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FIRST EXPERIENCES USING CLIMATE SCENARIOS FOR THE NETHERLANDS IN BUILDING PERFORMANCE SIMULATION

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ABSTRACT

In the beginning of 2008 the new Dutch standard NEN 5060:2008 (NEN,2008) was published (status is still 'preliminary'). The standard contains four new weather data files for various applications. The files are intended as replacement for the commonly used defacto standard "De Bilt 1964/1965", which is used as a reference year for building performance simulation in the Netherlands. The Royal Dutch Metrological Institute (KNMI) has defined four possible future scenarios for the expected climate change. The weather data files according to NEN 5060:2008 and the KNMI-future scenario's are combined into future weather data files for the use with building performance simulation program VA114 (Vabi, 2008). A study of an office building with a "top-cooling" concept shows the first experiences with the use of this weather data to determine the future building performances regarding energy consumption and indoor thermal comfort.

It was found the future data sets can well be used for a robustness assessment of integrated building concepts. Over 30 years for the most extreme scenario a 70 % higher peak cooling load is needed to reach a similar comfort level as in the original situation.

INTRODUCTION

Building performance simulation (BPS) programs make use of hourly weather data sets for the prediction of e.g. energy consumption, overheating hours, heating and cooling capacity. These weather files are typically based on recorded historical data. When designing building systems, practitioners expect HVAC components to function successfully for up to 30 years. There is a risk that HVAC systems will fail to meet their performance requirements before the end of their expected lifetime, when the operational conditions are different from the design conditions. A building system's robustness describes the ability to maintain performance requirements under conditions deviating from the design conditions. It is questionable whether historical data sets are suitable to assess a building system's robustness to climate variations over the life time of the installed systems.

Until now, the recorded data of the Dutch weather station 'De Bilt' from the period April 1964 – March 1965 have been used as a reference climate file for performance simulation. At the beginning of 2008 the new Dutch standard NEN 5060:2008 was published. NEN5060:2008 provides four data sets based on more recent weather data, one to be used for energy calculations and three data sets for overheating risk assessment. In a cooperative effort of the Eindhoven University of Technology (TU/e) and Vabi Software BV the data sets were combined with climate change scenarios for The Netherlands published by the Royal Dutch Meteorological Institute (KNMI). The results of the work are weather data sets containing one year of hourly values that represent the projected future climate. Here the periods 'over 15 and over 30 years', representing the life time of HVAC components, are considered. The data sets are available for all four NEN reference data sets, for all four KNMI climate change scenarios and for the periods 'over 15 and over 30 years'.

In order to assess the usefulness of the datasets for design practitioners a design concept critical to climate change, called "top-cooling" in the Netherlands, was used and simulated with all data sets available. Top-cooling is a system in which the supply air is centrally cooled and then distributed over the floors and rooms. The temperature difference between the outside air and the inlet air is never more than 10 degrees. The cooling energy is almost entirely used to cool the air and not for dehumidification and so the required cooling capacity is limited. In a first step the model performance based on the traditionally used data set 'De Bilt 64/65' was compared to the four new NEN data sets. In a second step the performance comparison was extended to the data sets representing future climate projections..

METHODOLOGY

The climate weather data sets for the future are established in collaboration between the Technical University of Eindhoven and Vabi Software BV. The data is used in a case study regarding an intermediate floor of an office building consisting of 8 zones and a central core (see figure 2). The zones are conditioned by means of top-cooling with air supply. It is expected that this concept is not robust regarding climate changes. The performance of this concept is evaluated by means of building simulation. The building simulation program VA114 is used.

Four KNMI climate scenarios and four NEN-weather data sets are considered in three time frames: current (the original NEN 5060-data sets), 15 years and 30 years from now. The weather data set with historical data of the location "De Bilt" in the Netherlands from the years 1964/1965 is used as a common reference. The reference year will be referenced as 'De Bilt64/65'. In total 37 simulations have been done. In this study only the summer (cooling season) has been simulated, because this seams the most critical period for the performance of the chosen system concept. The period from April t/m October is taken, according to the definition of the cooling season in the standard NEN 5060:2008. The following performance indicators are studied: the total energy consumption for cooling, the maximum cooling load for the entire floor and the overheating risk assessment per zone (number of overheating hours above 25 ºC (TO) and weighted overheating hours (GTO)). The heating demand during the summer is negligible for this specific case.

