indoor temperatures will arise resulting from the exterior climate and from indoor influences (ventilation, persons, etc.)

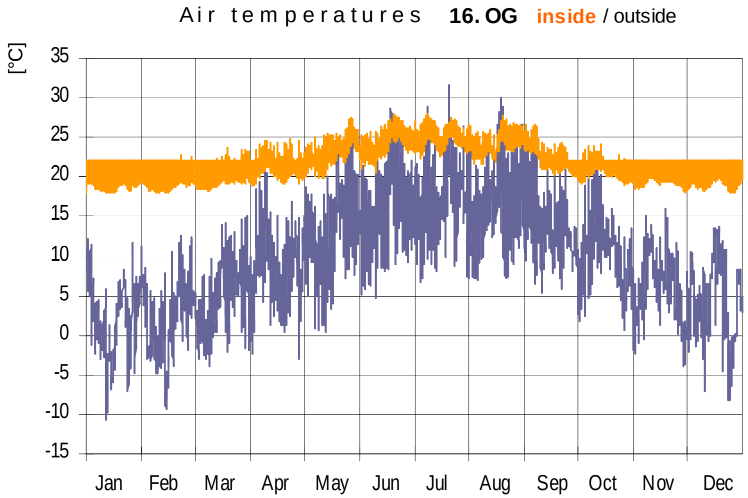


Dynamic development
of indoor temperatures
(and outside temperatures)
In the 15th and 16th floors .



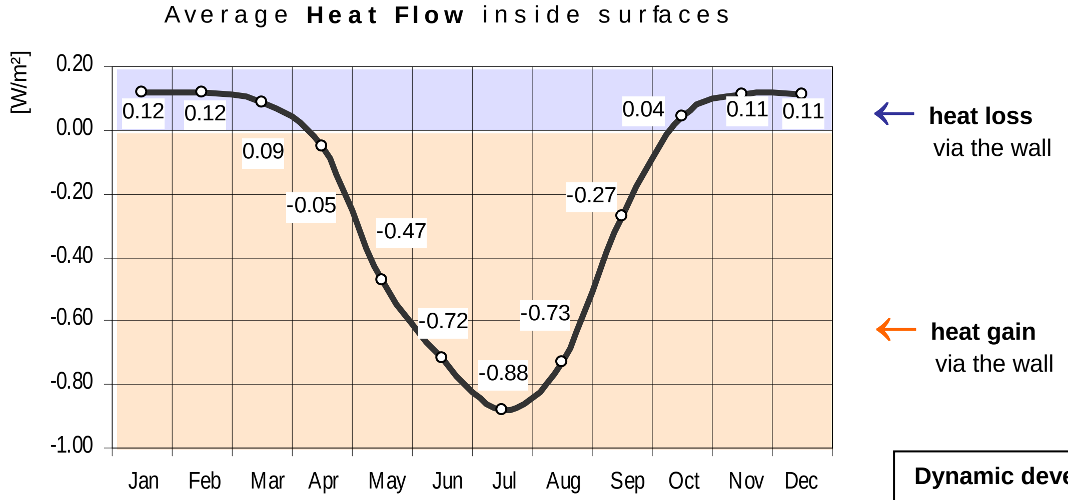
exemplary daily data
of indoor temperatures with
set Itemperature during
hours of use and individual
night setback.



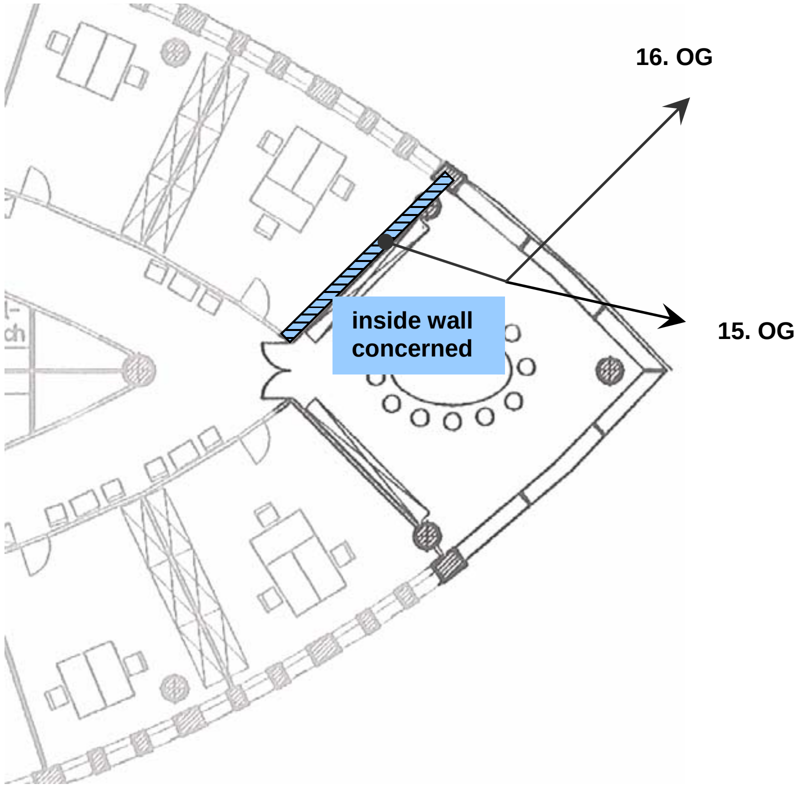


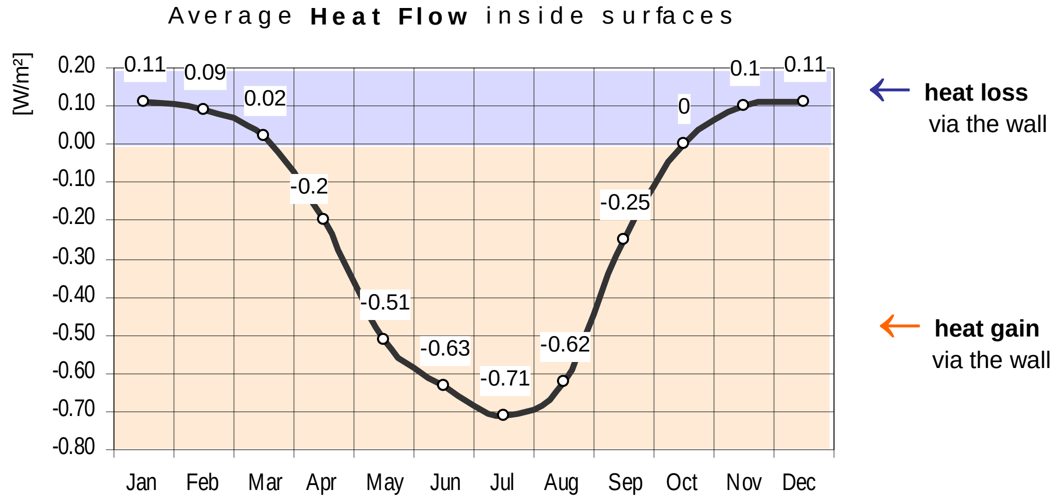
Heat flow in building parts

Via simulated temperatures indoors and on indoor surfaces the heat loss and gain on building structures can be determined in the form of a heat flow.
[Compared with a transient simulation, dynamic interactions between rooms via the inside walls become clearly visible here.]

