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MASTER'S THESIS

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SUMMARY

This master thesis presents the results of comparing climate data file based on EN-ISO 15927-4 approach and new one- year compact climate data file to climate data file based on 11- years of hourly raw data observations from 01.01.2003 to 31.12.2013 in Blindern, Flesland, Kise, and Kirkenes representing different climate zones in Norway.

A new one- year compact climate data file was used for simulating seven rounds of random years started with different weekdays on building with high thermal mass in Blindern to investigate if years started with different weekdays would have appreciable deviation comparing with a reference climate data file with raw data.

The results of this master thesis were compared for total heating, total cooling, total supplied electricity use, PV Production, exhaust temperature, and operative temperature on the south facade of the building. The results of the research may be used for energy performance of the building, designing of the HVAC systems, and indoor climate analyses.

3 KEYWORDS
Climate data
Energy performance of buildings
HVAC systems

Preface

This master thesis was based on the theoretical framework of bachelor thesis "Climate data for peak-load design of building energy systems" by Yekaterina Artyukova, Jonas Haugrud, Haakon Olsen.

For mater thesis, a reference climate data file with 11-years of hourly raw data observations, climate data file based on EN-ISO 15927-4 approach, and a new one-year compact climate data file were tested on more advanced building models, plant system, PV panels and internal gains bases on SN-NSPEK 3031.

All simulations and analysis of this thesis is an original work by Yekaterina Artyukova, and no part of the results and analysis were published before.

For this research it was arranged a survey and sent to experts in HVAC design and energy analysis in Norway.

I would like to thank Cathrine Chantal Grini, Mads Mysen, Ankell Jonas Petersen and Trond Ivar Bøhn who kindly participated in the survey.

I would like also to thank my supervisor Peter G. Schild for support and guidance during the research process.

Abstract

This master thesis presents the results of comparing climate data file based on EN-ISO 15927-4 approach and new one- year compact climate data file to climate data file based on 11- years of hourly raw data observations from 01.01.2003 to 31.12.2013 in Blindern, Flesland, Kise, and Kirkenes representing different climate zones in Norway.

Three climate data sets were tested on the middle floor of the Office building assuming no heat loss between the floors with two types of exterior facades: with high, and low thermal masses.

A new one- year compact climate data file was used for simulating seven rounds of random years started with different weekdays on building with high thermal masses in Blindern to investigate if years started with different weekdays would have appreciable deviation comparing to a reference climate data file with raw data.

The results of this master thesis were compared for total heating, total cooling, total supplied electricity use, PV Production, exhaust temperature, and operative temperature on the south facade of the building.

The results of the research may be used for energy performance of the building, designing of the HVAC systems, and indoor climate analyses.

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Nomenclature

θ3d- Three days mean temperature
CFB- Temperate oceanic climate
COP The coefficient of performance

DD Wind direction, [0]

DFB- Warm summer humid continental climate.

DFC- Sub artic climate

DM Wind direction, [0]

EN ISO International organization for standardization in English

etc. Et cetera, means "and other similar things"

FF Wind speed, [m/s]

FM Wind speed, [m/s]

kW kilowatt

kWh kilowatt in an hour

L/W Concrete lightweight concrete

LMT Agricultural meteorological service

PO Atmospheric pressure, [hPa]

QO Global horizontal solar radiation, [W/m^2]

TA Dry- bulb temperature, [?]

TD Maximum wet- bulb temperature, [?]

UU Relative humidity, [%]

$\bar{x}$ The sample mean
NIA Net internal area

Abbreviations

AHU Air handling units

CAV Constant Air Volume

CDF Cumulative distribution function

DRY Design reference year

ECDF Empirical distribution function

F-S Finkelstein and Schafer

GA Genetic algorithm

GOF Goodness- of- fit

HVAC Heating, ventilation and air Conditioning

ISO International organization for standardization

K-S Kolmogorov and Smirnov

NS Norwegian standard

RMSE Root mean square error

TMY Typical meteorological year

TRY Test reference year

Contents

1 Introduction

The existing methods for assessing the energy use for heating and cooling have several disadvantages which causes to reduced accuracy and reduced quality of buildings energy performance and indoor climate analysis. The results to these are wrong sizing of HVAC installations, increased energy consumption of the buildings, higher expenses, and pollution of the environment. Greenhouse gas emissions damage the ozon layers contributing to climate changes affecting the planet, while air pollution influences people's health and quality of life.

Energy consumption in buildings has dramatically increased during the past decades and it takes a great part of a total energy consumption in the world. The reason to this is not only the population growth, but also increased demand for indoor environmental quality and building functions, small focus on energy efficiency and "cheap" solutions when designing HVAC systems, which cause to high operating costs.

HVAC systems are the main consumers of the energy within the buildings and the assessing average use for heating and cooling is the greatest challenge for engineers at early stage of buildings project and sizing of the HVAC systems. It is essentially important to find new ways to improve energy performance of the buildings and energy efficiency as a result.

This master thesis presents the results of testing of three climate data files: 11- years with raw data observations from 01.01.2003 to 31.12.2013, climate data file based on ISO 15927-4 approach [2] and a new one-year compact climate data file. These climate data files were based on the same meteorological data but had different methods of generating. EN-ISO 15927-4 climate data file and new one-year climate data file were compared to a reference climate data file with 11 years of hourly raw observations.

These climate data files were tested on the middle floor with three zones of the office buildings with high and low thermal masses assuming no heat loss between floors. PV panel which was 355 m^2 was installed on the roof. Thus, a building with infinite number of floors and zones could be tested using the same algorithm.

Four locations in Norway presenting different climate zones in North Europe were chosen for testing the climate data files.

The results for total heating, total cooling, total supplied electricity use, and PV production for the buildings with high and low thermal masses in different climate zones had been compared using duration curves for 99,0000; 99,4292; 99,600; 99,9863; and 99,9943 percentiles.

The results for arithmetic mean values, mean values differences, 99,6000 percentiles, and 99,9943 percentiles differences were presented in tables.

99,6000 percentiles represent the results for design summer and winter conditions, while 99,9943 percentiles represent the peak load for 30 minutes during a year. Peak load gives important information for energy advisors, and it is essential for equipment with lack of capacity.

The operative temperature in the zone on the south side and exhaust temperature were analyzed when the cooling coil for AHU was turned off on Office buildings with high and low thermal masses without automatic blinds in Blindern and Flesland.

The results for seven rounds of simulation of a new one-year compact climate data file for random years started with different weekdays for total heating, total cooling, total supplied electricity use, PV production, exhaust temperature, and operative temperature on the south side for the buildings with high thermal mass in Blindern had been compared with reference climate data file based on 11 years of hourly raw meteorological observations using standard deviation were presented in diagrams.

The results may give new perspectives for energy performance of the buildings, designing of the HVAC systems, and indoor climate analyses.

1.1 Background for this study

Traditions for estimating the average energy use for heating and cooling, designing heating, and cooling loads have not changed for years.

Different types of climate data are used when designing modern buildings in Norway:

- The winter external design air temperature is used for estimating the design heat load [1];
- The summer external design day method is used to estimate the design cooling load [3];
- EN- ISO 15927-4 method of constructing a reference climate data file is used for assessing the average annual energy use for heating and cooling [2];

These methods have disadvantages because weather is a dynamic phenomenon and simulation of a design winter or summer day in energy performance software packages is potentially uncertain method. The weaknesses of climate data file based on EN-ISO 15927-4 approach were highlighted in chapter 2.3.

Energy advisors simulate the energy performance of the building using the actual year that does not give a full picture of all possible scenarios for years started with different weekdays.

The years started with different weekdays have different sequence of working days, and weekends, and, therefore, they may have different energy demand. If, for example, the warmest or the coldest day happen in the weekend, the energy demand will be lower.

For the best accuracy of the results for energy performance of the buildings, it is important to test different methods to choose the most suitable.

1.2 Problem formulation

Despite the variety of methods, there are some difficulties in evaluating energy efficiency and thermal performance of buildings such as

1. Modern HVAC systems use heat storage between summer and winter period that reduces energy consumption;
2. Using winter external design temperature in stationary conditions for calculation the effect demand of the buildings causes oversizing of the HVAC systems;
3. Energy advisors do not have enough capacity to perform separate simulations of design winter and summer conditions. Most of them use the simulation software for assessing the annual average energy use of the building. Calculating the peak loads for design summer and winter conditions are not in priority that may cause to the problems for installations with lack of capacity.

4. Simulation of design summer day do not provide any information about number of hours over 26°C during the year.

Sum it up, the existing methods for estimating the system energy use are not enough effective today due to increased demand for energy efficiency of the buildings, population growths, indoor climate quality, and building functions. “Passive” and “Future” houses demand new methods and standards for estimating annual energy use for heating and cooling.

This master thesis presented the results of comparing a new one-year compact climate data file and climate data file based on EN- ISO 15927-4 approach using 11- years climate data file with raw data as a reference on the Office buildings with high and low thermal masses in different climate zones in Norway, and the results testing a new one-year compact climate data file started with different weekdays of random years compared to 11- years climate data file with raw data to investigate if energy consumption of the building depends on which day the actual year starts.

The first hypothesis was that a new one- year compact climate data file would have a better approximation with 11- years “raw data” climate data file than traditional ISO 15927-4 method due to different approaches of generating of climate data sets. Therefore, it might be more suitable for energy performance of buildings.

The second hypothesis was that years started with different weekdays had appreciable deviation comparing with a reference climate data file with raw data. Hypothetically, it is more effective to run seven rounds of one-year climate data file that 11-years or more with raw data only once in terms of time and the accuracy for the results. Therefore, for energy performance of the building, the energy advisors need to run seven rounds of the years started with different weekdays to predict different scenarios of energy demand.

1.3 Objectives

The primary goals of this master thesis are:

- To find out if a new one- year compact climate data file has better approximation with reference climate data file with 11- years hourly meteorological observations than climate data file based on EN-ISO 15927-4 approach.
- To find out if the weekday opening the year has an influence on energy demand of the building.

Thus, the following secondary goals are:

1. To test three climate data files on the Office building with high and low thermal masses in Blindern, Flesland, Kise, and Kirkenes, which present different climate zones in Norway;
2. To test seven random years started with different weekdays to investigate if there is a great deviation in their results;
3. To compare the results of testing climate data file based on EN-ISO 15917-4 approach and a new one-year compact climate data file using 11-years climate data file with raw data as a reference for total heating, total cooling, total supplied electricity use, PV Production, exhaust temperature, and operative temperature;
4. To analyse the results and present them in form of duration curves, tables, and diagrams.

The results of the study may be used for improvement of building energy performance, designing of the HVAC systems, and indoor climate analyses.

1.4 Scope of work

Referring to the primary and secondary goals of this master thesis, the following limitations can be determined:

1. Climate data files have been tested on Office building. For other types of the buildings the results may be different;
2. Climate data files have been tested in four climate zones in Norway. The results may be different for other climate zones, for example, tropics and different weather conditions;
3. Both buildings with high and low thermal masses have the same HVAC installations, same size of PV panel and the same plant unit. The results for the buildings with other types of technical installations may be different;
4. Both buildings have the same internal gains. The buildings with different internal gains have not been tested;
5. The climate data files have been tested on the sample of the Office building suggested by Sintef and used for energy calculations in the report "New regulatory requirements for energy demand of buildings" [41, p 24]. The buildings with other geometry have not be tested.

2 Theoretical framework

Different climate data sets were implemented for calculating the average annual energy consumption for heating and cooling over past 40 years.

Historical development of the climate data files for building energy simulation, requirements for climate data files, problems with EN-ISO 15927, Norwegian building code, overview of the software for simulating building energy performance, computational analysis, and a survey for Norwegian experts are presented in this chapter

2.1 Historical development of climate data files for building energy simulation

EN-ISO 15927-4 is a method for generating a climate data file which is based on hourly meteorological observations during a certain period.

Historical development of the study about climate data files for building energy simulation went through following stages:

1. In 1970s a reference year was constructed from the most typical monthly- mean temperatures.

2. In 1978s, Sandia National laboratories presented a new method for selecting a typical meteorological year (TMY) [14]. The twelve most typical months were combined to generate a reference year. Dry bulb temperature, dew point temperature, wind velocity, and solar radiations on a horizontal surface were chosen parameters for this purpose. These meteorological values were based on measurements recorded over a 23- year period from 1953 to 1975. [14]. This method was well-known as "Sandia method" and had been implemented in EN ISO 15297-4.