Because of the 'preliminary'-status and the recent publication date of the standard NEN 5060:2008 there are hardly any experiences available in the use of the new weather data sets. That is why the choice has been made to compare the old reference year 'De Bilt 64/65' and the new NEN 5060:2008 weather data sets first. Afterwards the combination of NEN 5060:2008 and the climate scenarios are used for the calculations and compared with the first results.

WHEATHER DATA FILES FOR BUILDING PERFORMANCE SIMULATION IN THE NETHERLANDS

Up until now 'De Bilt 64/65' is used for overheating risk assessment in the Netherlands. This year is regarded as a year with an 'average' summer (ISSO,2004). Earlier it was shown that this reference year doesn't represent the trend of climate change (Weele 2008,H.M. van Schijndel et al,2006). For energy purposes a Test Reference Year (TRY) based on the period 1971-1980 was available for energy calculations (also the basis for the Dutch Energy Performance Standard). For the implementation of the EPBD there was a need for reliable reference years. NEN-EN-ISO 15927 describes a method to come to a representative year (ISO,2004). Part 4 of this series describes a method to aggregate a reference year from a measured data set containing at least an unbroken period of 10 years. A reference year aggregated on base of this method can only be used for the calculation of the yearly energy consumption for heating and cooling..

NEN 5060:2008

At the beginning of 2008 NEN 5060:2008 was released. With this new standard the reference weather data sets, which were used for energy calculations and overheating risk assessment, are actualized. The standard uses statistical procedures from NEN-EN-ISO 15927. The method in part 4 of this international series of standards has been used to aggregate a reference year for energy consumption calculations. In NEN-EN-ISO 15927 a method to generate reference years for overheating risk assessment is lacking. This is why in the new standard NEN 5060:2008 a new procedure based on NEN-EN-ISO 15927-2 en NEN-EN-ISO 15927-5 is proposed.

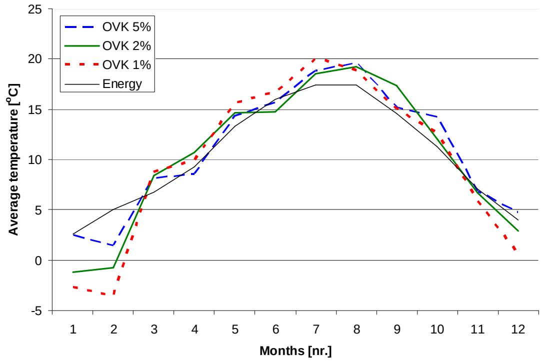

Fig. 1: Comparison of monthly average temperatures for the four climate files of NEN 5060:2008

NEN 5060:2008 describes a statistical analysis of 20 years of historical weather data (1986-2005) of the weather station De Bilt. A statistical analysis is used in order to select 12 months, which together form the reference year. A distinction is made into four types of reference years. The first year represents an average year and is meant for the calculation of a yearly energy demand and the energy performance coefficient. The method is based on part 4 of NEN-EN-ISO 15927. The remaining three reference years contain more extremes and are intended for the assessment of thermal comfort/overheating risk. Like in NEN-EN-ISO 15927-2 and NEN-EN-ISO 15927-5 a frequency distribution of '5-day-average' temperatures is drawn up. Based upon this distribution months are selected with a probability of 5%, 2% resp. 1% for the occurrence of an actual warmer summer. The selected months are joined together to form a reference year. The reference years will be revised every 5 year and updated when necessary. In figure 1 the monthly average temperatures for the four reference years are given as an illustration.

KNMI Climate change scenarios

The Intergovernmental Panel on Climate Change (IPCC) formulates climate scenarios for the world wide climate change, based on emission scenarios.

These are assumptions regarding the emission of greenhouse gasses, which are based on the development of population, economy, technology and so on. The climate scenarios of the IPCC give information on global warming and sea level rise. The global scenarios, based on Global Circulation Models (GCM), are made more specific with the aid of Regional Circulation Models (RCM) in order to predict the effects of climate change for a smaller area, like The Netherlands. The climate change in the Netherlands is highly dependent on the global rise of temperature and the change of airflow patterns over Western Europe. That is why the division of the scenarios is based on these two aspects (KNMI,2008).