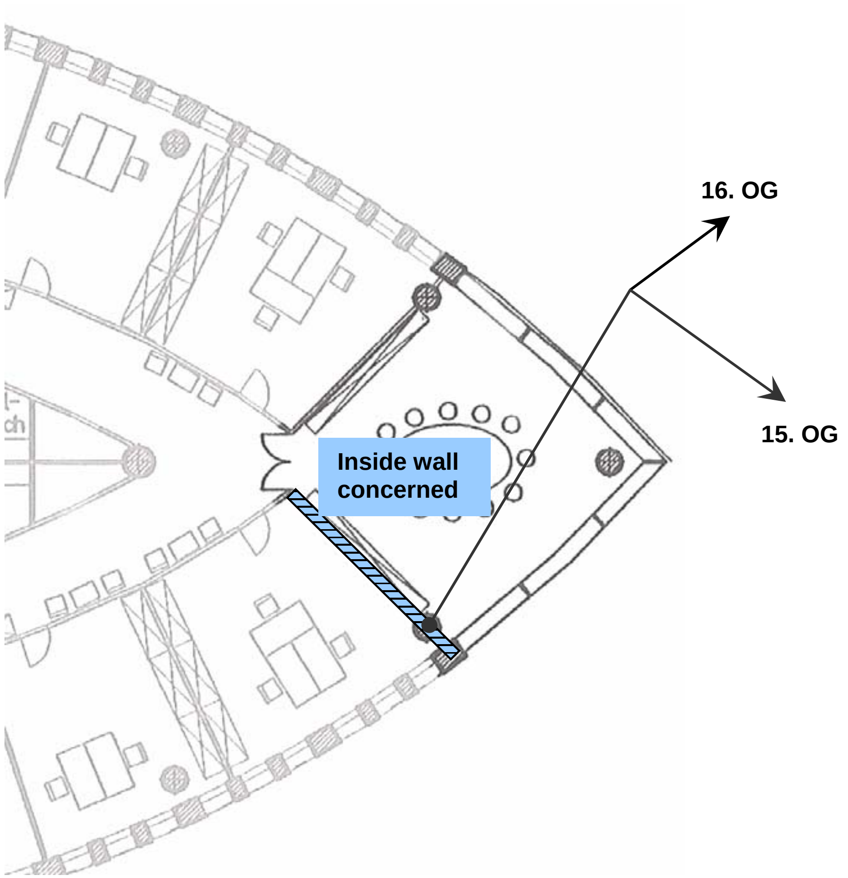


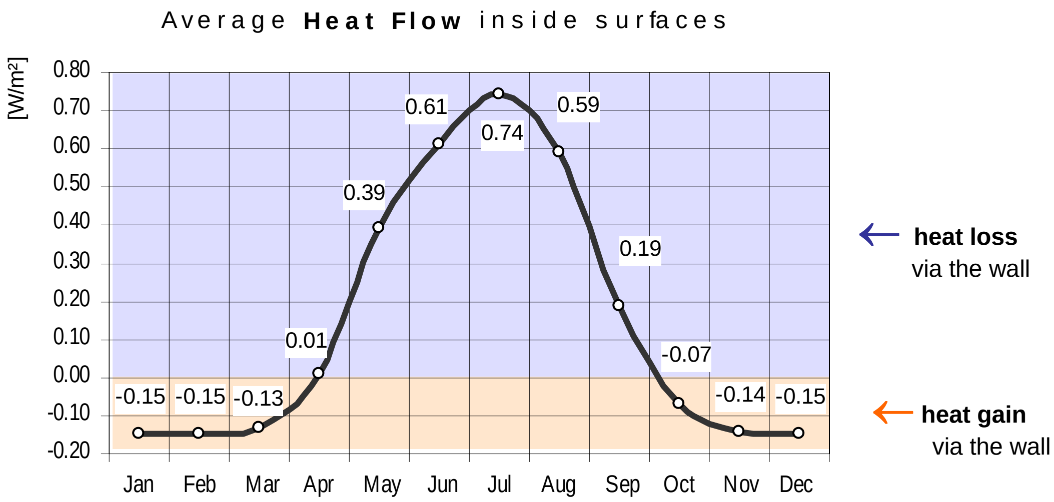
Dynamic development of <u>heat flow</u> on the inside surfaces (average monthly values)

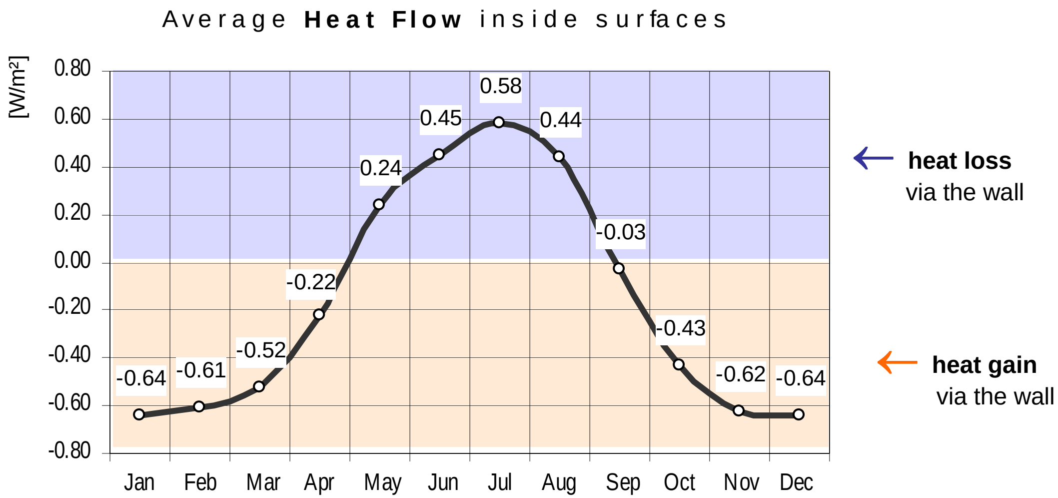




Compared with the inside wall observed above, a seasonal reversal of the heat flow direction can clearly be seen.
As opposed to the inside walls on the South-Eastern side, the inside walls on the South-Western sides transfer heat to the neighbouring rooms.