Each month of the calendar year consisted of the best meteorological parameters from five candidate months using the cumulative distribution functions (CDFs). Candidate monthly CDFs were compared to the long-term CDFs [14]. For analysis of hourly values for the required period was applied The Finkelstein- Schafer statistic which had been described in "Improved Goodness-of- fit tests" [15].

3. A "semi- synthetic" design reference year DRY file was introduced in1994. "A design Reference year (DRY) is a collection of weather data for one year, arranged as 8760 hours sets of simultaneous parameters" [4]. The Design Reference Year (DRY) [4] is also known as Test Reference Year (TRY) [1], [2], [3] and Typical Meteorological Year (TMY) [5], [13]. The main idea was to use CDF fitting "The output from a computer simulation with a DRY as input, should deviate as little as possible from the output obtained by using the complete multi- year meteorological record as input". [4, p. 7]

The weather parameters for DRY should meet the following criteria [4, p. 3]:

- Frequency distributions;
- Autocorrelation;
- Cross-correlation structure.

The generating of the file included three steps [4, p. 7]:

- A selection process: From a climate data base for more than 10 years for each of the twelve calendar months was selected the most typical month
- An adjustment process: This month was given the long- term distribution for important weather parameters such as dry- bulb temperature, humidity, solar radiation

- Reconstruction process: Parameters that had been unavailable were taken from the data.

4. The differentiated weight factor which had been highlighted in the article “Development of weighting factors for climate variables for selecting the energy reference year according to the EN- ISO 15927- 4 standard” was introduced in 2012[5].

According to this method “the climatic parameters may have different influence on the heating and cooling energy demand of buildings in different climatic zones” [5].

By weight factors the authors of the study meant also type of buildings, geometry and thermal mass [5].

5. In 2013, the Department of the Built Environment, Free University of Bozen- Borzano introduced the improved method for constructing TMY was introduced with Finkelstein- Schafer critical values less than one percent. It was published in Journal of building performance in February 2014 [17]. Two modified variants of the climate data file based on EN-ISO approach were tested to improve the accuracy of the reference year for estimating the annual energy use for heating and cooling. The first climate data set was generated without considering its final use, while for the second one, the specific weather parameters were weighted to generate climate data file for heating or cooling [17]

The method has not been implemented in EN ISO 15297-4 yet.

2.2 Requirements for climate data files

Climate data files are also known as typical meteorological year (TMY) file [5], [13], test reference year (TRY) file [1], [2], [3] and design reference year (DRY) [4] and are used for energy performance of the buildings and indoor climate analysis [23].

According to ISO 15927- 4 the reference years “is a sequence of 8760 hourly values of dry- bulb temperature, water vapour pressure (or other humidity parameter), solar irradiation, wind speed and any other available climate parameter” [2].

The climate data files should correspond to an average year, both for monthly and seasonal mean values [23]. The basic requirements for a reference year suggested by Hans Lund are [23]:

1. True frequencies. True mean values should be as near as possible over a longer period;
2. True sequences of the weather situations, which should have a certain duration and recorded for a location;
3. True correlations between different parameters such as temperature, solar radiation, cloud cover, wind speed and direction.

2.3 Problems with EN- ISO 15927

ISO 15927 «Hygrothermal performance of buildings. Calculation and presentation of climatic data» is a standard for hygrothermal performance of buildings and explains the methods for calculation and presentation of climatic data. It includes six parts which are: part one “Monthly means of single meteorological elements” [37], part two “Hourly data for design cooling load” [3], part three “Calculation of a driving rain index for vertical surfaces from hourly wind and rain data" [38], part four is "Hourly data for assessing the annual energy use for heating and cooling" [2], part five is "Data for design heat and load for space heating" [1] and part six "Accumulated temperature difference (degree days)" [39].

Traditionally, different types of climate data have been used for designing modern buildings. They are described in ISO 15927-4, ISO 15927- 2 and ISO 15927-5.

2.3.1 EN- ISO 15927-4

- ISO 15927-4 describes the method of constructing ISO standard climate data file. Hourly values of a proper meteorological data are used to assess the average annual energy use for heating and cooling. The reference year should include hourly values of the following parameters: dry-bulb temperature, direct normal solar irradiance and diffuse solar irradiance on a horizontal surface, relative humidity, absolute humidity, water vapour pressure or dew point temperature and wind speed at a height ten meters above ground [2].

The producing of ISO 15927 one-year climate data file includes the following steps:

1. From at least 10 years or more of hourly values of climate parameter, calculate the daily means of them
2. For each calendar month, calculate the cumulative distribution function of the daily means overall years in the data set,
3. For each year of the data set, calculate the cumulative distribution function of the daily means within each calendar month by sorting all the values for that month and that year in increasing order and then rank order of daily means within a calendar month in the year
4. For each calendar month, calculate the Finkelstein- Schafer statistics for each year of the data set using equation
5. For each calendar month, rank the individual months from the multiyear record
6. For each calendar month and each year, add the separate ranks for three climate parameters
7. For each calendar month, for the three months with the lowest total ranking, calculate the deviation of the monthly mean wind speed from the corresponding multi- year calendar month mean. The month with the lowest deviation in wind speed is selected as the "best" month to be included in the reference year [2, 3-4].

2.3.2 EN- ISO 15927-2

- In ISO 15927-2 there is description of the summer external design day method. Hourly data for design cooling load is used to determine the design cooling load of buildings and the design of air condition systems. Summer external design day is "a day from any calendar month with a specified return period for extreme values of the significant meteorological parameters, for example: temperature swing, dewpoint, dew point temperature, solar irradiation and wind speed" [3]. Hourly data of these parameters for analyses should be given for minimum ten years.

2.3.3 EN- ISO 15927-5

- ISO 15927-5 describes the method of calculation the data for design heat load for space heating. The winter external design air temperature with the average wind speed during an appropriate period and its direction are the data required for design heat load for space heating in buildings. The winter design air temperature is the lowest temperature with a defined return period, preferably for at least 20 years [1].

Climate data file based on EN-ISO 15927-4 approach consists of twelve the most typical months. For constructing ISO 15927- 4 climate data file the twelve most typical month's splices together from the multi- year record for each calendar moth. As a result, the following disadvantages of the method can be determined:

- The method does not guarantee a smooth transition from one month to another, if, for example the end of January is much colder than beginning of February. It causes to low accuracy when assessing the annual energy use for heating and cooling.
- Finkelstein- Schafer statistics which is used for analysis of hourly values for required period in EN-ISO 15927-4 is not effective since the weather is not a static phenomenon.
- ISO 15927- 4 method is suitable for assessing the average annual energy for heating and cooling, but it is not suitable to construct extreme years.
- Simulation of design summer day do not provide any information about number of hours over 26°C during the year.
- Using winter external design temperature in stationary conditions for calculation the effect demand of the buildings causes oversizing of the HVAC systems that means too high unnecessary expenses.

2.4 Norwegian building code and standards

National office of Building Technology and administration, or The Norwegian Building Authority is the main agency for implementing building policy [25].

The organisation of the Norwegian Authority is based on the following approach:

1. Department of construction process;
2. Department of products and systems;
3. Department for central approval;
4. Department for communication;
5. Department for internal services.

Norwegian building code includes the following definitions:

1. The plan- and Building Act. The plan- and Building Act is the main and the most important act for building and construction industry. The Plan- and Building Act belongs to public laws and is enforced by the municipalities. The act covers building case provisions, planning provisions and material requirements for construction works [21].
2. Regulations. The regulations provide supplementary rules and detailed provisions to the the Plan- and Building Act. There are two regulations SAK 10 which presents regulations for building permit application and handling, quality control, inspection, and guidelines for qualifying individual and organizations; and TEK 17 which defines regulations for technical building limitations to be legally built in Norway and DOC, which presents regulation for documentation and building materials [25];
3. Department for communication. The department often uses messages to announce changes about laws or regulations, provides guidance and interpretation of statutory provisions or conveys other information [21];
4. Building guides clarify legislative and regulatory provisions with guidelines or recommendations [21];
5. Standards. Norwegian standards present the methods for construction works and building materials. Standards are voluntary and the municipality cannot demand those methods, materials and building process follow the Norwegian Standard if there is documentation that the requirements have been covered in another way [21];
6. The Building Research Design Guides are the complete sources to technical solutions for buildings. It includes three sub-series which are Architectural Planning, Building Details and Building Management and Maintenance and presents experience and solutions from both practice and research. The Building Research Design Guides can be used as a planning and design tool. The design guides are continuously being updated to comply with the building code and experience-based knowledge [24].
7. Department for central approval. All construction materials should have sufficient trade documentation [21].

2.4.1 Passive house standard and Plus house

Passive house is a voluntary standard for energy efficiency of the buildings. It gives advises how to reduce demand in energy of buildings and achieve high thermal comfort on low total costs. In Norway there are two standards with criteria for passive houses and low energy buildings described in NS 3701: 2012 for Non-residential buildings [18] and in NS 3700: 2013 which applies for Residential buildings [19].

NS 3701 had been developed by Standards Norway SN/K 034 “Energy performance of the buildings” with support from ENOVA SF, Husbanken, Low- energy program and National Office of Buildings Technology and administration and was set in September 2012. It has practical utility when planning, constructing and evaluating low- energy buildings [18].

In this master thesis the buildings with high and low thermal masses meet all the requirements of Passive house standard for Office building.

The net internal area of the floor was 1149 $m^{2.}$ Annual mean temperature and design winter temperature were taken from Byggforskserien 451.021[43].

Maximum net energy demand for cooling [kWh/(m^{2}year)] was calculated with the following equation suggested by Passive house standard [18]:

20 [kWh/(m^{2}year)] +3.6*(6.3- annual mean temperature)

Maximum net energy demand for cooling [kWh/(m^{2}year)] was calculated with the following equation suggested by Passive house standard [18]:

1,4* (Design winter temperature-20)

Sintef suggested to identify a Plus house as a building which produces minimum 2 kWh/m^{2}NIA surplus energy [44].

On the buildings with high and low thermal masses there is a 355 m^2 PV panel.

Building with high thermal mass in Blindern meets the requirements for plus house and produces over 2 kWh/m^{2}NIA surplus energy.

2.5 Software packages for simulating building energy performance

Software packages for simulating building energy performance, such as Energy Plus, Simien, IDA-ICE have become widespread in engineering for estimating energy efficiency of the buildings and sizing of the HVAC systems. The use of simulation tools makes it possible to test different alternatives for energy load, energy efficiency measures, thermal masses, locations, types of installations and constructions. The greatest advantage of all software packages for simulating energy performance is that simulations take much less time than manual calculations and the results are accurate.

IDA- ICE is a software for simulating building energy performance that has been used for testing climate data files in this master thesis.

2.5.1 IDA ICE

"IDA Indoor Climate and Energy (IDA ICE) is a dynamic multi-zone simulation application for accurate study of indoor climate and individual zones as well as the energy consumption of an entire building" [16]. IDA ICE was chosen as a simulation tool for this master thesis to test three climate data files: 11-years with raw data, EN-ISO 15927-4 and a new one-year compact.

2.5.2 The climate data files for this study

Three climate data files were tested in this master thesis: 11 years of hourly raw data observed from 01.01. 2003 to 31.12.2013; climate data file based on EN-ISO 15927-4, which was generated by program EPW-Gen by Peter G. Schild based on 11 years of observations from 01.01.2003 to 31.12. 2013, and ; climate data file based on EN-ISO 15927-4, which was generated by program EPW-Gen by Peter G. Schild based on 11 years of observations from 01.01.2003 to 31.12.2013 with adjusted values to fit CDF for all years.

As it was mentioned above, the climate data files tested in this master thesis have been prepared by Peter G. Schild using the following programs:

1. Klimadata- XL [12]. It has been used to download the climate data with hourly observations and chosen parameters, locations and periods from Landbruks Meteorologisk Tjeneste (LMT) [13].
2. EPW-Gen, developed by Peter G. Schild, which is based on Excel spreadsheet using genetic algorithms and has an integrated single- zone building energy model, which is similar to that in Simien and TEK sjekk, for selecting the suitable climate data. "Genetic algorithms (GAs) are heuristic search and optimisation technique inspired by natural selection" [9]. In this case genetic algorithm has been used to splice the different climate data files in one PRN file.