A distinction is made in a global temperature rise of 1°C or 2°C in the period of 1990 till 2050. The moderate scenario (G) corresponds with 1°C rise and the warm scenario (W) with 2°C rise. Both scenarios are combined with a scenario with and without a change in the airflow pattern over Western Europe. A change in airflow pattern means more westerly winds during winter and more easterly winds during summer. The winters will become softer and the summers warmer and dryer. Change of airflow patterns is indicated with a '+' sign (G+ and W+). With the current knowledge it is impossible to indicate which of the four scenarios is most likely. All four they are plausible and therefore they are regarded of equal importance for the simulations (KNMI2,2008).

In order to get an impression of what these climate scenarios mean for the change in temperature and precipitation, the KNMI website gives the possibility to transform KNMI time series of temperature and precipitation to projections on the future. Normally the website use the weather data from 1976-2005 (30 years), but it is also possible to upload your own data. For the scenario of your choice the daily average and precipitation are generated, together they make up the future climate. The generated time series are projections and can not be seen as forecasts for a specific moment in the future.

Future weather data files for Building Performance Simulation

The transformed data available on the website of the Dutch Meteorological Institute have a format of 30 years of daily average temperatures. Building simulation programs, like VA114, need hourly values. Normally only one year is calculated instead of 30 because of data processing and calculation time. In order to reach this goal a combination of the reference weather data sets form NEN 5060:2008 and the transformed time series has been made. Only the temperature change has been taken into account. The other parameters are unchanged. The global solar radiation, the second most important parameter for comfort- and energy calculations (Haarhof et al 2006, Hong 1995) remains unchanged. It is assumed that the cloud coverage, the most important factor on the global solar radiation remains unchanged (KNMI2,2008). The Netherlands is situated in the transition area between Northern Europe, where the cloud coverage increases, and Southern Europe, where the cloud coverage decreases.

NEN 5060:2008 is based on the period 1986-2005. Usually the KNMI use the time series from 1976-2005, the period of the KNMI comprise the period of the NEN standard. Transformations were made for the four climate scenarios. The result contains the daily average temperatures. For the selected months of NEN 5060:2008 the raise in temperature is taken into account per individual day. The values are added to each hourly temperature. The same has been done for a period of 15 years ahead. The result are 36 different weather data sets: the four original NEN 5060:2008 data sets, plus for each of these original data sets four climate scenarios times two time schedules (15 and 30 years). These new data sets are named 'future climate data'.

CASE STUDY

A case study is used in order to get a first impression of the effects of the "future climate data'.

Description case office floor.

The case in question is based on the office building 'La tour' in Apeldoorn. The building consists of a flexible office floor with a central core (see figure 2). The building is conditioned with a top-cooling concept. Air is conditioned centrally and distributed over the floors and rooms. The top-cooling capacity is only used to lower the air supply temperature and not to control the air humidity. According to general expectations this widely used concept is very critical towards climate changes. For the calculations an intermediate floor is used.

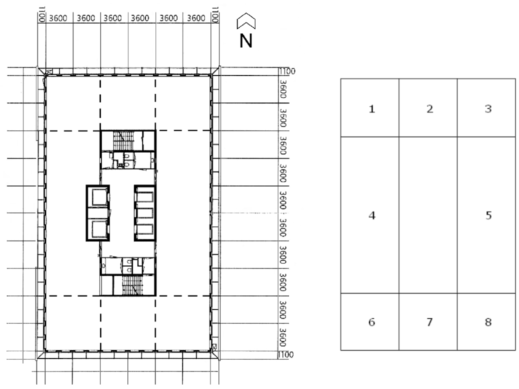

Fig. 2: Floor plan of the model (height: 3.4 m) and numbering of the rooms

The space around the core is divided in corner rooms and façade rooms. Hallways and passage doors are neglected in order to keep the model as simple as possible.

The core is enclosed with a concrete wall of 200 mm. The corner and facade rooms are separated by light system walls. The façade has a glazing percentage of 27%, with an overall solar transmittance of 0.30 (g-value). The East, South and West façades are equipped with overhangs. During office hours the offices are maintained on 20°C and the core on 18°C.