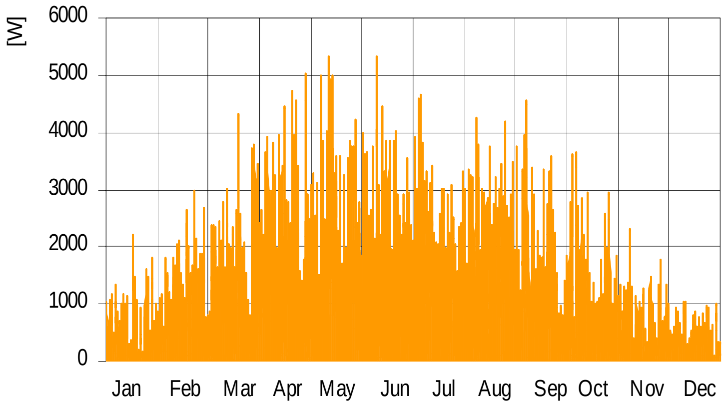




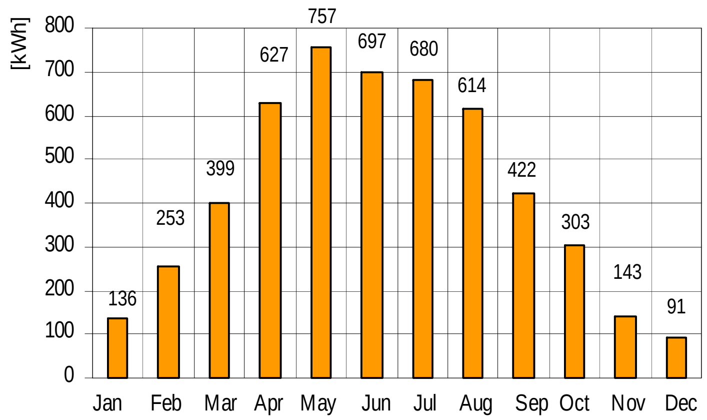


H e a t   a s s e s s m e n t   *Room 15th floor*

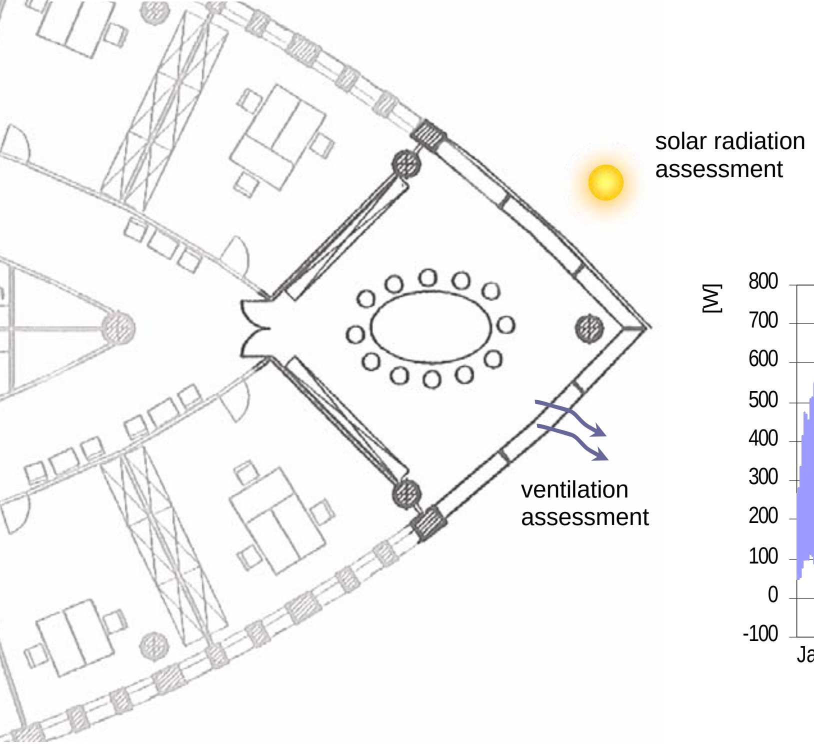
Solar radiation - gain *(hourly values)*



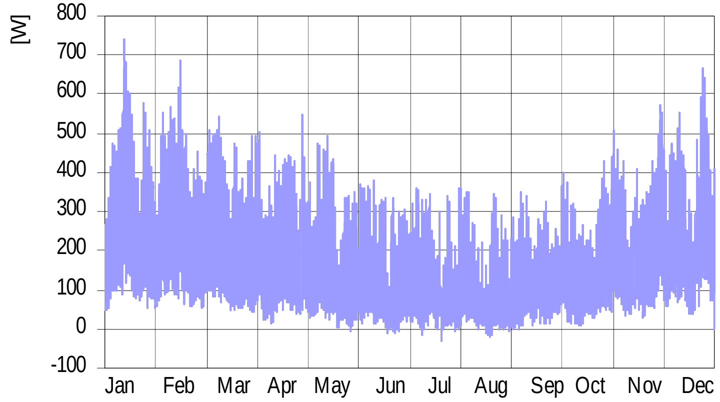
Solar heat - gain *(monthly values)*



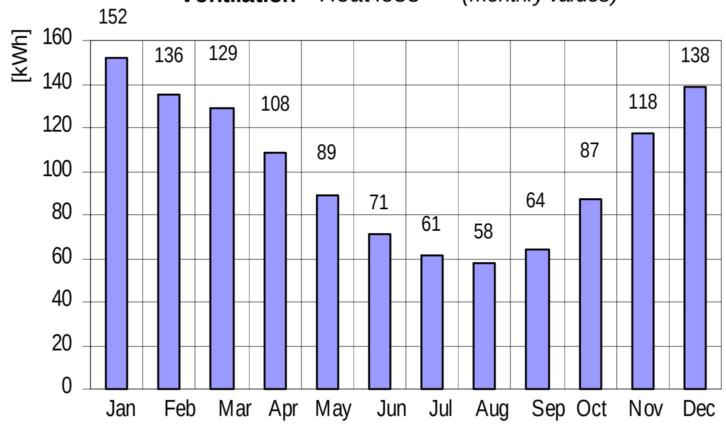
The overall view of heating energy in a room includes all thermic and energy-related individual influences (heat flow density, ventilation flow, solar source, indoor heat sources) which all dynamically interact with each other all the time.
To determine a comprehensive <u>monthly/annual overall view of heating energy</u>, all these factors are combined during the course of the observations periods.



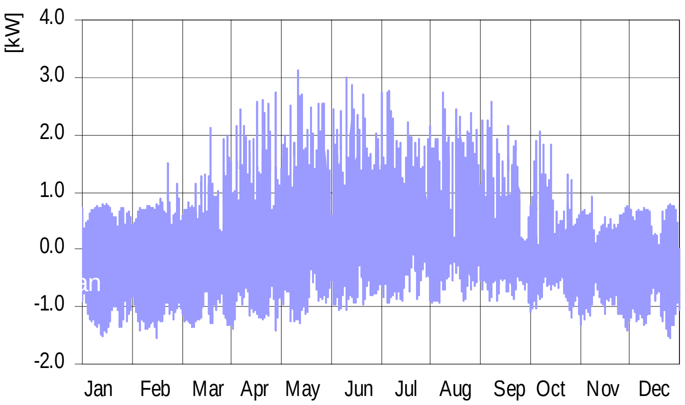
Ventilation performance loss *(hourly values)*



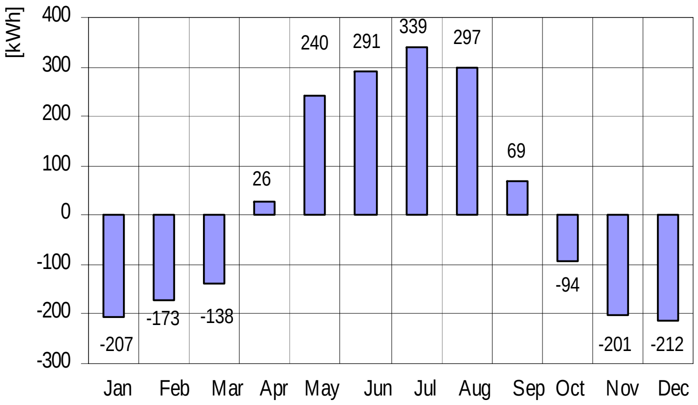
Ventilation Heat loss *(monthly values)*



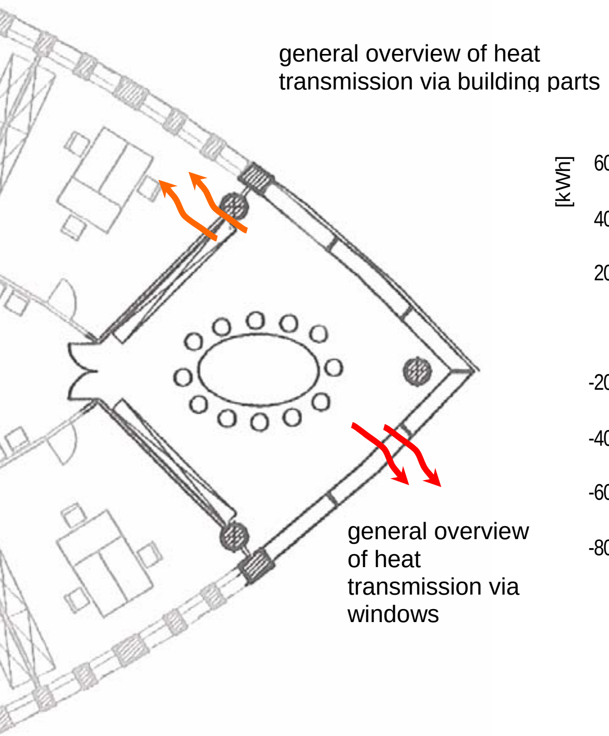
Transmission flow loss *(hourly values)*



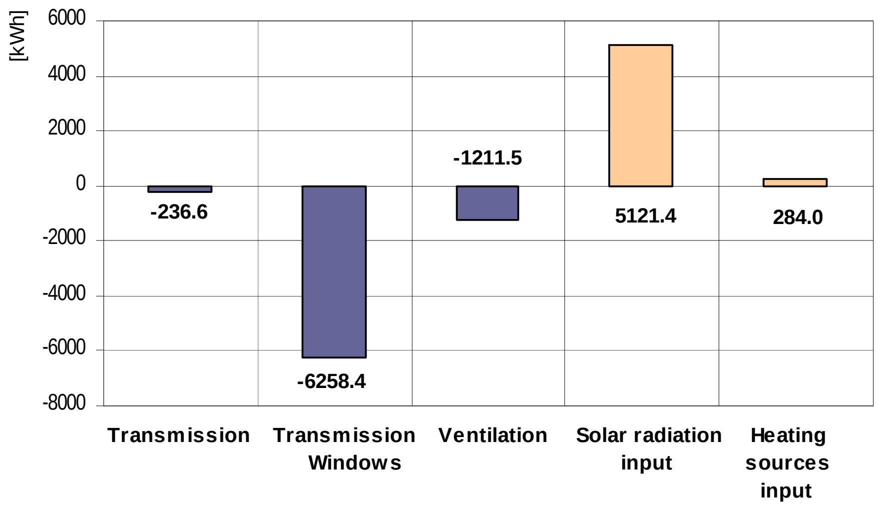
Heat transmission flow loss *(monthly values)*



In view of the heat transmission via all enclosing room surfaces *(walls, ceilings, windows, etc.)* a general overview of heat transmission individual rooms can be determined.