The disadvantages of ISO 15927 method are described in chapter 2.3. Thus, the following advantages of a new one- year compact climate data file are:

1. A new one- year compact climate data file consists of twelve random periods with different length and therefor has:
- A smooth transition between periods;
- The least deviation and therefor much more precise energy performance of the building than ISO 15927 climate data file;
- No month shift in twelve splices;
2. The periods with big differences in temperature were considered as not valid and were not included in a climate data file;
3. Twelve periods spliced together make sure that the design periods, or in other words, extreme periods are included;
4. It doesn't have CDF fitting. At the end of the algorithm for selecting the random periods, the program makes duration curves for the following parameters: dry- bulb temperature, direct normal solar irradiance and diffuse solar irradiance on a horizontal surface, global horizontal solar radiation, wind speed and relative humidity. It makes the vlues for climate data file more desirable for energy performance of the buildings, sizing HVAC systems and indoor climate analysis.

11- years climate data files with "raw data", a traditional ISO climate data file [2], and a new one-year compact climate data file have the same input data but different climate parameters. For these climate data files the following parameters have been taken into consideration:

1. Dry- bulb temperature, TA [°C];
2. Atmospheric pressure, PO [hPa];
3. Global horizontal solar radiation, QO [W/m^2];
4. Wind speed, FM or FF [m/s];
5. Wind direction, DM or DD [^{0}];
6. Relative humidity, UU [%].

2.6 Computational analysis

2.6.1 Goodness of fit test

The goodness- of- fit of a statistical model describes how well the observed data fits the assumed model. GOF indices outline the disparity between the observed data and the data of the assumed statistical model [31].

First, The Kolmogorov- Smirnov (K-S) goodness- of- fit test [32] had been applied for analysis of hourly meteorological observations for the required period when generating a climate data file, [33], but later for these purposes it was applied The Finkelstein- Schafer (F-S) statistic [15].

The K-S goodness- of- fit test is a nonparametric test that is based on the empirical distribution function. The K-S statistic summarize the discrepancy between the empirical distribution function (ECDF) of the sample and the cumulative distribution function (CDF) of the reference model.

The null distribution is calculated under the null hypothesis. The distribution under null hypothesis may be continuous either for discrete or mixed, for the one sample cases. The distribution under null hypothesis for the two sample cases is a completely specified theoretical continuous CDF.

The main advantage of the K- S statistic is that it doesn't depend on the basic CDF that is being tested. But nevertheless, it has the following disadvantages:

- K-S statistic cannot be applied for discrete variables;
- If the distribution is not precise (scale, location or shape parameters), the K-S goodness- of – fit test becomes not valid [26, pp 273- 276]

In the article "Improved goodness- of-fit tests" by J.M Finkelstein and R.E. Schafer was presented more powerful than Kolmogorov- Smirnov statistics in cases tested [15]. Two statistics were for small sample sizes. The first statistics could be used to test the fit of any completely specified continuous distribution function, and the second statistics tested the fit to an exponential distribution with mean unknown [15].

2.6.2 Root mean square error

A standard deviation or root mean square error of an estimator is a measure of the imperfection of the fit of the estimator to the reference data [36].

For example, there are given two data sets -1,0,1 and - 10, 0,10. In both cases the mean value is 0 even the numbers in the second set are more widely spread than in the first one [36].

Let $\mathbf{x_1}$, $\mathbf{x_2}$, ……., $\mathbf{x_n}$ be **n** measurements with a mean $\mathbf{\bar{x}}$. Then $\mathbf{x_1 - \bar{x}}$ is the amount by which $\mathbf{x_i}$ varies from the mean. The difference between $\mathbf{x_1}$ and $\mathbf{\bar{x}}$ is the deviation of $\mathbf{x_i}$. The deviations can be positive or negative and the mean of them is always zero. Since negative and positive deviations cannot be used for measuring because they give zero in sum, it is taken the squared deviation $\mathbf{(x_1 - \bar{x})^2}$ [36].

If $\mathbf{x_i - \bar{x}}$, **i= 1, 2, ….. n,** then Root mean square error, or standard deviation is [36]

$$\mathbf{RMSE} = \left(\sum_{i=1}^{n} (xi - \bar{x})^2 / n \right)^{1/2}$$

3 Research methods

The existing methods for assessing the energy use for heating and cooling demand have range of disadvantages. Nowadays the demand for accuracy of indoor climate analysis and energy performance of the buildings dictates new demands for energy analysis methods. This chapter presents the overview of research methods applied in this master thesis.

3.1 IDA ICE as a simulation tool for building energy performance

In this master thesis IDA ICE has been used for the following purposes:

1. To test three climate data files:11- years with "raw data", a traditional one-year climate data which is based on ISO 15927-4 approach [2] and a new one-year compact climate data file with adjusted values to fit CDF for all years on Office buildings with high and low thermal masses in different climate zones in Norway;
2. To simulate the seven rounds of the years started with different weekdays;
3. To test the buildings with and without exterior shading to analyse the operative temperature on the south side of the building.

Custom dynamic setup was used for all simulations because it was the most effective method to run big climate data sets with maximum time setup at 0,5 hour and time set for output at 1 hour.

11-years climate data set with raw data was used as a reference and had setup from 00:00:00 01.01.2003 to 24:00:00 31.12.2013.

EN-ISO 15927-4 and a new one-year compact climate data sets were simulated using a random 2010 for Blindern, Flesland, Kise and Kirkenes starting with the first of January 00:00:00 and ending at 24:00:00 on the 31st of December.

A new one- year compact climate data file was used for simulating seven rounds of random years started with different weekdays on building with high thermal mass in Blindern. A random 2023 was used for simulation started on Sunday, a random 2024 for Monday, a random 2030 for Tuesday, a random 2025 for Wednesday, a random 2026 for Thursday, a random 2027 for Friday and a random 2028 for Saturday. Seven rounds of simulations were tested on the building with high thermal mass in Blindern.

Three climate data files were tested on buildings with high and low thermal masses in four climate zones in Norway presented by Blindern, Flesland, Kise and Kirkenes with exterior automatic blinds and cooling coil turned on to estimate the total cooling and total supplied electricity use; to estimate the exhaust temperature and operative temperature on the south side, three climate data files were tested on buildings with high and low thermal masses in Blindern and Flesland without exterior blinds and with cooling coil turned off; new one year compact climate data file was tested on buildings with high and low thermal masses in Blindern for random years started with different weekdays with and without exterior blinds and cooling coil. In total, 50 simulations.

3.2 Excel worksheet for results analysis

When the simulations were completed, all files were saved as IDA system files idm. for further analysis in Excel worksheet prepared by Peter G. Schild.

PRN.files for total heating, total cooling, total supplied energy use for electricity, PV production, exhaust temperature and operative temperature were extracted from IDA ICE system files and calculated in Excel worksheet.

3.2.1 Arithmetic mean value

Arithmetic mean value is a mean between annual minimum 24- hours mean with percentiles equal to 0,000057, and annual maximum 24- hours mean with percentiles equal to 0,999943.

Arithmetic mean values were used in this master thesis to analyse the results for total heating, total cooling, total supplied electricity use, and PV Production.

3.2.2 Mean value difference

Mean value difference is a difference between annual minimum and maximum 24 hours mean values and it was calculate using the following equation:

Mean value difference= $\frac{\sum_{i=1}^{8760}(x-y)}{8760}$

x- is a reference climate data file with raw data

y- compared climate data file (EN-ISO 15927-4 or new one-year compact climate data file)

Mean value difference was used for analysis of the results for total heating, total supplied electricity use and PV Production in this master thesis.

3.2.3 Percent difference compared to raw data

Percent difference compared to raw data was used for analysis of the results in this master thesis for total heating, total cooling, total supplied electricity use, PV Production, exhaust temperature, and operative temperature on the south side using the following equation:

Percent difference= $((P_y - P_x)/(P_{max,x} - P_{min\,x}))/100\%$

P_x percentile for reference climate data file with raw data

P_y percentile for compared climate data file (EN-ISO 15927-4 or new one-year compact climate data file).

3.3 Duration curves

Duration curves were used to present the results of the comparing a new one-year compact climate data file to EN-ISO 15927-4 climate data file using 11- years climate data with hourly raw data observed from 2003 to 2013. One year consists of 8760 hours and there were two types of duration curves in this master thesis: on the first type, the y- axis presents percent difference in percent between reference raw data climate data file with EN-ISO 15927-4 climate data file and new one-year compact climate data file; on the second type of the curve, the y-axis presented the electricity loads in Watt, or, in other words, the rate of energy use. The x-axis presented the percentiles from 99,0000 to 99,9943: where 99,0000 percentiles were equivalent to 87,6 hours per year, 99, 4292 percentiles were equivalent to 50 hours per year, 99,6000 percentiles were equivalent to 35 hours per year, 99,9863 were equivalent to 1,2 hours per year and 99,9943 percentiles were equivalent to 30 minutes per year.

99,6000 percentiles that are equivalent to 35 hours per year were used to present the design winter and summer conditions. 99,9943 represented the highest load during 30 minutes during a year in this master thesis. 99,6000 and 99,9943 percentiles were used for analysis of total heating, total cooling, total supplied electricity use, PV Production, exhaust temperature, and operative temperature on the south side.

3.3.1 Total heating demand

PRN.file with results for boiler with single water circulation covers the demand for total heating demand, which includes zone heating, AHU heating, domestic hot water.

Total heating demand in this master thesis was studied on building with high and low thermal masses in Blindern, Flesland, Kise and Kirkenes.

3.3.2 Total cooling demand

PRN.file with results for chiller with single water circulation covers the demand for total cooling demand, which includes zone cooling, and AHU cooling.

Total cooling demand in this master thesis was studied on building with high and low thermal masses in Blindern, Flesland, Kise and Kirkenes. The cooling coil was turned on.

3.3.3 Total supplied electricity use

PRN file for total supplied electricity use was extracted from IDA ICE for further calculations and analysis on excel worksheet. The total supplied electricity use includes electric cooling, electric heating, HVAC, lighting facility and PV production and was studied on buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise.

3.3.4 PV Production

PRN file for PV Production was extracted from IDA ICE to excel worksheet.

0,0057 percentile was used to calculate the highest load in Watt during 30 minutes per year, and 0,4000 percentiles are equivalent to 35 hours per year.

PV production was studied on buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise.

3.3.5 Exhaust temperature

The exhaust temperature was studied on buildings with high and low thermal masses in Blindern, and Flesland to make sure that the room temperature meets all the requirements for indoor climate quality. To run the simulations for exhaust temperature the cooling coil for AHU was turned off.

PRN file for exhaust temperature was extracted from IDA ICE to excel worksheet for further analysis.

3.3.6 Operative temperature on the south side

Operative temperature on the south side in this master thesis was studied in two climate zones in Norway: in Blindern and in Flesland. Since Kise and Kirkenes represented colder climate zones in Norway exceeding of operative temperature was not expected.

Operative temperature was studied in this master thesis to make sure that the room temperature does not exceed 26 °C more than 50 hours per year.

To study the operative temperature on the south side, the buildings with high and low thermal masses were tested without automatic blinds and with cooling coil for AHU cooling turned off.

PRN file for operative temperature on the south side was extracted from IDA ICE to excel worksheet for further analysis.

99,6000 percentiles represent the operative temperature which does not exceed more than 35 hours per year. 99,9943 percentile represents the highest operative temperature in the zone on the south side during 30 minutes per year.

3.4 Root mean square error

Root mean square error or standard deviation was used for analysis of seven rounds of simulations in IDA ICE for the building with high thermal mass in Blindern for the random years started with different weekdays. The climate data file with 11 years of hourly raw data observations from 01.01.2003 to 31.12.2013 was used as a reference for the calculation of standard deviation for new one-year compact climate data file, which was considered as "predicted".

$$\mathrm{RMSE}_{fo} = \left[\sum_{i=1}^{N} (z_{f_i} - z_{o_i})^2 / N\right]^{1/2}.$$

RMSE Root mean square error for 11- years climate data file with raw data, which was set as a reference climate data file

Zf new one-year compact climate data file

Zoi 11 years climate data file with raw data

Seven rounds of simulations in IDA ICE of a building with high thermal mass in Blindern for random years started with different weekdays were compared to results for reference climate data file with 11-years raw data using standard deviation for total heating, total cooling, total supplied electricity use, PV production, exhaust temperature, and operative temperature on the south side.