RESULTS

Because of the recent publication date and the preliminary status of the new NEN standard at the moment there are no publications about experiences with the reference climate data sets of NEN 5060:2008 or with future projections. In order to be able to judge the results, the commonly used old climate data set has been used as a reference for comparison with the four new reference sets of NEN 5060:2008. The results are then used for the analysis of the results for the projected future climate data sets.

In the standard it is indicated that the energy data set is meant for energy calculations, like yearly energy demand and Energy Performance Coefficient (EPC). The 5%, 2% and 1%-data sets are meant for simulation calculations like overheating risk assessment. As performance indicators, total energy demand for cooling and maximum cooling load are used. Further the overheating hours (TO) and weighted overheating hours (GTO) are used as a performance indicator for the 5%, 2% and 1%-climate data sets.

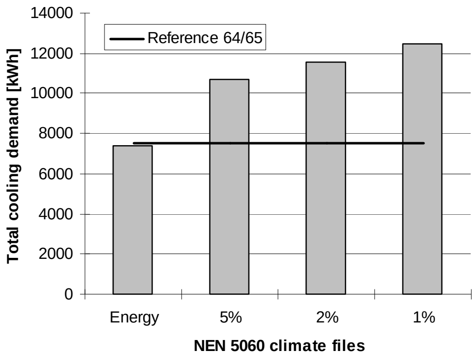

Fig. 3: Total energy demand for cooling, original NEN 5060:2008-files, whole storey

Results – NEN 5060:2008 files

In figure 3 and 4 the results are given for the energy demand and the maximum load for cooling of the entire floor. The climate data sets of NEN 5060:2008 are in the expected sequence from mild to more extreme. The total cooling demand is in correspondence with the old reference data set 'De Bilt 64/65', (see figure 3).

The deviation is less than 2%. The 5%, 2% and 1%-data sets show 42%, 53% en 66% higher energy demand with respect to the reference year 64/65.

For the maximum cooling load the results of 'De Bilt 64/65' coincide with the 2%-data set of NEN 5060:2008 (see figure 4).

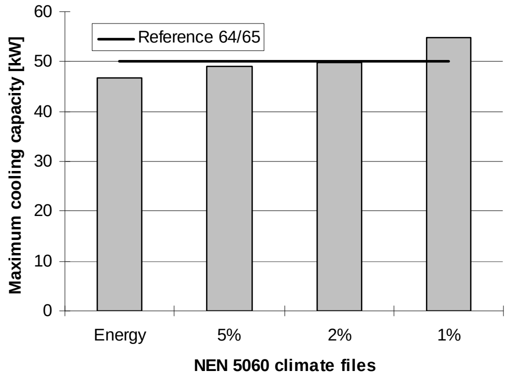

Fig. 4: Maximum cooling load, original NEN 5060:2008 -files, whole storey

The results for the 1%-data set are 9% higher, the results for the 5%-data set and the energy data set are 2% and 7% lower.. The deviations for the maximum cooling load are less than for the total cooling demand.

As performance indicators for comfort the overheating hours above 25°C (TO) and the weighted overheating hours above PMV =+0.5 (GTO) are presented. They are determined for every room separately. For both comfort-indicators the corner room show considerably higher values than the facade rooms. It also shows that East facing rooms give a higher overheating risk than West facing rooms; this is due to the fact the office hours (8.00 – 17.00 h) are not symmetrical with the solar insolation (sun summit is at about 13.40 h – daylight saving time).

For further analyses rooms 5 and 8 are used as a representative example (see figure 5 and 6). The results for 'De Bilt 64/65' are not given; there is no

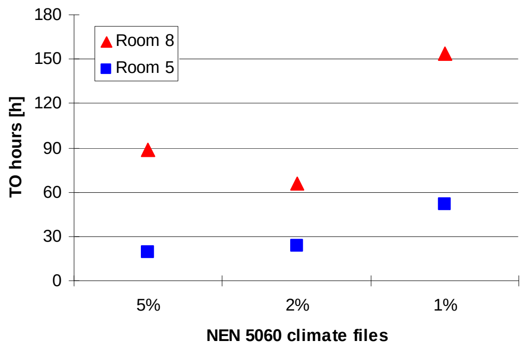

Fig. 5: Exceeding hours of 25°C (TO), original NEN 5060:2008 -files, rooms 5 and 8

overheating risk for these rooms. Room 8 is a corner room and room 5 is a façade room (see figure 1).