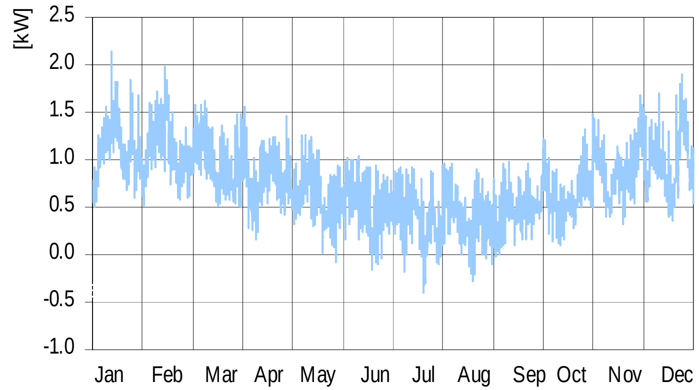


A n n u a l   H e a t i n g   o v e r v i e w   [kWh]

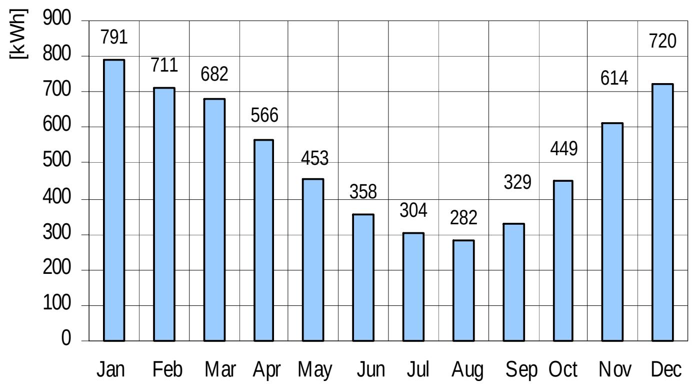


annual heating requirement :   2301,2   kWh

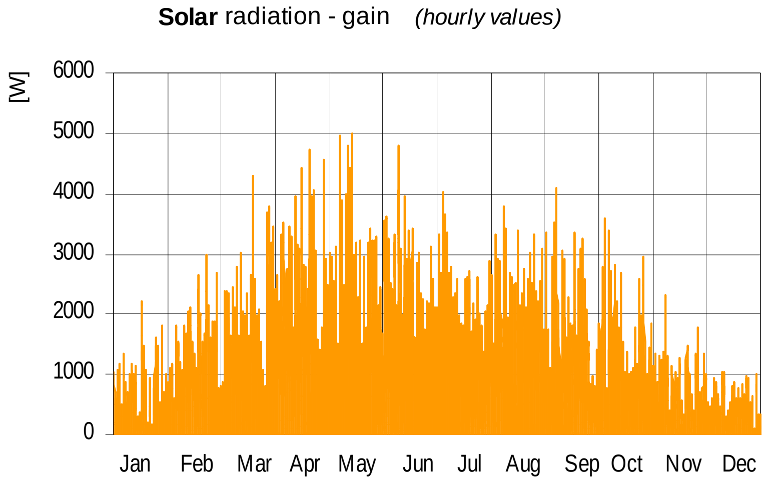
Transmission flow loss **Windows** *(hourly values)*

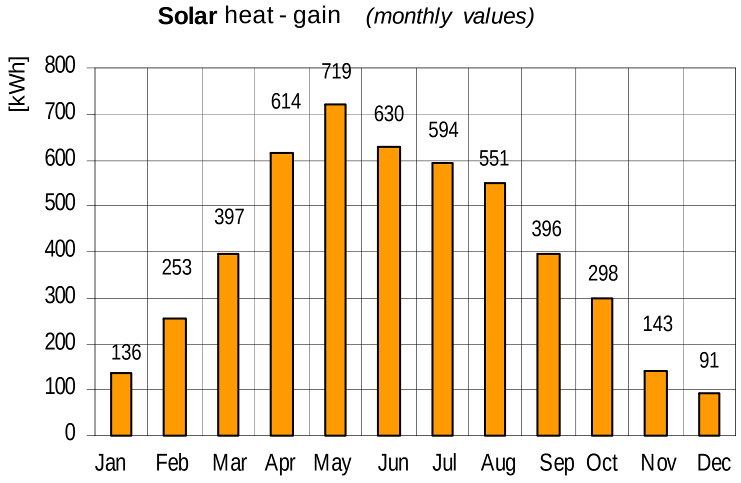


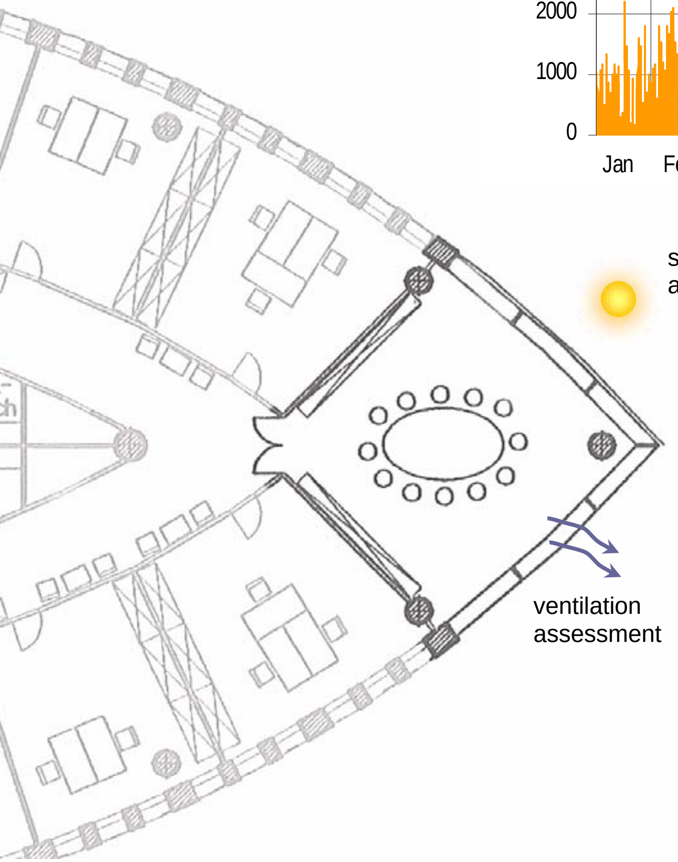
Heat transmission flow loss **Windows** *(monthly values)*