3.5 Testing of climate data on buildings with high and low thermal masses

The climate data sets in this master thesis were tested on Office building suggested by Sintef and used for energy calculations in the Sintef report "New regulatory requirements for energy demand of buildings" [41, p 24]. This sample was suitable for building energy performance in

Norwegian climate conditions. High and low thermal masses were tested in this master thesis. Both buildings meet the requirements for all elements of building construction, thermal bridges, and energy efficiency.

For this master thesis it was decided to simulate the middle floor of the building with three zones with floor area 1149,2 m^2, room height 3,02 m, assuming no heat loss between floors in order to reduce the simulating time. Since the goal was to compare EN-ISO 15927-4 and a new one-year compact climate data file with 11 years climate data set with raw data, it did not matter how many zones are included in simulation.

The building has length 60 m, and width 20 m. The total windows area is 35,5 m^2. There are four windows 20 m^2 on the north and the south side, two windows 5 m^2 and one 10,5 m^2 on the east and on the west side.

PV panel which is 355 m^2 was install on the roof and automatic exterior blinds on windows.

The time schedules for internal gains for occupancy, equipment and light were set after SN-NSPEK 3031:2020 [45].

Air handing unit had maximum air supply 6,12 m^3/m^2h from 6.00 am to 6.00 pm during working week and minimum air supply 1,44 m^3/m^2h otherwise. The minimum requirements, energy demand of the buildings, and total energy use per year are presented in tables under.

Table 3.5.1 The minimum requirements of Passive house standard

Parameter	**Passive house minimum requirements**
Thermal bridges	0.03 W/ (m^2 K)
Ventilation	1.7 l/s during work hours, 0.27l/s when not in use
Specific fan power	1.0 kW/ (m^3 s)
Lighting	12.5 kWh/m^2

Table 3.5.2 Energy demand of the buildings for Passive house standard and calculated using a reference climate data file with 11 years raw data

Location	Thermal mass	Annual mean temperature [°C]	Design winter temperature [°C]	Maximum net energy demand for heating kWh/(m2 year)	Maximum net energy demand for cooling kWh/(m2 year)	Energy demand for heating kWh/(m2 year)	Energy demand for cooling kWh/(m2 year)
Blindern	high	6,1	-19,8	20,7	55,7	20,95	10,2
Blindern	low					22,21	11,51
Flesland	high	7,8	-12	20	44,8	15,49	5,80
Flesland	low					16,75	7,23
Kise	high	4,7	-31,7	25,76	0	25,83	
Kise	low					27,21	
Kirkenes	high	0,1	-40,8	42,32	0	39,46	
Kirkenes	low					41,14	

Table 2.4.2.3 The total energy use per year using reference climate data file with 11 years raw data

Location	Thermal mass	Cooling coil for AHU	Total kWh/m²
Blindern	high	Turned on	-2,38
Blindern	low	Turned on	-0,61
Flesland	high	Turned on	1,31
Flesland	low	Turned on	3,12
Kise	high	Turned off	0,2233
Kise	low	Turned off	0,2283
Kirkenes	high	Turned off	28,33
Kirkenes	low	Turned off	30,65

The buildings with high and low thermal masses located in Kise does not meet the requirements for Passive house standard. To meet of the requirements of Passive house standard, the window with lower U- value can be implemented.

The building with high thermal mass in Blindern meets the requirements for Plus house suggested Sintef [44].

The details for buildings with high and low thermal masses can be found in attachments.

3.6 Testing of climate data in different climate zones

Norway is in Northern Europe and affected by Golf Stream that gives mild winters on the west coast. Coast climate zone, continental climate zone and Polar (Arctic) climate zone are three climate zones in Norway.

The climate data files were tested in Blindern which represented the Cost climate with cold winters, in Flesland which represented the West Coast climate with mild winters, in Kise which represented the continental climate but with much colder winters than in Blindern, and Kirkenes which representd Polar climate. Testing of climate data files in these locations gave an overview how EN-ISO 15927-4 climate data file and new one-year compact climate data file work in different climate zones in Norway on buildings with high and low thermal masses comparing to a reference climate data file with 11 years raw meteorological observations.

The climate can be categorised using the The Kyoppen-Geiger climate classification [35].

The west coast climate has mild winters and rain all year. The temperature is above average for its location so far north, because of the Golf Stream. It is classified as Kyoppen climate zone C and climate type CFB.

The east coast climate around Blindern, with cold winters and warm summers, is classified as zone D, and type DFB.

Kise represents the continental continental climate, which is also zone D, and type DFC. There are cold to mild summers, and cold winters.

Kirkenes is polar climate, zone D and type DFB.

The different climate files have been tested in three different climate zones in order to see which climate data file, the one based on EN-ISO 15927-4 or new one-year compact climate data file has better approximation with a reference climate data file with 11-years hourly raw meteorological observation. The second point to that was to ensure that the new method presented by new compact one- year climate data file is effective in different climate zones in Norway and North Europe.

The details about the climate zones are presented in the tables 3.6.1, 3.6.2, 3.6.3, 3.6.4 [34].

Table 3.6.1 Blindern

Summer temperature [°C]	Winter temperature θ_{3d} [°C]	Annual mean temperature [°C]	Location	Population
16,7	−19,8	6,1	59°54′40″N 10°45′10″E	673 469

Table 3.6.2 Flesland

Summer temperature [°C]	Winter temperature θ_{3d} [°C]	Annual mean temperature [°C]	Location	Population
10,7	−12,0	7,8	60.3837N 5.3321	356

Table 3.6.3 Kise

Summer temperature [°C]	Winter temperature θ_{3d} [°C]	Annual mean temperature [°C]	Location	Population
22,0	−29,8	4,2		33 842

Table 3.6.4 Kirkenes

Summer temperature [°C]	Winter temperature θ_{3d} [°C]	Annual mean temperature [°C]	Location	Population
23,5	−40,8	0,1	69°43′30″N 30°3′6″E	3529

3.7 Survey for experts

For analysis of climate data files in the most effective way it was very important to choose the criteria for the study. Therefore, a survey with questions about study criteria was sent to the experts in designing of HVAC systems and energy analysis in Norway. The survey was sent to 15 people and four of them had answered.

The following survey was suggested to the respondents:

Which design conditions do you think is the most desirable for calculation:

- The coldest / warmest day (24 hours mean value);
- Which does not exceed 50 hours per year;
- The coldest / the warmest hour;
- A specific percentile (for example 99%);
- If none of these, come with your suggestion.

Which parameters should be used for analysis in thesis:

- Heating demand for heating coil;
- Cooling demand for cooling coil;
- Total supplied energy use for electricity;
- Feel free to name other parameters for analysis.

The first respondent suggested hourly calculation for one day (24 hours) to determine the design winter and summer conditions for old buildings which does not meet the requirements for modern buildings. For other types of buildings, the first respondent suggested the hourly calculation for three days (72 hours) for design winter and summer conditions. Heating coil, cooling coil and room heating systems were interesting parameters according to the opinion of the first respondent.

The second respondent suggested to use the coldest and the warmest day (24 hours) during a year for design winter and summer conditions; the condition which does not exceed 50 hours per year for summer conditions as a traditional method; to use a certain percentile; and to use an appropriate climate data for one- year simulation. Heating coil, cooling coil, dry coolers, total supplies energy for electricity, and demand for zone heating are the interesting parameters for results analysis according to the opinion of the second respondent.

The third respondent suggested to use the coldest and the warmest hour are important to take into consideration for installation with lack of capacity. Heating demand for heating coil and zone heating, cooling demand for cooling coil and zone cooling, and total supplied energy use for electricity are the interesting parameters to analyse the results.

The fourth respondent suggested to use design winter temperature and design summer temperature for calculating heating demand in winter, and for calculating cooling demand in summer; one week simulation for winter conditions in Simien; to use a certain percentile; 50 hours for summer conditions which does not exceed 26 [°C] as a traditional method in TEK 17 §13-4 [46]; also mean values for 72 hours, 96 hours, and 120 hours can be used for calculating heating and cooling demand. AHU heating, AHU cooling, zone heating, and zone cooling with use of variety of sun protection and PV panels can be used for results analysis.

The results of this survey helped to choose conditions and parameters for this master thesis.

4 Results and discussion

This chapter presents the results of testing a reference climate data file with 11 years of hourly raw data observations from 2003 to 2013, one- year climate data file based on EN-ISO 15927-4 approach and a new one-year compact climate data file.

These climate data files were tested on the middle floor of Office building with three zones, assuming no heat loss between the floors.

Two types of thermal masses: high and low were tested in four climate zones in Norway.

All results of testing EN-ISO 15927-4 climate data file and new one-year compact were compared using 11- years climate data file with raw data as a reference.

The results for total heating and cooling demand, total supplied energy for electricity, PV production, exhaust temperature and operative temperature on the south side were compared using 99,0000; 99,4292; 99,600; 99,9863; and 99,9943 percentiles for reference climate data file, climate data file based on EN-ISO 15927-4 approach, and new one-year compact climate data file and were presented in Watt and degrees Celsius on y-axis on the duration curves. Percentile difference between reference climate data file with raw data and compared climate data files in percent on y-axis for total heating, total cooling, total supplied electricity use, PV production, exhaust temperature and operative temperature on the south side were presented using the duration curves. The details can be found in the attachments.

Arithmetic mean value in Watt for reference climate data file with 11 years raw data, EN-ISO 15927-4 climate data file, and new one-year compact climate data file tested on buildings with high and low thermal masses in four climate zones in Norway were presented in tables and can be found in the attachments.

Arithmetic mean value difference for climate data file based on EN-ISO 15927-4 approach and new one-year compact climate data file for total heating, total cooling, total supplied electricity use, and PV Production were presented in tables in kilowatt per square meter and can be found in the chapter 4.1.

The values for 99,6000 and 99,9943 percentiles in Watt for total heating, total cooling, total supplied electricity use, and PV production for reference climate data file with 11 years raw data, EN-ISO 15927-4 climate data file, and new one-year compact climate data file tested on buildings with high and low thermal masses in four climate zones in Norway were presented in tables and can be found in attachments.

The values for 99,6000 and 99,9943 percentiles in degrees Celsius for exhaust temperature and operative temperature for reference climate data file with 11 years raw data, EN-ISO 15927-4 climate data file, and new one-year compact climate data file tested on buildings with high and low thermal masses in Blindern and Flesland were presented in tables in attachments.

99,6000 and 99,9943 percentiles difference compared to raw climate data file for EN-ISO 15927-4 and new one-year compact climate data file in percent for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise were presented in tables in chapter 4.2 and 4.3.

For analysis of the results of testing climate data files, 99,6000 percentiles were used for evaluating the design conditions in winter and in summer, that is equivalent to 35 hours during a year, and 99,9943 percentiles for peak load, that is equivalent to 0,5 hour during a year. The results of comparing a reference climate data file with raw data, climate data file based on EN-ISO

15927-4 approach and new one-year compact climate data file on buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise were presented in diagrams.

Difference for 99,6000 and 99,9943 in precent for reference climate data file with 11 years raw data, EN-ISO 15927-4 climate data file, and new one-year compact climate data file tested on buildings with high and low thermal masses in four climate zones in Norway were presented in tables.

The results for seven rounds of simulation new one- year compact climate data file for random years started with different weekdays compared to the 11- years "raw data" climate data set tested on building with high thermal mass in Blidern were presented in two types of diagrams for standard deviation between the 11- years climate data file and new one-year compact climate data file: in Watt on y-axis for total heating, total cooling, total supplied electricity use and PV Production, and temperature in °C for exhaust temperature and operative temperature, respectively, and in precent on y-axis for total heating, total cooling, total supplied electricity use and PV Production, exhaust temperature and operative temperature. The details can be found in attachments.

The results for total heating, total cooling, and total supplied electricity use for 99,0000; 99,4292; 99,600; 99,9863; and 99,9943 percentiles for random years started with different weekdays and a reference climate data file with raw data in Watt were presented in diagrams in 4.4.

Arithmetic mean values, difference for arithmetic mean values, 99,6000 percentiles and 99,9943 percentiles in Watt for total heating, total cooling, total supplied electricity use and PV production, and in degrees Celsius for exhaust temperature and operative temperature for reference climate data file with 11 years raw data, and new one-year compact climate data file tested on building with high thermal mass in Blindern for random years started with different weekdays were presented in tables.

Difference for 99,6000 and 99,9943 in precent for reference climate data file with 11 years raw data, and new one-year compact climate data file tested on buildings with high thermal mass in Blindern for random years started with different weekdays were presented in tables.