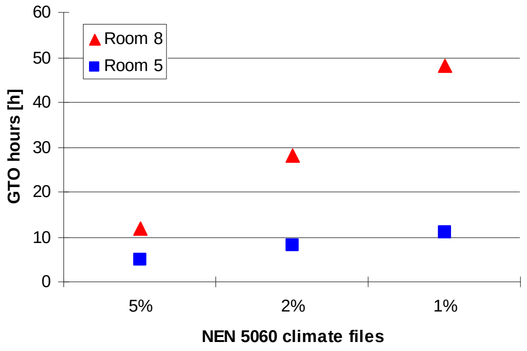

Fig. 6: Weighted exceeding hours (GTO), original NEN 5060:2008 -files, rooms 5 and 8

According to NEN 5060:2008 the energy data set is the most average followed by the 5%- and 2%-climate data set. The 1%-data set is the most extreme. However the results do not correspond with this for every room. The overheating hours (TO) in room 8 are for the 2%-data set lower than for the 5%-data set; the 1%-climate data set shows the highest overheating risk. For room 5 the mutual differences are less distinct than for room 8. The overheating risk for 1%-data set is higher than for 2% and for 2%-data set is higher than for 5%. This effect for room 8 is partly caused by the fact the NEN 5060:2008 reference years are selected on ambient temperature as the primary selection indicator. The highest ambient temperatures do not always coincide with the highest solar insulation. So depending on the sensitivity of the system concept (sensitive to temperature or to solar radiation) the differences between the climate data sets will vary.

Discussion – NEN 5060:2008 climate data sets

According to the Dutch standard NEN 5060:2008 the total energy demand has to be determined on basis of an average year. In order to make the result comparable between the different climates data sets, the performance indicator 'cooling demand for the entire floor' has been determined for all four reference climate data sets (also the extreme sets) and for 'De Bilt 64/65'. The difference between the cooling demand calculated with 'De Bilt 64/65' and the average year according to NEN 5060:2008 is only 2% for this case study. NEN 5060:2008 and 'De Bilt 64/65' have both the same rigorousness in the assessment of cooling energy for this floor. The results for the 5%, 2% en 1%-climate data sets are considerably higher resp. 42%, 53% en 66%. This is along the expectations.

The maximal cooling load is an important performance indicator for the sizing of a system. An average year is not adequate for the sizing because then the system will not work properly under more extreme conditions. The results for the maximum cooling load do not differ that much. Compared to the reference data set 'De Bilt 64/65' the other results are within a range of 10% (lower and higher).

A remark has to be made: besides the higher energy demand and maximum cooling load the overheating risk is also higher. So there is a difference in thermal comfort. This is an important point for the assessment of the robustness of a system concept.

The thermal comfort / overheating risk is expressed in overheating hours above 25°C (TO) and weighted overheating hours above PMV = +0.5 (GTO). The values for these indicators are considerably higher for the corner rooms. This is explained by the fact the glazing area related to the floor area for the corner rooms is twice as high as for the façade rooms. The wall in between the central core and the offices acts as a thermal buffer because of the high thermal mass of the concrete. The light walls in between the offices themselves do not have this property.

Figure 7 shows a comparison of the overheating risk for heavy and lightweight constructions where the lightweight inner walls are replaced by heavy weight ones

One would expect the overheating risk for the 1%-data set should be higher than for the 2%-data set. The simulations show that this is not always the case. The selection method applied in NEN 5060:2008 for the 5%-, 2%- and 1%-data sets are based on the frequency distribution of the average ambient temperature over 5 days. The solar radiation plays a minor role in the selection method, but is an important factor for the overheating risk (Especially for rooms with large glazing areas and low thermal mass).