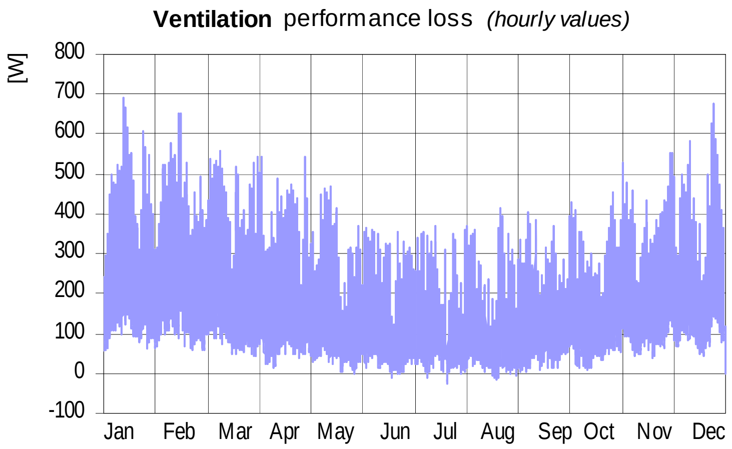


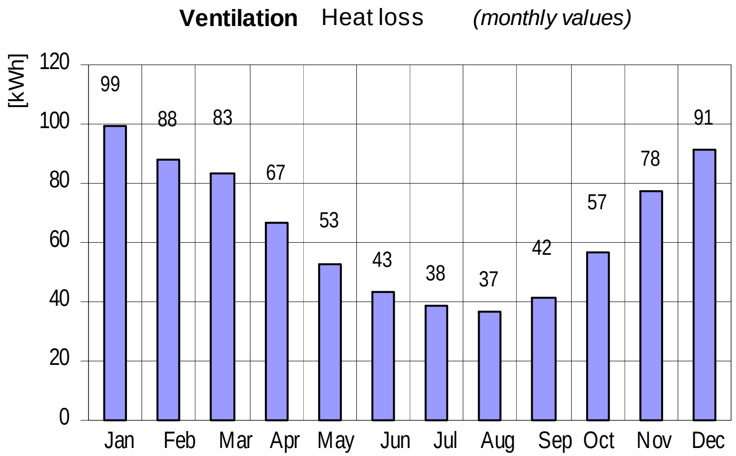
Heat assessment *Room 16th floor*

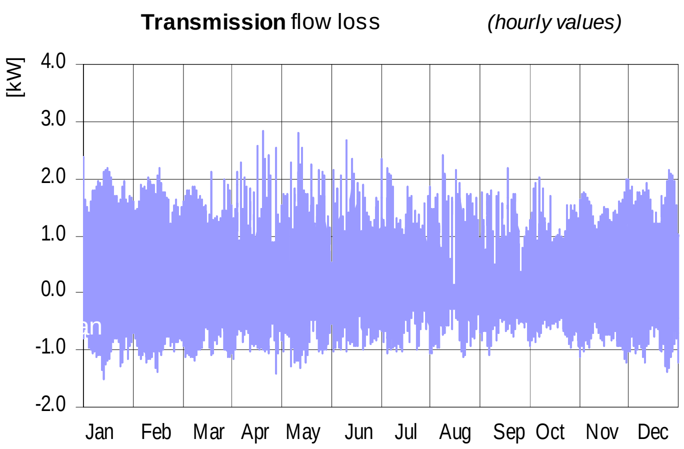


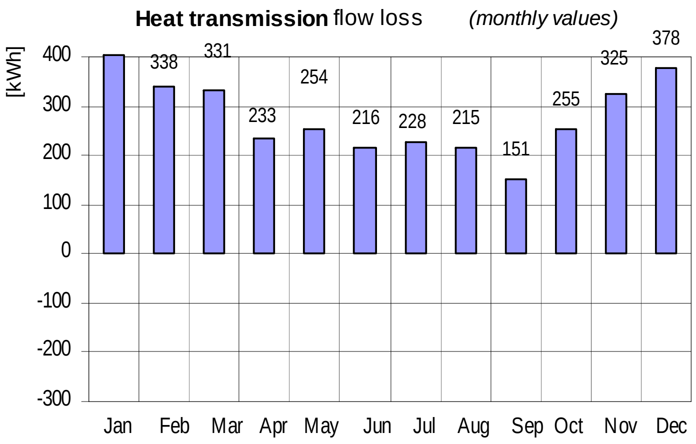




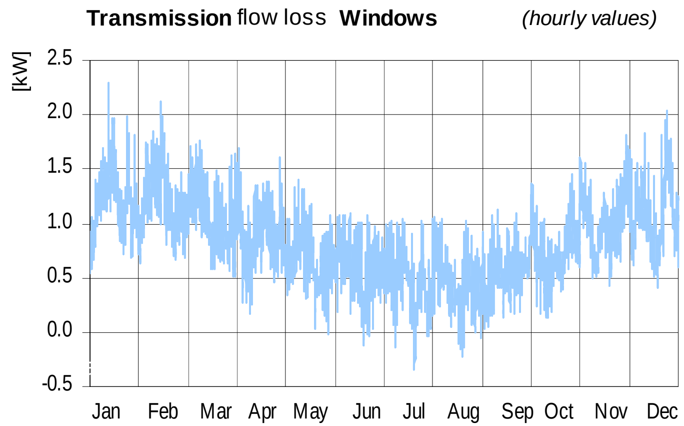


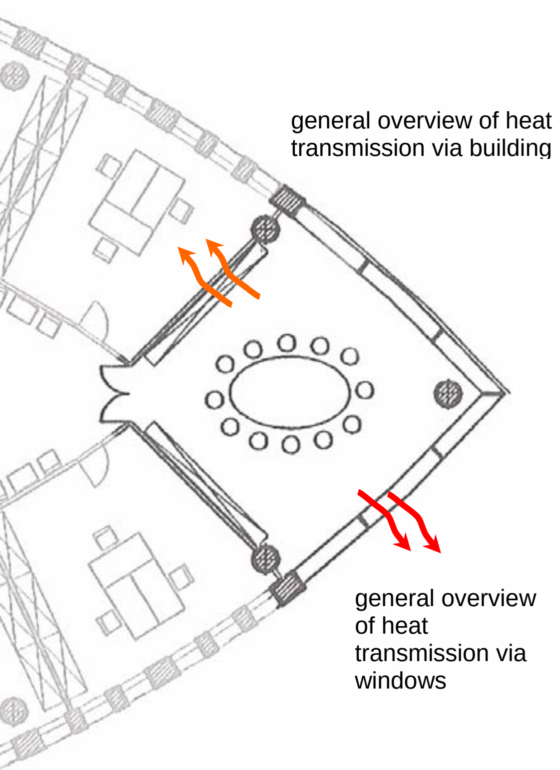


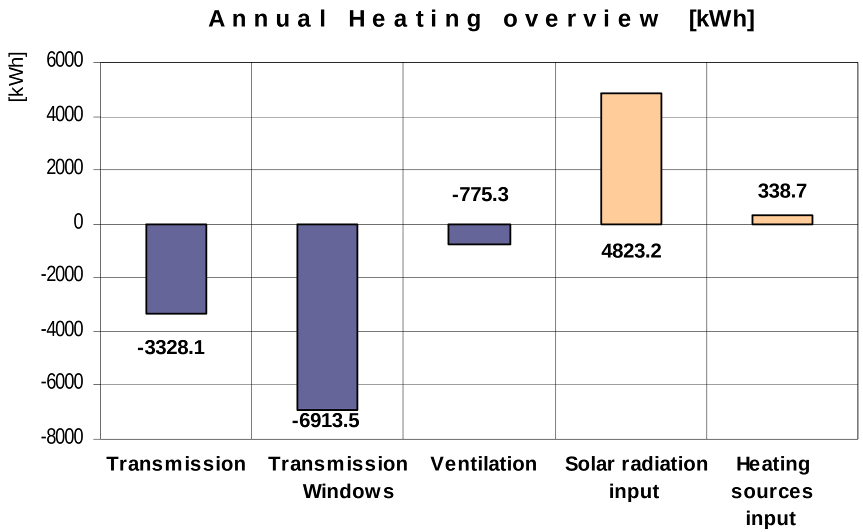




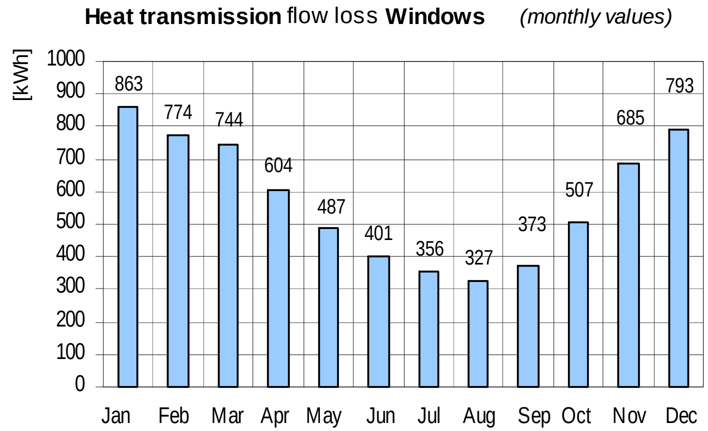
As opposed to the room on the 15th floor, the room on the 16th floor does not obtain any average heat transmission gain from neighbouring walls and ceilings during the Winter months, due to the fact that it gives off more to the outside air, being the top floor.