Outside air temperature for reference climate data file with raw data, climate data file based on EN-ISO approach and new one-year climate data file was tested in Blindern, Flesland, Kise and Kirkenes to demonstrate which climate data set EN-ISO 15927-4 or new one-year compact had better approximation with 11 years raw data climate data file in terms of meteorological parameters. The results for outside air temperature were presented in percentiles from 99,0000 to 99,9943 for summer conditions, and from 0,0057 to 1,0000 for winter conditions in duration curves. The results can be found in attachments.

For evaluating of the results for climate data file based on EN-ISO 15927-4 approach and new one-year climate data file, the deviation from reference climate data file with 11 years hourly raw data observations from 01.01.2003 to 31.12.2013 less than 5,0 precent, either positive or negative, was assumed as acceptable in this master thesis. The positive deviation would cause to oversizing of the building installations when the negative deviation would cause to undersizing.

4.1 Average values for climate data files for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes and Kise

This chapter presents the results and discussions for mean values of EN-ISO 15927-4 climate data file and new one-year compact climate data file compared to reference climate data file with 11-years raw data.

Table 4.1.1 presents the arithmetic mean value difference in kilowatt per square meter for EN-ISO 15927-4 compared to raw data climate data file and table 4.1.2 presents the arithmetic mean value difference for new one- year climate data file compared to raw data climate data file.

Table 4.1.1 Arithmetic mean value difference compared to raw data climate data file. EN-ISO 15927-4

Location	**Type of thermal mass**	**Heating demand [kW/m2]**	**Cooling demand [kW/m2]**	**Total supplied electricity use[kW/m2]**	**PV Production [kW/m2]**
Blindern	high	75,13	120,5	-335,18	-411,09
Blindern	low	77,38	119,56	-341,53	-412,16
Flesland	high	90,69	25,51	53,76	-12,38
Flesland	low	91,78	24,12	62,21	-6,05
Kirkenes	high	-205,51	29,49	-0,38	-27,86
Kirkenes	low	-203,44	29,17	-0,20	-30,04
Kise	high	21,26	134,76	-131,82	-232,76
Kise	low	20,76	134,93	-134,77	-232,01

Table 4.1.2 Arithmetic mean value difference compared to raw data climate data file. New one-year compact

Location	Type of thermal mass	Heating demand [kW/m2]	Cooling demand [kW/m2]	Total supplied electricity use[kW/m2]	PV Production [kW/m2]
Blindern	high	-47,68	139,41	104,35	42,67
Blindern	low	-46,76	137,23	100,16	42,69
Flesland	high	38,35	7,36	124,34	96,65
Flesland	low	37,59	6,75	123,05	98,86
Kirkenes	high	-73,21	16,44	106,22	67,30
Kirkenes	low	-73,84	14,89	101,56	63,39
Kise	high	-11,06	31,93	85,89	48,08
Kise	low	-12,51	33,53	88,76	50,91

Analysis of the results for arithmetic mean value difference of climate data file based on EN-ISO 15927-4 approach and new one-year compact climate data file using a reference climate data file with 11 years raw meteorological data allowed to confirm that mean values of new one-year climate data file has less deviation with a reference climate data file for heating demand for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise; for cooling for buildings with high and low thermal masses in Flesland, Kirkenes, and Kise; for total supplied electricity use in Blindern, Kirkenes, and Kise.

Therefore, it can be concluded that new one-year climate data file fits better the average demand for heating, cooling, and supplied electricity use for most climate zones in Norway.

New one-year compact climate data file has less deviation with a reference climate data file for PV Production in Blindern and in Kise. Climate data file based in EN-ISO 15927-4 approach showed better results in Flesland and Kirkenes. The reason to this can be the static solar conditions in Kirkenes because of the midnight sun which lasts from the 17th of May to the 21st of June and polar night which lasts from the 21st of November to the 21st of January [47]. As it was described in chapter 2.3, for generating climate data file based on EN-ISO 15927-4 approach, it is used a Finkelstein- Schafer statistics that fits good static conditions and, therefore, it had less deviation with a reference climate data file. Another reason to this may be that for generating climate data file, whole months are spliced together. If, for example, a reference climate data file had the warmest week in June 2010, and for generating EN-ISO climate data file the month with this week was chosen, then it was not surprising that EN-ISO 15927-4 had better approximation with a reference climate data file with raw data.

Analysis of the results for 24- hours mean difference in percent presented in attachments allows to confirm that max difference for 24-hour mean value is less between reference climate data file and climate data file based on EN-ISO 15927-4 approach for cooling. For total heating, a new one-year compact climate data file had shown better results with deviation less than 5 % in Blindern and Kise. For max difference for 24- hours mean value for total supplied electricity use, and PV Production, both climate data files have deviation less 5% with a reference climate data file.

More results for mean values can be found in attachments 8.13.

4.2 99,6000 percentiles for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes and Kise

This chapter presents the results and discussions for 99,600 percentiles difference for EN-ISO 15927-4 climate data file and new one-year compact climate data file compared to reference climate data file with 11- years raw data.

Tables 4.2.1 and 4.2.2 present 99,6000 percentiles difference in percent between reference climate data file and EN-ISO 15927-4 and, respectively, between reference climate data file and new one-year compact.

Table 4.2.1 99,6000 percentiles difference compared to raw climate data file. EN-ISO 15927-4

Location	Type of thermal mass	Heating demand %	Cooling demand %	Total supplied electricity %	PV Production %	Exhaust temperature %	Operative temperature %
Blindern	high	5,19	1,85	0,09	0,25	0,02	-0,5
Blindern	low	4,16	1,66	0,01	0,28	3,52	-0,85
Flesland	high	6,52	1,20	-0,07	-0,33	-0,02	-1,16
Flesland	low	6,66	0,57	-0,14	-0,34	0	0,98
Kirkenes	high	-12,06	9,96	0,04	-0,41		
Kirkenes	low	-11,84	10,06	0,04	-0,63		
Kise	high	6,20	-2,69	0,13	0,30		
Kise	low	5,51	-2,63	0,22	-0,32		

Table 4.2.2 99,6000 percentiles difference compared to raw climate data file. New one-year compact climate data file

Location	Type of thermal mass	Heating demand %	Cooling demand %	Total supplied electricity %	PV Production %	Exhaust temperature %	Operative temperature %
Blindern	high	0,63	5,82	0,42	-0,15	0	-0,57
Blindern	low	0,32	6,28	0,28	-0,08	0,02	-0,31
Flesland	high	6,52	-3,18	0,21	-0,13	0	0,92
Flesland	low	14,03	0,96	-0,59	-0,35	0,02	1,14
Kirkenes	high	-1,65	3,77	-0,05	0,36		
Kirkenes	low	-1,58	3,71	0	0,22		
Kise	high	2,89	-3,45	0,13	0,29		
Kise	low	2,88	-3,37	0,17	0,37		

Deviation between tested climate data file and a reference climate data file less than 5% was assumed acceptable on this master thesis.

Climate data file based on EN-ISO 15927-4 approach had deviation greater than 5 % for total heating load for buildings with high and low thermal mass in Blindern, Flesland, Kirkenes, and Kise. For total cooling load, the climate data file based on EN-ISO 15927-4 approach had deviation greater than 5 % in Kirkenes. Since climate in Kitkenes is rather cold, the results for cooling load were not interesting. In other locations, the deviation for cooling load is less than 5%. The deviation for total supplied electricity and PV Production is less than 1 %for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise.

New one-year climate data file had deviation greater than 5% only in Flesland and for cooling in Blindern. Since the winters in Flesland are rather warm, it was more reasonable to take into consideration the low deviation between new one-year climate data file with reference in Blindern, Kise, and Kirkenes where the winters are much colder. Since the summers in Blindern are very warm, the results for estimating the cooling load are significant.

The analysis of the results for 99,6000 percentiles difference between climate data file based on EN-ISO 15927-4 approach with a reference climate data file, and 99,6000 percentiles difference between new one-year compact climate data file with a reference climate data file allows to conclude that new one- year compact climate data file fits better for estimating the design condition in winter.

The diagrams under present the results for 99,6000 percentiles for three climate data files tested on buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise. More results can be found in attachments.

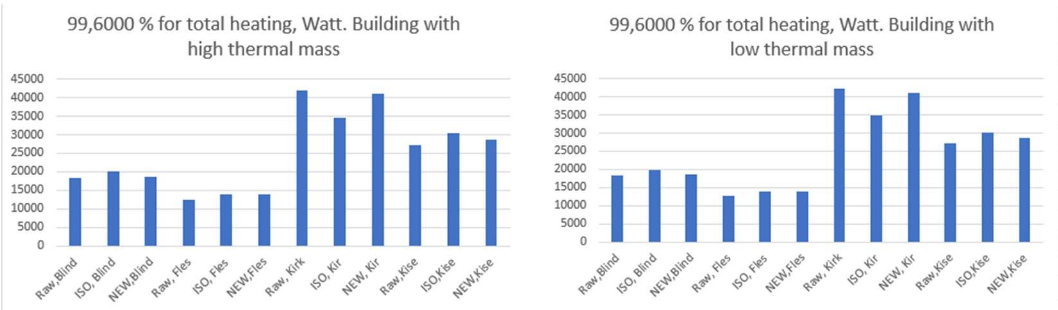

Figure 4.2.1 99,6000 for total heating in Watt for building with high and low thermal masses

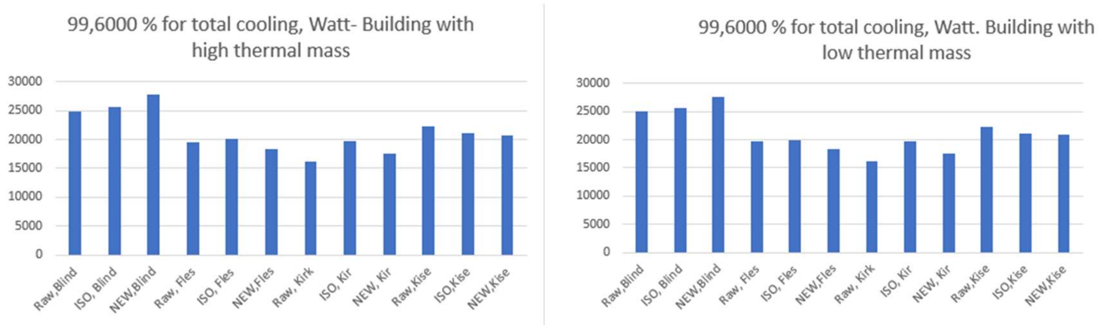

Figure 4.2.2 99,6000 for total cooling in Watt for building with high and low thermal masses

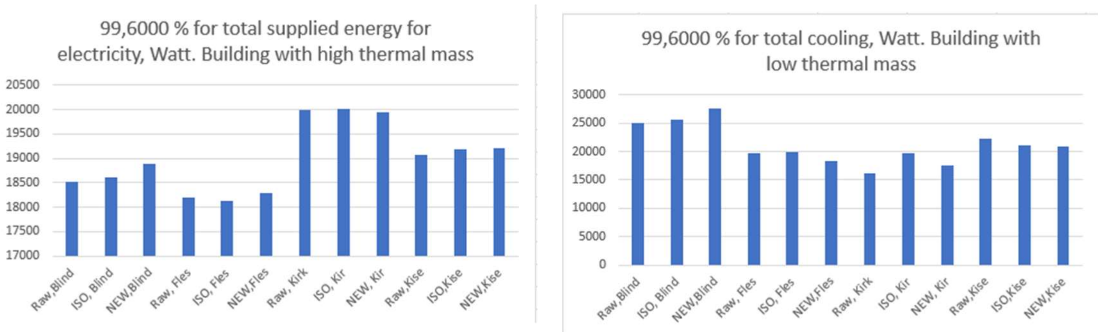

Figure 4.2.3 99,6000 for total supplied electricity use in Watt for building with high and low thermal masses

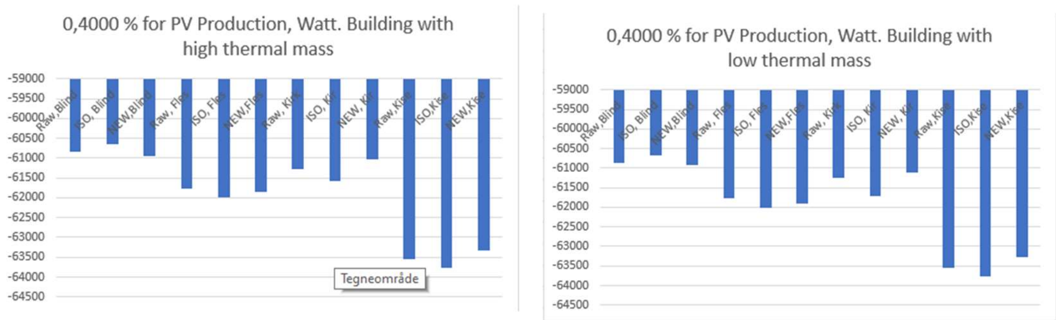

Figure 4.2.4 99,6000 for PV Production in Watt for building with high and low thermal masses

4.3 99,9943 percentiles for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes and Kise

This chapter presents the results and discussions for 99,9943 percentiles difference for EN-ISO 15927-4 climate data file and new one-year compact climate data file compared to reference climate data file with 11- years raw data.