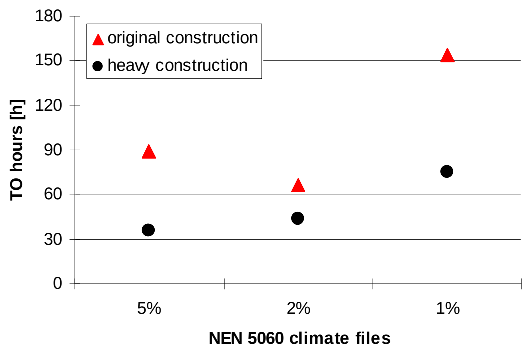

Fig. 7: Exceeding hours of 25°C, original NEN 5060:2008 -files, room 8, comparison heavy and light weight construction

Figure 8 shows the solar heat gain for room 8 for the months with overheating: July and August. The values for the 5%-data set are much higher than the values for 2%- and 1%-data set.

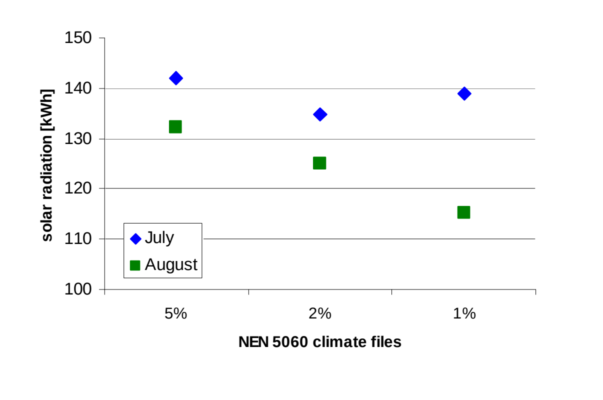

Fig. 8: Heat gains by solar radiation for months July and August, original NEN 5060:2008 -files, room 8

'TO-hours' and 'GTO-hours' can not be compared with each other. 'TO-hours' is the actual number of hours a certain threshold temperature is exceeded (in this case 25 oC). For 'GTO-hours' this threshold is PMV = +0.5. Apart from air temperature the PMV-value also depends upon for instance air speed, clothing and activities of the people, so it can not be expressed by temperature alone. Additionally in 'GTO-hours' a weighting factor is applied based on the PPD. This weighting factor and the different threshold limits explain why this effect (the 5%-data set giving a higher overheating risk) does not occur for 'GTO hours'

Results – future projected climate data sets.

After the simulations with the original NEN 5060:2008 data sets and 'De Bilt 64-65', the simulations with the 32 future climate scenario data sets were performed. The energy demand for cooling for the entire floor calculated with the energy data sets is given in figure 9.

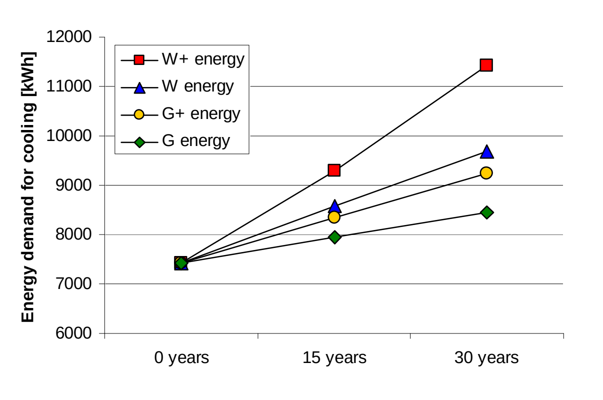

Fig. 9: Total energy demand for cooling, whole storey, future climate

The energy demand shows a trend as can be expected. The values increase when the years (15 or 30 years) and when the climate scenario becomes more extreme. After 30 years the increase for the G, G+, W and W+-scenario are respectively 14%, 25%, 31% and 54% compared to the original actual data set (0 years). The G+ and the W-scenario do not differ much; the W-scenario shows a 5% higher value after 30 years.

The maximum cooling load is determined for the 5%-, 2%- and 1%-data sets. As example the results for the W+-scenario are given in figure 10. The other

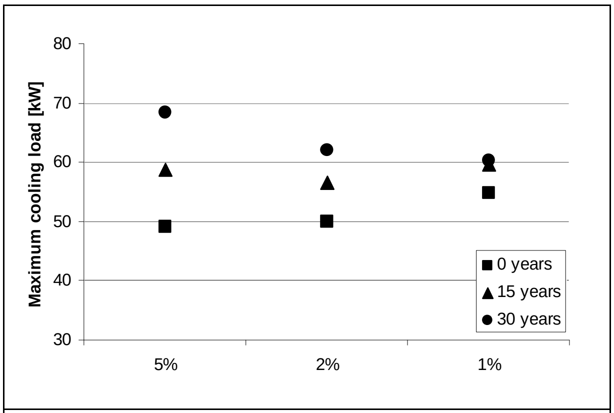

Fig. 10: Maximum cooling load W+-scenario, whole storey, future climate

scenarios show a similar picture, however less extreme. The values for the maximum cooling load become higher if you look further ahead in time. The original NEN 5060:2008 1%-data set shows the highest value. After 30 years the 5%-data set shows the largest rise, followed by the 2%-data set. The 1%-data set has the lowest value.