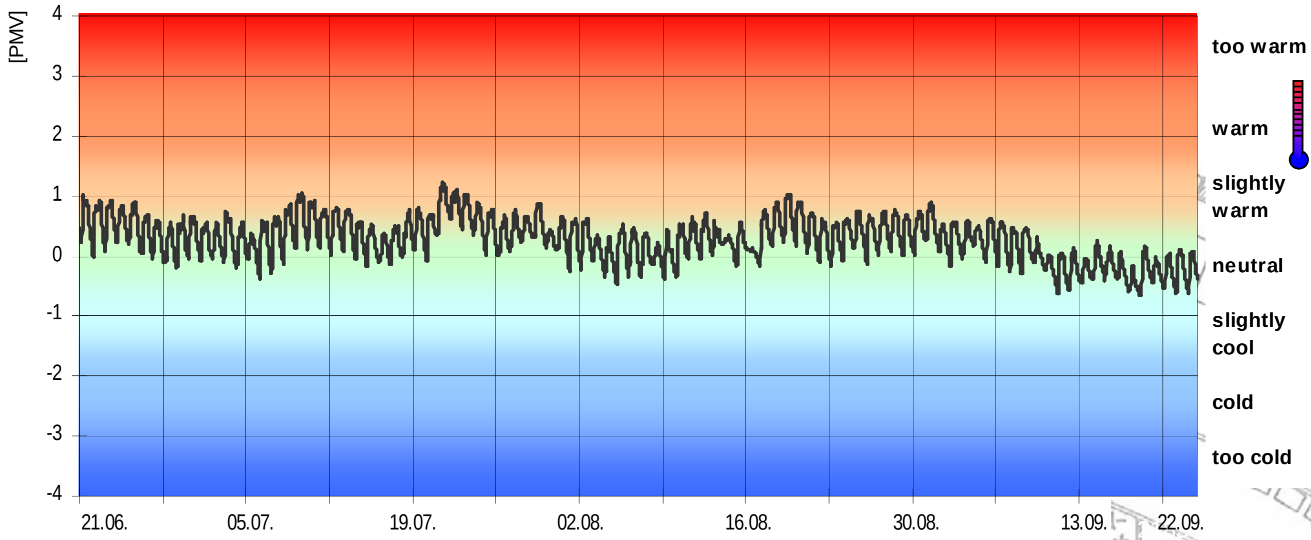
annual heating requirement : 5855,0 kWh



Thermal Comfort *Room **15th floor*** *Summer*

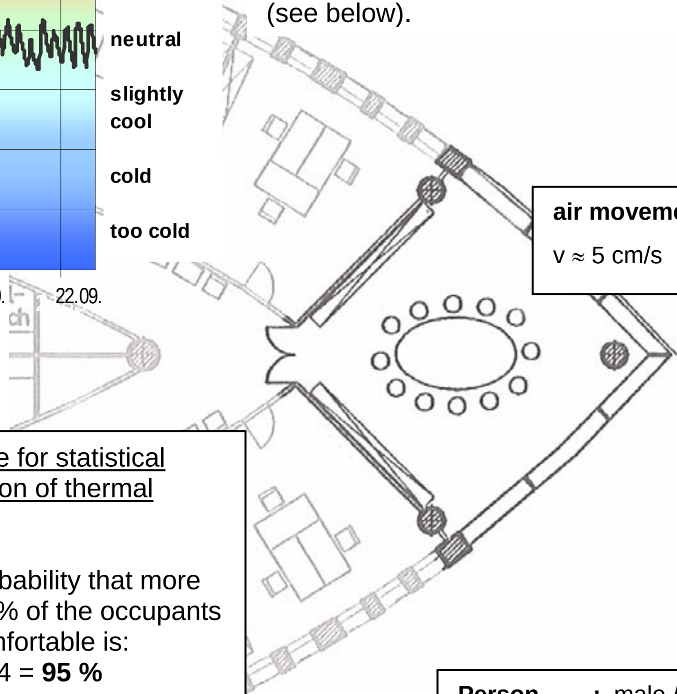
Comfort

Predicted Mean Vote (Sommer 21.06. - 22.09.)



Thermal comfort of people occupying rooms depends on numerous physical and physiological factors and can be felt differently by each individual. Therefore, only average data evaluation can be done for an ideally large group of persons.
As a rule the recommended data for indoor climate conditions is the one which provides thermal comfort to 80 – 85% of the occupants.

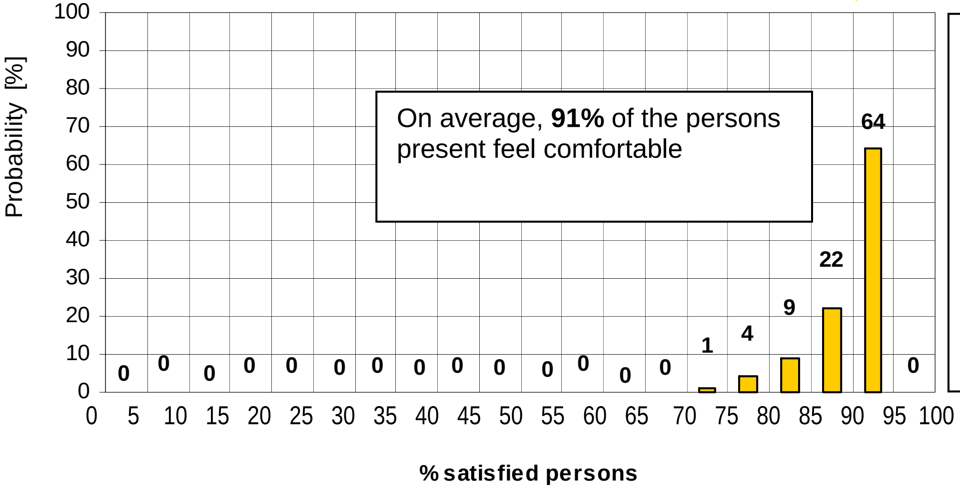
Taken into consideration are work clothes, seasonally appropriate clothing as well as local working conditions (see below).



air movement :

v ≈ 5 cm/s

Thermal Comfort



Example for statistical evaluation of thermal comfort

The probability that more than 80% of the occupants feel comfortable is:
9+22+64 = **95 %**

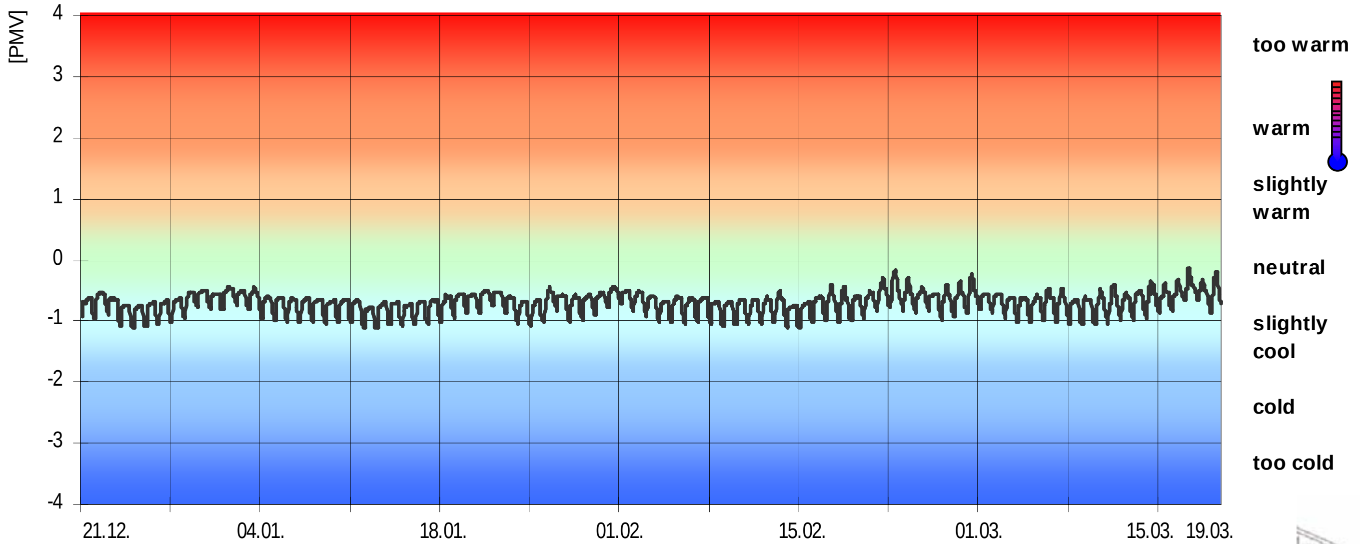
On a statistical average 91% feel comfortable.