Tables 4.3.1 and 4.3.2 present 99,9943 percentiles difference in percent between reference climate data file and EN-ISO 15927-4 and, respectively, between reference climate data file and new one-year compact.

Table 4.3.1 99,9943 percentiles difference compared to raw climate data file. EN-ISO 15927-4

Location	**Type of thermal mass**	**Heating demand %**	**Cooling demand %**	**Total supplied electricity %**	**PV Production %**	**Exhaust temperature %**	**Operative temperature %**
Blindern	high	9,84	-8,97	4,74	-1,5	-8,7	-0,15
Blindern	low	10,15	-9,26	4,31	-1,59	-6,19	-1,14
Flesland	high	10,02	-2,77	-0,08	-0,82	0,22	-1,62
Flesland	low	10,87	-3,26	-0,18	-0,86	-3,61	-0,63
Kirkenes	high	4,27	-21,81	0,04	1,14		
Kirkenes	low	3,66	-20,88	0,69	0,54		
Kise	high	25,41	-18,38	-0,02	0,95		
Kise	low	25,74	-18,20	0	1,29		

Table 4.3.2 99,9943 percentiles difference compared to raw climate data file. New one-year compact climate data file

Location	Type of thermal mass	Heating demand %	Cooling demand %	Total supplied electricity %	PV Production %	Exhaust temperature %	Operative temperature %
Blindern	high	-14,83	-11,05	3,21	-0,96	-7,37	-1,14
Blindern	low	-14,51	-10,74	2,46	-1,09	15,56	0,37
Flesland	high	6,23	-18,90	0,18	1.92	13	1,64
Flesland	low	7,04	-19,24	0,13	-0,86	8,65	-0,12
Kirkenes	high	-1,36	-16,80	0,02	-1,47		
Kirkenes	low	-1,76	-16,07	0,06	-3,09		
Kise	high	-2,92	-13,09	-0,09	-3,82		
Kise	low	-3,46	-13,79	-0,05	-3,99		

Deviation between tested climate data file and a reference climate data file less than 5% was assumed acceptable on this master thesis.

Climate data file based on EN-ISO 15927-4 approach had deviation for total heating greater than 5% for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise.

For total cooling demand, climate data file based on EN-ISO 15917-4 approach had deviation greater than 5% for buildings with high and low thermal masses in Blindern, Kirkenes, and Kise, while in Flesland it had deviation less than 5%. The results for cooling demand in Kirkenes and Kise are not significant due to cold climate, while the results for Blindern demonstrated that EN-ISO climate data file was not effective for estimating the peak load in warmer climate.

The deviation for total supplied electricity and PV Production were less than 5 % for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes and Kise.

The deviation exhaust temperature for Blindern was greater than 5% due to the same reason described above. The deviation for operative temperature was less than 5% for buildings with high and low thermal masses in Blindern and Flesland.

New one-year compact climate data file for total heating had deviation greater than 5% in Blindern and Flesland and less than 5 % in Kirkenes and Kise. This allowed to conclude that new one-year compact climate data file is more suitable for estimating the peak load in winter than EN-ISO 15927-4 climate data file. For total cooling, the new one-year compact climate data file had deviation greater than 5% for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise.

For total supplied electricity, the new one-year compact climate data file had deviation less than 5 % for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise and even smaller than it had EN-ISO 15927-4 climate data file.

For PV Production, the new one-year compact climate data file had deviation less than 5% for buildings with high and ow thermal masses in Blindern, Flesland, Kirkenes, and Kise. Exhaust temperature had deviation greater than 5% in Blindern and Flesland. The deviation for operative temperature was smaller than 5% for buildings with high and low thermal masses in Blindern and Flesland.

The analysis of the results for 99,9943 allowed to conclude that new one-year compact climate data file is more suitable for estimating the peak load demand in winter for cold climate zones with significantly lower temperatures in winter. Since it had less deviation for total supplied electricity, it can be concluded that new one-year compact climate data file is more effective for estimating the total peak load on system that is very important at early stage of the project.

The diagrams under present the results for 99,9943 percentiles for three climate data files tested on buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise. More results can be found in attachments.

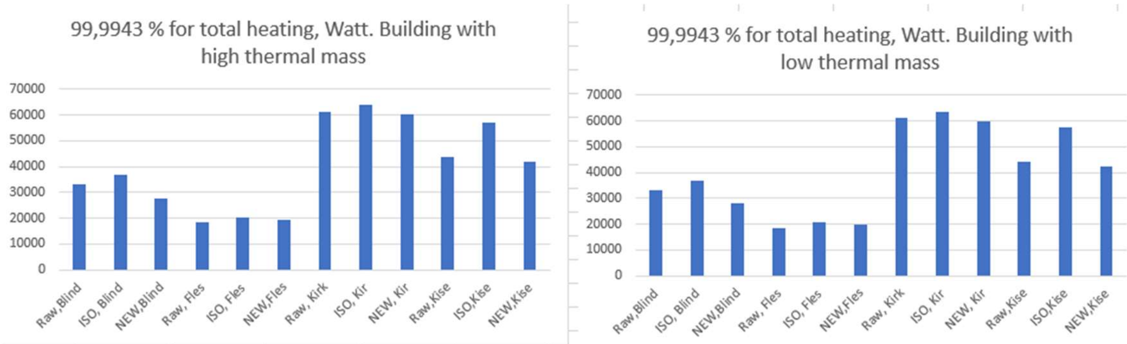

Figure 4.3.1 99,9943 for total heating in Watt for building with high and low thermal masses

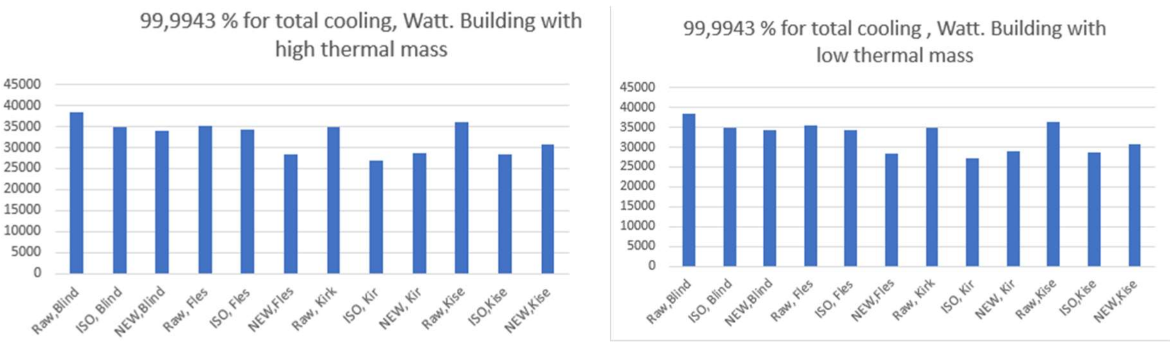

Figure 4.3.2 99,9943 for total cooling in Watt for building with high and low thermal masses

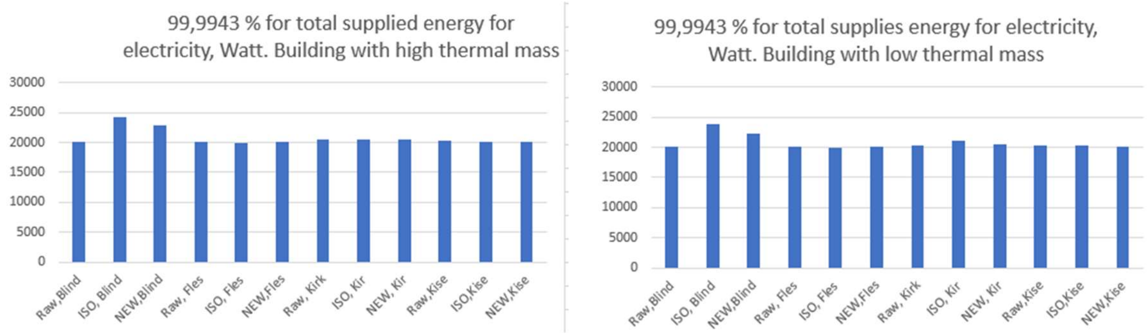

Figure 4.3.3 99,9943 for total supplied electricity use in Watt for building with high and low thermal masses

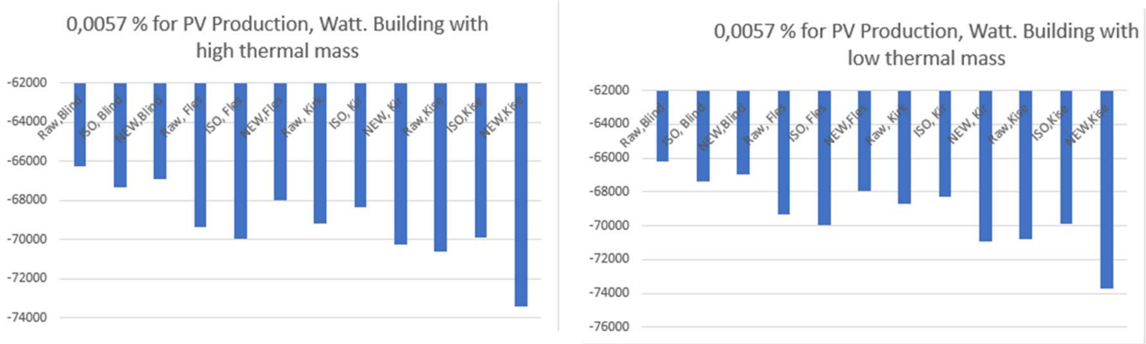

Figure 4.3.4 99,9943 for PV Production in Watt for building with high and low thermal masses

4.4 Testing of new one- year compact climate data file on building with high thermal mass in Blindern for random years started with different weekdays

This chapter presents the results and discussions for testing random years started with different weekdays tested on new one-year compact climate data file using the 11- years climate data file with raw data as a reference.

Table 4.4.1 presents the arithmetic mean value difference in kilowatt per square meter for new one- year climate data file compared to raw data climate data file for building with high thermal mass in Blindern.

Table 4.4.1 Arithmetic mean value difference for years started with different weekdays compared between a new one-year compact climate data file to raw climate data file on building with high thermal mass in Blindern

Weekday	Heating demand [kW/m2]	Cooling demand [kW/m2]	Total supplied electricity use [kW/m2]	PV Production [kW/m2]
Sunday	-28,93	42,29	50,76	42,76
Monday	6,53	20,29	53,23	68,17
Tuesday	22,039	37,23	23,64	42,62
Wednesday	-0,99	22,14	4,71	44,90
Thursday	-15,70	77,24	55,42	44,044
Friday	-53,56	138,80	102,37	43,36
Saturday	-61,96	110,49	78,48	66,03

The highest arithmetic mean difference for total heating for the building with high thermal mass in Blindern had random years started on Friday, Saturday, Sunday, and Tuesday. The lowest arithmetic mean difference had a random year started on Wednesday.

The highest arithmetic mean difference for total cooling for the building with high thermal mass in Blindern had random years started on Thursday, Friday, Saturday, and Sunday. The lowest arithmetic mean difference had random year started on Tuesday.

The highest arithmetic mean difference for total supplied electricity use had the random year started on Friday and Saturday, and the lowest, on Wednesday.

For PV Production, the highest arithmetic mean difference had a random year started on Saturday and Monday.

Therefore, it can be concluded that for arithmetic mean difference, the weekday that opens the year has a significant influence for total heating, total cooling, and total supplied electricity use tested using new one-year compact climate data file on building with high thermal mass in Blindern.

Tables 4.4.2 and 4.4.3 present 99,6000 percentiles difference and 99,9943 percentiles difference in percent between reference climate data file and new one-year compact for building with high thermal mass in Blindern.