As with the original NEN 5060:2008 data sets the comfort indicators have been analysed separately. In figures 11 and 12 the results for overheating hours (TO above 25°C) and the weighted overheating hours (GTO) for room 8 are given for the W+-scenario.

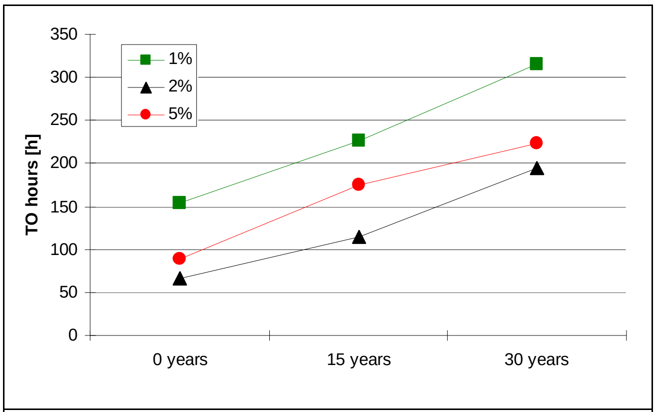

Fig. 11: Exceeding hours of 25°C (TO), room 8, future climate files, W+ scenario

As is the case with the original NEN 5060:2008, the values for the TO-hours of the 5%-data set stay in between the line for the 1%- and 2%-data set. All data sets show a clear rise in time. After 30 years the

TO-hours for the 1%-, 2%- en 5%-data sets have a 2, 3 and 2.5 times higher value. For the GTO-hours this is 5, 4.5 and 10 times as high. What catches the eye is the non-linear development over time, at 15 years there is a bend, sometimes up and sometimes down.

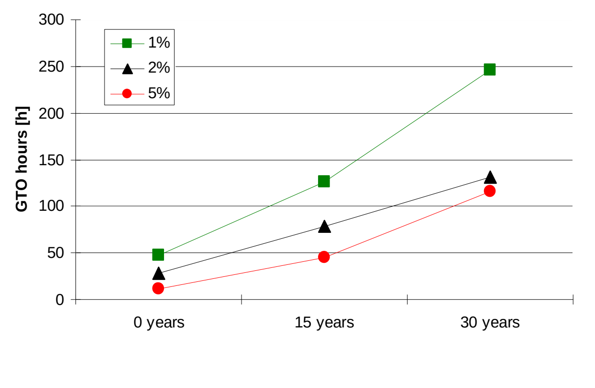

Fig. 12: Weighted exceeding hours (GTO), room 8, future climate files, W+ scenario

Robustness

The robustness of a system concept can be defined as the capability to fulfil the desired performance requirements, even when the actual conditions differ from the design conditions. In order to compare the performance of the system concept with top cooling under deviating conditions the following approach has been followed with the current and future NEN 5060:2008 data sets.

As a first step the performance indicators overheating hours 25°C' and weighted overheating hours are analysed. As requirements for the assessment for a reasonable thermal comfort the usual criteria of a maximum of 100 hours above 25°C and the maximum number of weighted overheating hours of 150 are used (see dashed lines in figure 11 and 12). These figures show that both criteria do not lead to the same conclusions. For the W+ scenario already after 15 years all 3 climate data sets exceed the requirements for the TO hours. The criteria for GTO-hours are only exceeded after 30 years for the 1%-data set. This observed difference agrees with the conclusion in ISSO publication 74 (ISSO,2004), that the GTO-requirement for heavy buildings is less severe than the TO-requirements.