Person	:	male / 40 years / 85kg / 1,80m
Clothing	:	light Summer clothing (0,5 clo)
Activity	:	Meeting (total output approx. 95W)

Thermal Comfort *Room **15th floor*** ***Winter***

Comfort

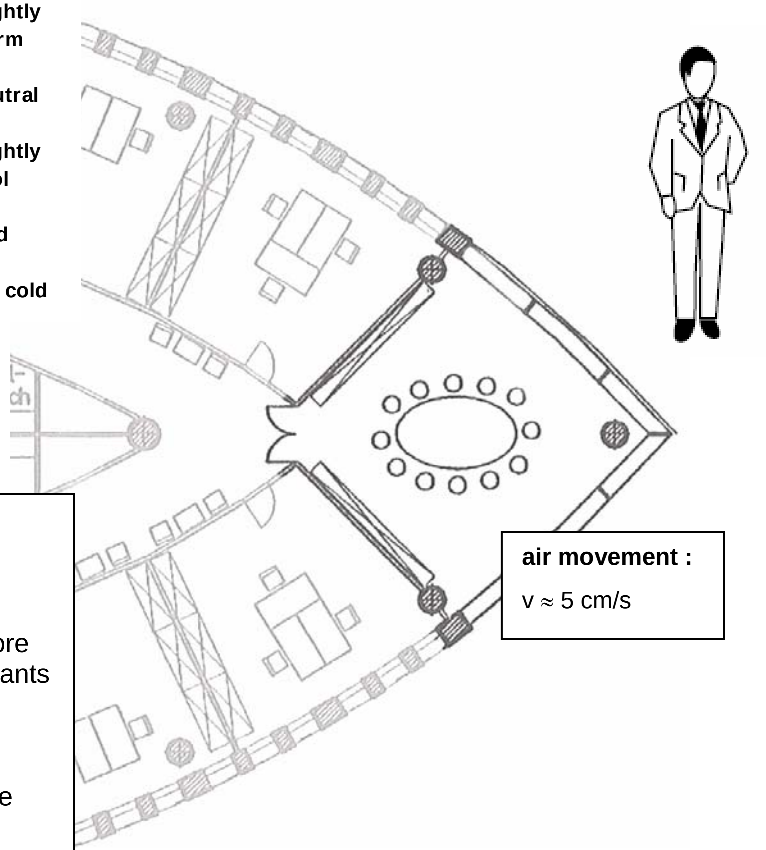
Predicted Mean Vote (Winter 21.12. - 19.03.)



Person : male / 40 years / 85kg / 1,80m

Clothing : Normal office clothing (0,7 clo)

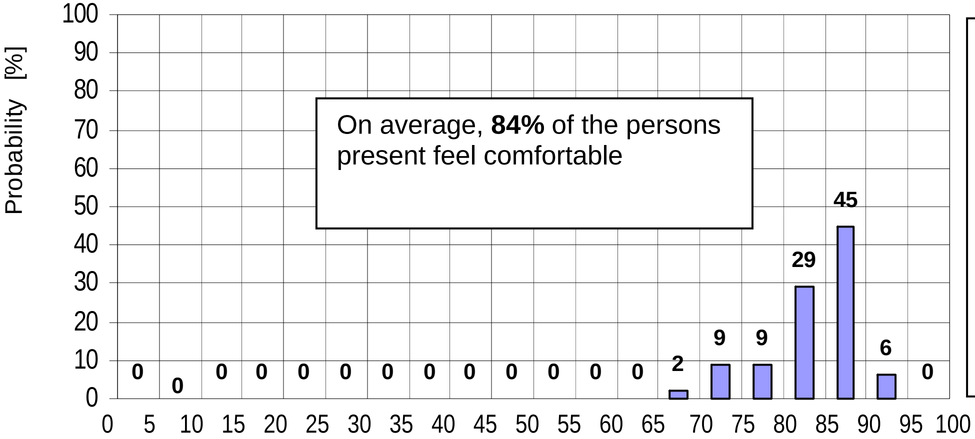
Activity : Meeting (total output approx. 95W)



air movement :

v ≈ 5 cm/s

Thermal Comfort



% satisfied persons

<u>Example for statistical evaluation of thermal comfort</u>

The probability that more than 80% of the occupants feel comfortable is:
29+45+6 = **80 %**

On a statistical average 84% feel comfortable.

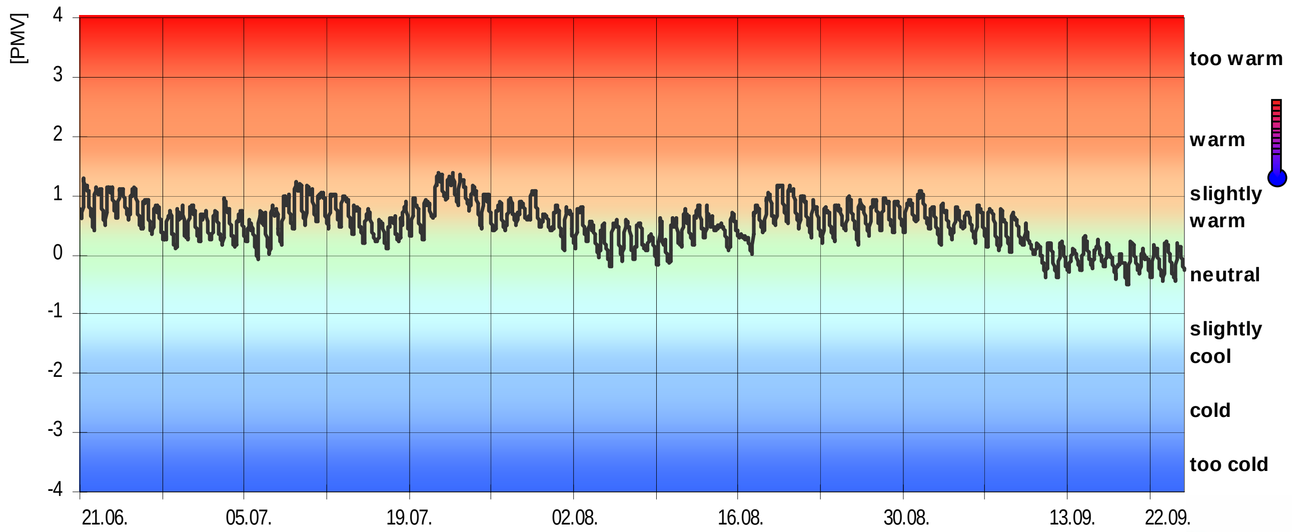
C o m f o r t   *Room **16th floor** **Summer***

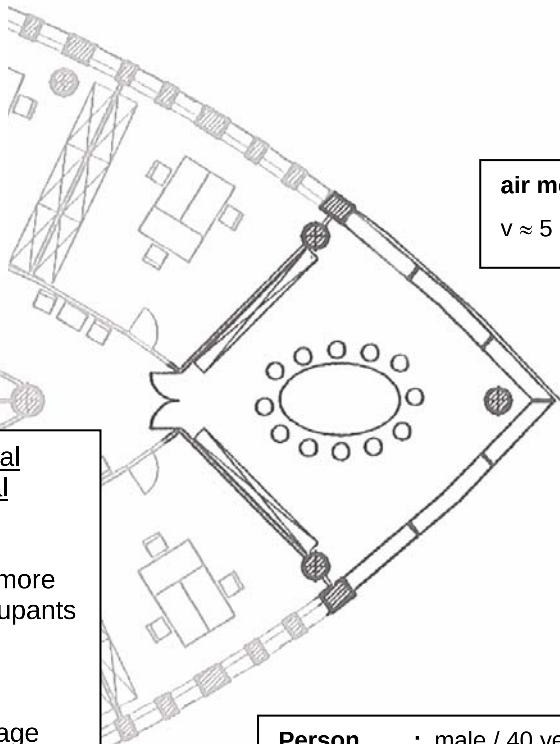
As opposed to the room on the 15th floor, the room on the 16th floor is more likely to provide less thermal comfort during the summer months due to the greater danger of overheating.