Table 4.4. 2 99,6000 percentiles difference in precent for new one- year compact climate data file compared to raw climate data file for weekdays. Building with high thermal mass in Blindern

Weekday	Heating demand %	Cooling demand %	Total supplied electricity %	PV Production %	Exhaust temperature %	Operative temperature %
Sunday	-1,92	3,47	0,4	-0,25	-0,04	-5,32
Monday	3,54	0,62	0,4	-0,12	-0,04	-5,05
Tuesday	4,44	3,98	3,98	-0,28	-0,02	-4,95
Wednesday	4,49	4,48	0,23	-0,19	-0,04	-5,11
Thursday	3,57	4,42	0,30	-0,22	-0,02	-5,34
Friday	0,63	6,90	0,33	-0,12	-0,02	-5,63
Saturday	-3,29	4,65	0,51	0,16	-0,04	-5,38

Analysis of the results for 99,6000 percentiles difference, that is equivalent to 35 hours per year between reference climate data file and new one-year compact climate data file tested on building with high thermal mass in Blindern gave the following observations:

- The highest 99,6000 percentiles difference for total heating had random years started on Tuesday and Wednesday and the lowest 99, 6000 percentiles difference had random year started on Friday.
- The highest 99,6000 percentiles difference for total cooling had random year started on Friday and the lowest had a random year started on Monday.
- The highest 99,6000 percentiles difference for total supplied electricity had random year started on Tuesday, the lowest 99,6000 percentiles difference had the random year started on Wednesday.
- The 99,6000 percentiles difference for PV Production, exhaust temperature and operative temperature had minor deviation with 11-years reference climate data file.

Therefore, it can be concluded that for design winter and summer conditions it matters which weekday starts the year due to sequence of working days and weekend.

Table 4.4.3 99,9943 percentiles difference in precent for new one-year compact climate data file compared to raw climate data file for weekdays. Building with high thermal mass in Blindern

Weekday	**Heating demand** %	**Cooling demand** %	**Total supplied electricity** %	**PV Production** %	**Exhaust temperature** %	**Operative temperature** %
Sunday	-7,04	-10,93	0,04	-0,97	-4,80	-6,21
Monday	-6,17	-11,34	0,01	-1,02	-34,68	-5,43
Tuesday	-6,25	-11,51	3,88	-1,03	0,54	-4,91
Wednesday	-6,51	-11,58	3,55	-1,01	-4,05	-5,84
Thursday	-6,15	-11,64	3,37	-0,97	-6,48	-7,10
Friday	-14,83	-11,09	3,16	-0,96	-5,59	-6,81
Saturday	-20,10	-10,85	3,15	-0,96	22,45	-6,32

Analysis of the results for 99,9943 percentiles difference, that is equivalent to 0,5 hour per year between reference climate data file and new one-year compact climate data file tested on building with high thermal mass in Blindern gives the following observations:

- The highest 99,9943 percentiles difference for total heating had random years started on Friday and Saturday;
- The lowest 99,9943 percentiles difference for total supplied electricity had random year started on Sunday and Monday;
- The highest 99,9943 percentiles difference for exhaust temperature had random year started on Saturday and Monday, while the lowest 99,9943 percentiles had a random year started on Tuesday;
- The 99,9943 percentiles difference for total cooling; PV Production, and operative temperature were insignificant.

Therefore, it may be concluded that it is desirable to run seven rounds of simulations for random years started with different weekdays for the best accuracy of estimation the peak load for heating systems in winter. High 99,9943 percentiles difference for exhaust temperature means that particularly that year had the highest outside air temperature during the weekdays.

Two types of diagrams under demonstrate the results for 99,0000; 99,4292; 99,600; 99,9863; and 99,9943 percentiles and separately for 99,6000 percentiles that equivalent to 35 hours per year and can be used for design winter and summer conditions for reference climate data file and random years started with different weekdays for total heating, total cooling, and total supplied electricity.

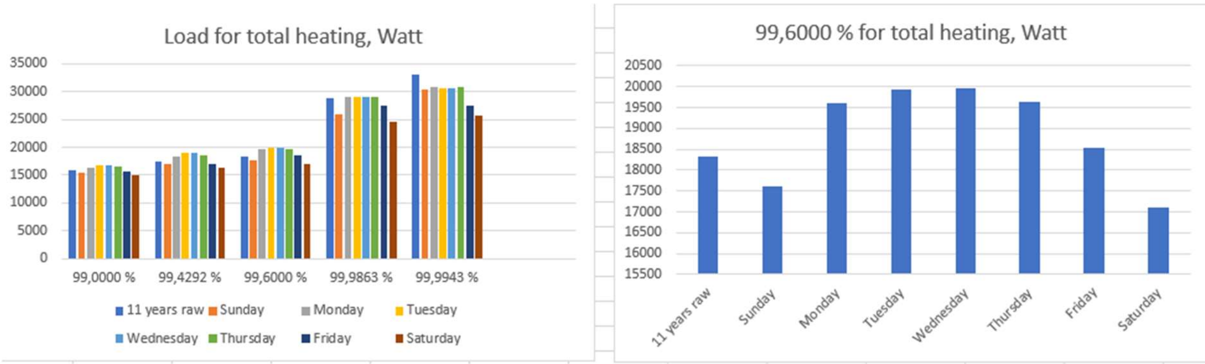

Figure 4.4.1 Total heating for reference climate data file and new one-year climate data file on building with high thermal mass in Blindern, Watt

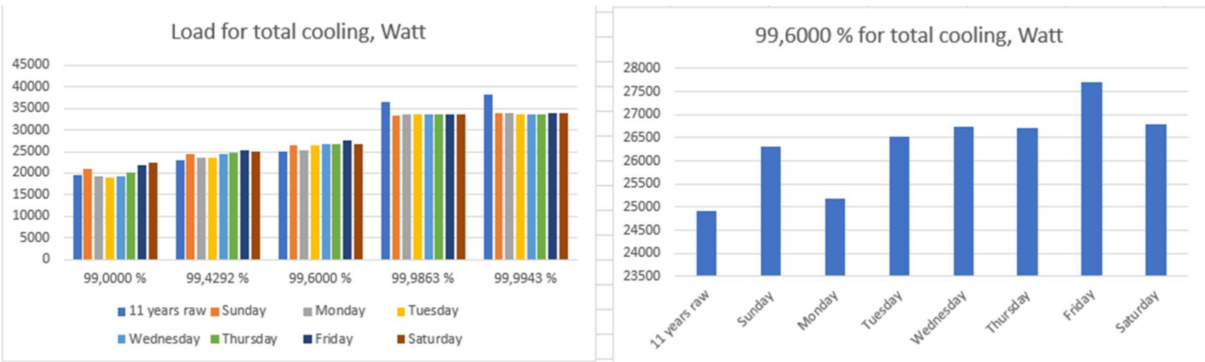

Figure 4.4.2 Total cooling for reference climate data file and new one-year climate data file on building with high thermal mass in Blindern, Watt

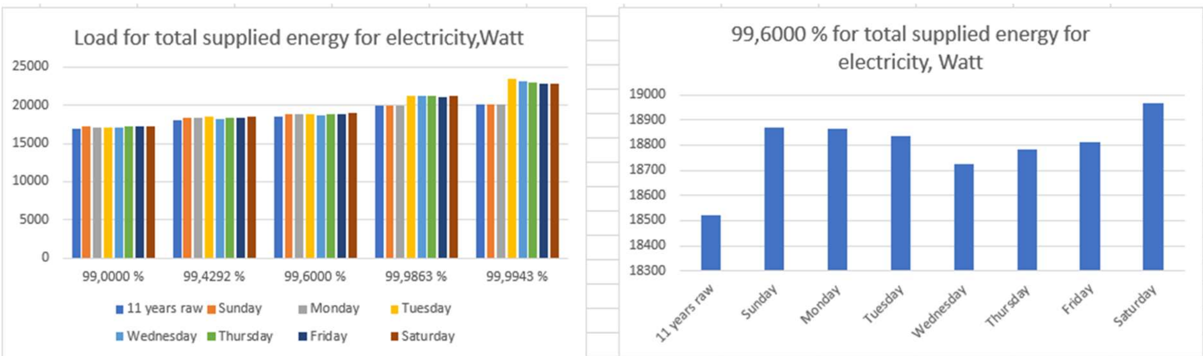

Figure 4.4.3 Total supplied electricity use for reference climate data file and new one-year climate data file on building with high thermal mass in Blindern, Watt

The diagrams for standard deviation and peak load for total heating, total cooling, total supplied electricity use, PV Production, exhaust temperature, and operative temperature on the South side for new one-year compact climate data file and reference climate data file with 11-years raw data tested on building with high thermal mass in Blindern are presented in attachments 8.14.

5 Conclusions

This master thesis presented the results of comparing a new one-year compact climate data file and climate data file based on EN- ISO 15927-4 approach using 11- years climate data file with raw data as a reference to reference on the Office buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise presenting different climate zones in Norway and North Europe, and the results of testing a new one-year compact climate data file started with different weekdays of random years using 11- years climate data file with raw data as a reference to investigate if energy consumption rate of the building depends on which day the actual year starts.

The results for total heating, total cooling, total supplied electricity use, PV Production, exhaust temperature, and operative temperature on the south side were presented in this master thesis for 11-years climate data file with raw data, climate data file based on EN-ISO 1927-4 approach and new one-year compact climate data file on buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise.

The first hypothesis of this master thesis was that a new one- year compact climate data file had a better approximation with climate data file with 11-years raw data than traditional ISO 15927-4 method due to different methods for constructing of climate data sets. Therefore, it might be more suitable for energy performance of buildings.

The second hypothesis was that years started with different weekdays would appreciable deviation comparing with a reference climate data file with raw data.

The results of comparing one year climate data files, which were climate data file based on EN-ISO 15927-4 approach and new one-year compact climate data file to a reference climate data file with 11-years of hourly raw data observed from 01.01.2003. to 31.12.2013 allows to confirm that a new one- year compact climate data file has better approximation with 11-years raw data climate data file in the most of cases. But the “most of cases” do not mean all. For some situations EN-ISO 15927-4 climate data file demonstrated better results than new one-year compact climate data file. Reason to that can be specific of constructing EN-ISO 15927-4 climate data file when the most typical months splices together. That is why if the warmest week happened in June 2010, and for constructing EN-ISO it was selected exactly that period, then EN-ISO 15927-4 would have better approximation with raw data climate data file. To relay on possibility that exactly the desired period would be included in climate data file is potentially weak method for energy performance of the buildings. For this reason, the new one-year compact climate data file is safer, because it splices together short periods and there is higher possibility that greater number of design days would be included. But there is no guarantee for that.

Testing of the random years started with different weekdays showed an observable difference in total heating, total cooling and total supplied electricity use depending on which weekday started the year. Therefore, for energy performance of the building, the energy advisors need to run seven rounds of the years started with different weekdays to predict different scenarios of energy demand. It can be also more effective to run seven rounds of one-year climate data file that 11-years or more with raw data only once in terms of the accuracy for the results because then there would be higher possibility that greater number of design summer and winter days were simulated.

Therefore, to achieve the best results for energy performance of the building it can be recommended to run new one-year compact climate data file seven rounds for random years started with different weekdays to predict different scenarios of energy demand.

The exhaust temperature and operative temperature on the south side of the buildings with high and low thermal masses did not exceed 26 degrees Celsius during the year in Blindern and Flesland.

The figures under demonstrate the duration curves for arithmetic mean value differences for total heating, total cooling, and total supplied electricity for climate data file based on EN-ISO 15927-4 approach and new one- year compact climate data file for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise; 99,6000 percentiles differences for total heating, total cooling, and total supplied electricity for climate data file based on EN-ISO 15927-4 approach and new one- year compact climate data file for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise; and 99,9943 percentiles differences for total heating, total cooling, and total supplied electricity for climate data file based on EN-ISO 15927-4 approach and new one- year compact climate data file for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise.