As a following step the maximum cooling load has been analysed. When comparing the results for the original NEN 5060:2008 data sets and the different scenarios both the overheating hours and the energy demand increase. In order to make a good comparison one of the parameters has to stay the same. A choice has been made to keep the GTO hours the same. By increasing the ventilation rate in the offices the GTO hours can be reduced to the level of the original data sets. The maximal cooling demand needed, is compared. Table 1 shows the results for the 1% data set and the W+ scenario as example.

The ventilation rate has to be raised from 4 to 6.7 (170%) in order to reduce the GTO-hours from 246 to 48. The maximum cooling load raises to 92 kW compared to 55 kW for the original data set, a raise of 70%. The maximum cooling load is used in order to size the system. Normally a margin of 10-25% is taken, in this specific case 70% is needed. The high ventilation rate also demands a larger space for the HVAC system in the technical room. An additional disadvantage of the high ventilation rate are uncomfortable drafts caused by high air velocities.

Table 1: Comparison performance indicators, 1%-data set and W+-scenario

DATA SET	VENTILA-TION-RATE [H^{-1}]	GTO-HOURS [H]	MAXIMUM COOLING LOAD [KW]
NEN5060:2008 ,original,1%	4	48	54,7
W+-scenario, 30 years, 1%	4	246	60,4
W+-scenario, 30 years, 1%	6,7	48	92,2

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In the standard NEN 5060:2008 three climate data sets for the determination of the thermal comfort performance indicators (like overheating risk assessment) are presented. The climate data sets are than combined with the Climate Change scenarios of the meteorological institute KNMI. A case study is used to get an impression of the performance of a building regarding the changing climate. The case study used is an office building, conditioned with top cooling of the supply air temperature. The performance during the summer period is studied.

NEN 5060:2008 climate data sets

- The total cooling demand determined with the old reference data set 'De Bilt 64/65' corresponds well with the results of the NEN 5060:2008 energy data set. The difference is less than 2%. The more extreme 5%-, 2%- and 1%-data sets show much higher values with respect to the old reference year 64/65; an increase of respectively 42%, 53% and 65%.
- The results for the maximum cooling load are much closer to each other. Compared to the reference data set 'De Bilt 64/65' the results lay within a range of 10%. The 2%-data set corresponds well with 'De Bilt 64/65'.

- The expectation is that for the assessment of the thermal comfort according to NEN 5060:2008 the 1%- data set is more severe than the 2%-one, which on its turn will be more severe than the 5%-climate data set. It shows that this is not always the case. The results show that there is a dependency between the climate data set, type of room, and the type of comfort indicator. A room with high thermal mass and a moderate load by solar radiation performances as expected. The overheating hours (both TO and GTO) raise with the extremity of the climate data set. However rooms with low thermal mass and high loads due to solar radiation (like room 8) show the highest values for the 5%-climate data set. The data sets are selected on the basis of ambient temperatures; this does not always coincide with higher solar loads as the difference between the 5%- and the 2%-data set show

Future climate data sets

- The effects occurring with the NEN 5060:2008 climate data sets are also occurring with the future climate data sets.
- As expected the energy demand for cooling will increase in time (15 or 30 years) and with the more extreme climate scenarios. The G+ and the W-scenario are close together, but the W-scenario seams to give a little higher cooling demand.
- The values for the maximum cooling load increase with time and more extreme climate scenarios. As expected for NEN 5060:2008–climate data sets the 1%-data set shows the highest loads, followed by the 2%- and 5%-data sets. After 30 year the 5%-data set shows the biggest rise followed by the 2%-data set. The 1%-data set shows the lowest value.
- For the comfort performance indicators (TO and GTO) the same trends are visible. The 1%-data set shows the highest overheating risk both for the NEN 5060:2008 and for the future projections

Robustness

- The analyses show that the commonly used concept of top cooling of supply air is vulnerable for climate changes. The W+ scenario indicates a 70% higher maximum cooling load after 30 year for a comparable comfort for the 1%-climate data set. In practice such margins are not taken into account into the design.
- Whereas HVAC systems has a life span of 15 to thirty years its is worthwhile to evaluate them with future climate data. This may lead to concepts which are more decoupled from the ambient temperature like high efficient heat and moisture recovery.

Recommendations for further research

- In this paper only the cooling season is examined. More attention should be paid to the influence of the new climate data sets on the building performance during the winter and intermediate season.

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