The probability that more than 80% of the occupants feel comfortable here (under the set conditions), lies at only 80% whereas it would be 95% in the room on the 15th floor.

C o m f o r t

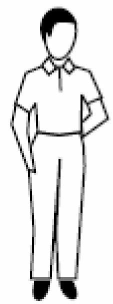
P r e d i c t e d   M e a n   V o t e   (Sommer 21.06. - 22.09.)





air movement :

v ≈ 5 cm/s



T h e r m a l   C o m f o r t

Example for statistical evaluation of thermal comfort

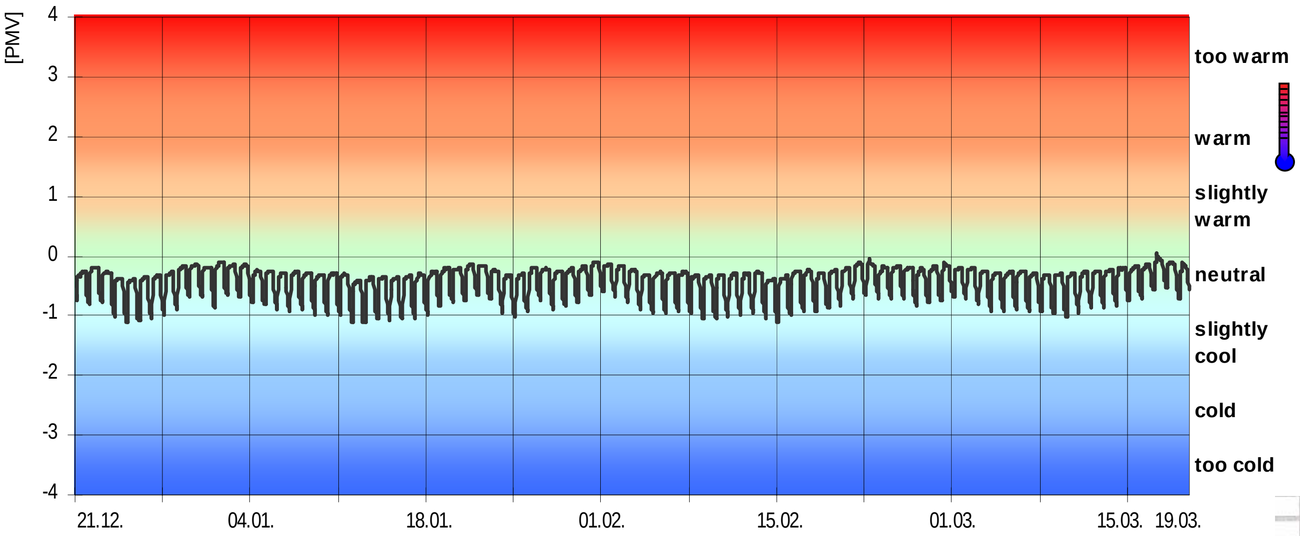
The probability that more than 80% of the occupants feel comfortable is:
17+22+41 = **80 %**

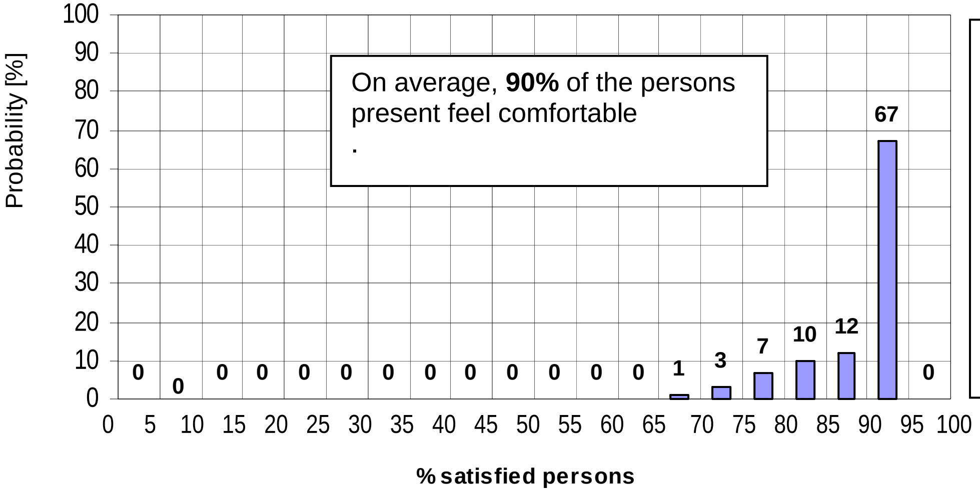
On a statistical average 87% feel comfortable.

Person	:	male / 40 years / 85kg / 1,80m
Clothing	:	light Summer clothing (0,5 clo)
Activity	:	Meeting (total output approx. 95W)

C o m f o r t *Room **16th floor** **Winter***

Person	: male / 40 years / 85kg / 1,80m
Clothing	: Normal office clothing (0,7 clo)
Activity	: Meeting (total output approx. 95W)

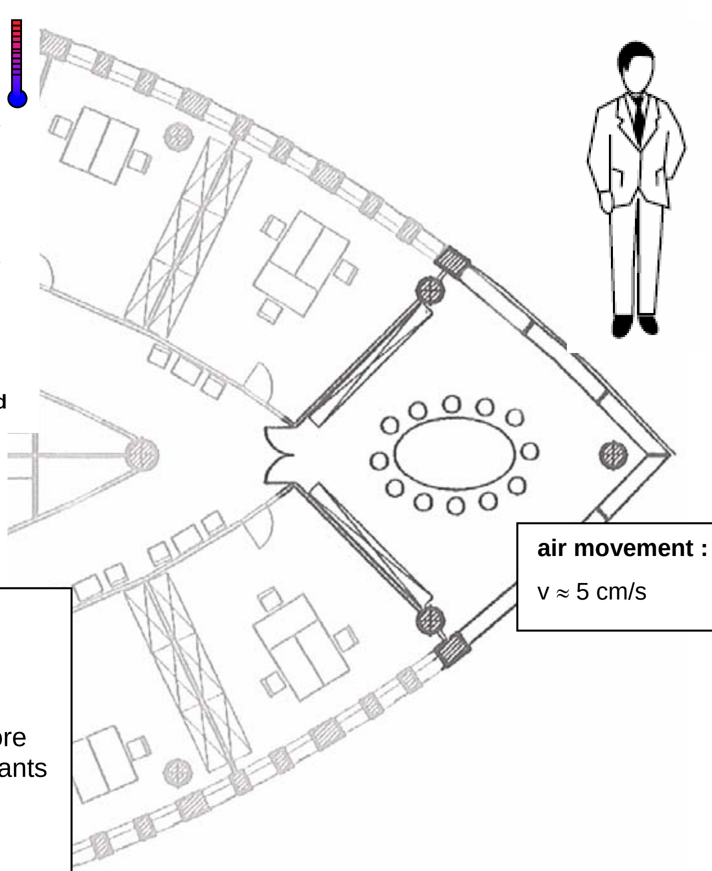




<u>Example for statistical evaluation of thermal comfort</u>

The probability that more than 80% of the occupants feel comfortable is:
10+12+67 = **89 %**

On a statistical average 90% feel comfortable.



air movement :

v ≈ 5 cm/s