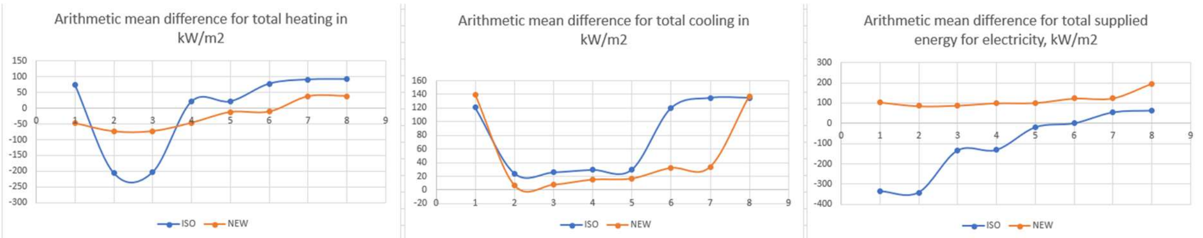

Figure 5.1 Arithmetic mean value differences for total heating, total cooling, and total supplied electricity use for climate data file based on EN-ISO 15927-4 approach and new one- year compact climate data file for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise

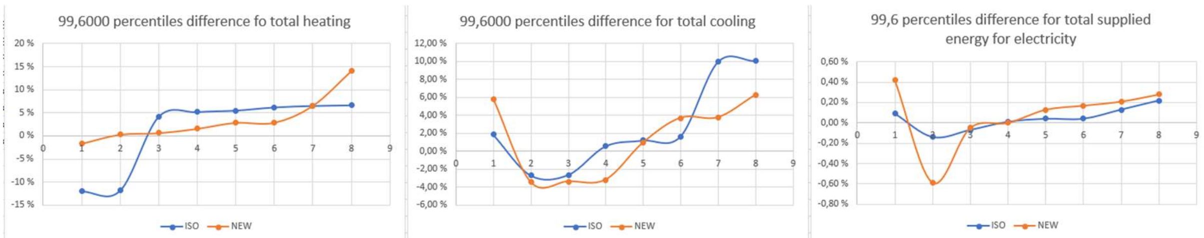

Figure 5.2 99,6000 percentiles differences for total heating, total cooling, and total supplied electricity use for climate data file based on EN-ISO 15927-4 approach and new one- year compact climate data file for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise

Figure 5.3 99,9943 percentiles differences for total heating, total cooling, and total supplied electricity use for climate data file based on EN-ISO 15927-4 approach and new one- year compact climate data file for buildings with high and low thermal masses in Blindern, Flesland, Kirkenes, and Kise

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7 List of figures

8 Attachments

8.1 Common data about the buildings

Name	Group	Floor height, m	Room height, m	Floor area, m2	Heat setp., °C	Cool setp., °C	AHU	System	Supply air, L/(s.m2)	Return air, L/(s.m2)	Occup., no./m2	Lights, W/m2	Lights, kWh/m2	Equipment, W/m2	Equipment, kWh/m2	Ext win. area, m2	Occup. schedule	Light schedule	Equipm. schedule
2nd-s2	direct-i...	3.02	3.02	303.8	21.0	24.0	Air Ha...	CAV	1.7	1.7	0.09876	1.0	12.32	1.0	17.68	89.98	NS SP...	© SN-...	© NS ...
2nd-s1-s1	direct-i...	3.02	3.02	317.3	21.0	24.0	Air Ha...	CAV	1.7	1.7	0.09456	1.0	12.32	1.0	17.68	89.98	NS SP...	© SN-...	© NS ...
2nd-s1-s2	direct-i...	3.02	3.02	528.1	21.0	24.0	Air Ha...	CAV	1.7	1.7	0.0947	1.0	12.32	1.0	17.68	21.0	NS SP...	© SN-...	© NS ...
Total/m2									1.7	1.7	0.09573	1.0	12.32	1.0	17.68	58.28			

Figure 8.1.1 Zones

Name	Group	Floor height, m	Zone multiplier	M*Area, m2	M*Supply air, L/s	M*Return air, L/s	M*Occupants, items	M*Lights, W	M*Lights, kWh	M*Equipment, W	M*Equipment, kWh	M*Volume, m3	M*Walls above gr., m2	M*Walls below gr., m2	M*Ext win. area, m2	M*Extdoor area, m2	M*Roof area, m2	M*Ground area, m2	M*floor to amb., m2	M*Tot env. area, m2	M*UAtot, W/K	M*UAwal above gr. W/K
2nd-s2	direct-i...	3.02	1	303.8	516.5	516.5	30.0	303.8	3742.3	303.8	5372.3	917.6	121.8	0.0	89.98	0.0	0.0	0.0	0.0	211.8	101.3	13.94
2nd-s1-s1	direct-i...	3.02	1	317.3	539.4	539.4	30.0	317.3	3908.6	317.3	5611.1	958.3	123.2	0.0	89.98	0.0	0.0	0.0	0.0	213.2	101.6	14.09
2nd-s1-s2	direct-i...	3.02	1	528.1	897.8	897.8	50.0	528.1	6505.3	528.1	9338.8	1595.0	32.16	0.0	21.0	0.0	0.0	0.0	0.0	53.16	24.39	3.679
Total			3	1149.2	1953.7	1953.7	110.0	1149.2	14156.2	1149.2	20322.2	3470.9	277.2	0.0	201.0	0.0	0.0	0.0	0.0	478.2	227.3	31.71

Figure 8.1.2 Zone totals

Name	Group	Setpoint collection	Heat setp., °C	Cool setp., °C	Min VAV air return, L/(s m2)	Max VAV air return, L/(s m2)	Min VAV air supply, L/(s m2)	Max VAV air supply, L/(s m2)	Min humidity, %	Max humidity, %	Min CO2, ppm (vol)	Max CO2, ppm (vol)	Min light, lx	Max light, lx	Min pressure diff, Pa	Max pressure diff, Pa	Var. heat setpoint	Var. cool s
2nd-s2	direct-i...	[local for zone]	21.0	24.0	0.4	1.7	0.4	1.7	20.0	80.0	700.0	1100.0	100.0	10000.0	-20.0	-10.0	<value not set>	<value not set>
2nd-s1-s1	direct-i...	[local for zone]	21.0	24.0	0.4	1.7	0.4	1.7	20.0	80.0	700.0	1100.0	100.0	10000.0	-20.0	-10.0	<value not set>	<value not set>
2nd-s1-s2	direct-i...	[local for zone]	21.0	24.0	0.4	1.7	0.4	1.7	20.0	80.0	700.0	1100.0	100.0	10000.0	-20.0	-10.0	<value not set>	<value not set>

Figure 8.1.3 Zone setpoints

Name	Type	Group	Number of units	Power, W	Activity level	Control	Select summary table	Energy meter	Mean, W	Yearly total, kWh
2nd-s2.Occupa...	© Occupant	direct-i...	30.0		1.0		NS SPEK 3031_o...			
2nd-s2.Equipm...	© Equipment	direct-i...	1.0	303.8			© NS SPEK 3031...	[Default] Equipment, tenant	613.3	5372.3
2nd-s2.Light	© Light	direct-i...	303.8	1.0		Schedule	© SN-NSPEK 303...	[Default] Lighting, facility	427.2	3741.9
2nd-s1-s1.Occ...	© Occupant	direct-i...	30.0		1.0		NS SPEK 3031_o...			
2nd-s1-s1.Equi...	© Equipment	direct-i...	1.0	317.3			© NS SPEK 3031...	[Default] Equipment, tenant	640.5	5611.1
2nd-s1-s1.Light	© Light	direct-i...	317.3	1.0		Schedule	© SN-NSPEK 303...	[Default] Lighting, facility	446.2	3909.2
2nd-s1-s2.Occ...	© Occupant	direct-i...	50.0		1.0		NS SPEK 3031_o...			
2nd-s1-s2.Equi...	© Equipment	direct-i...	1.0	528.1			© NS SPEK 3031...	[Default] Equipment, tenant	1066.1	9338.8
2nd-s1-s2.Light	© Light	direct-i...	528.1	1.0		Schedule	© SN-NSPEK 303...	[Default] Lighting, facility	742.6	6505.1

Figure 8.1.4 Internal gains

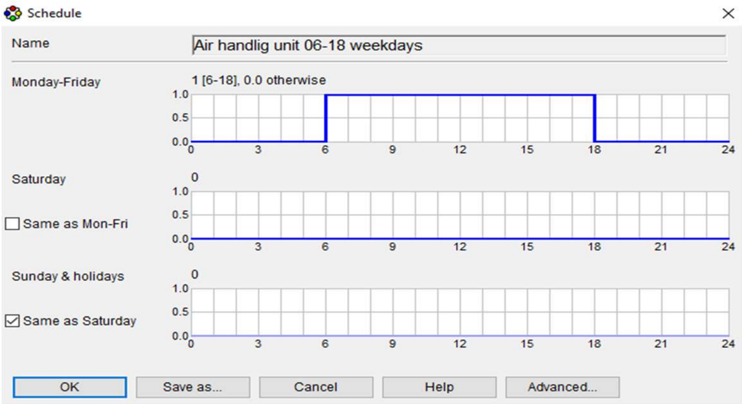


Figure 8.1.5 Schedule for Air Handling Unit

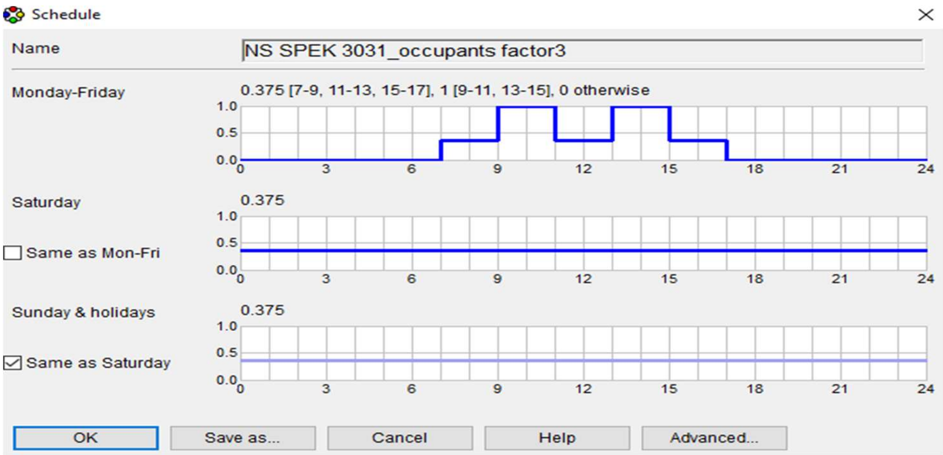


Figure 8.1.6 Schedule for internal gains for occupants

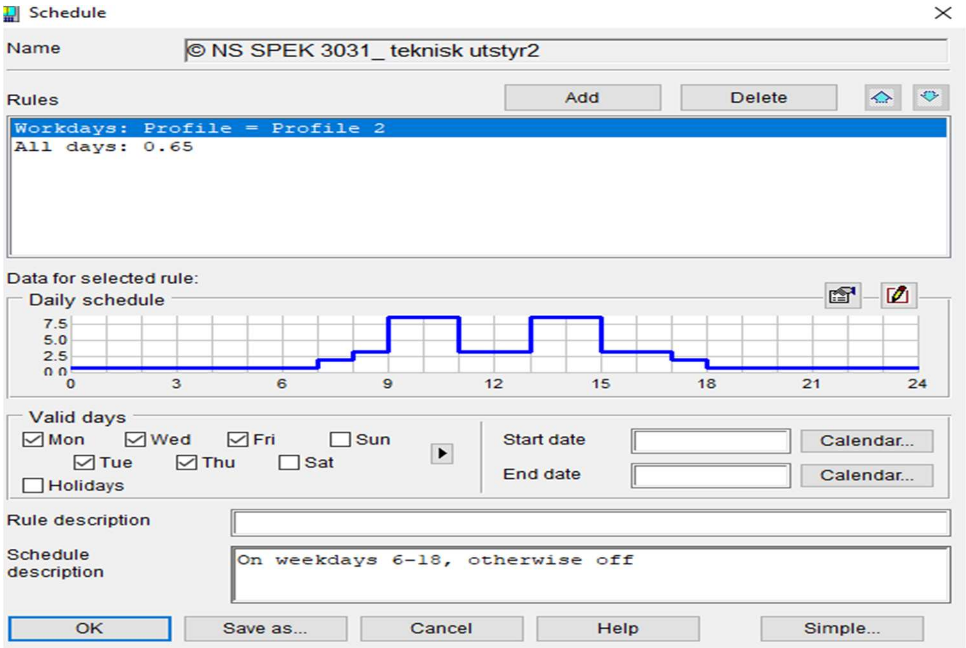


Figure 8.1.7 Schedule for internal gains for equipment

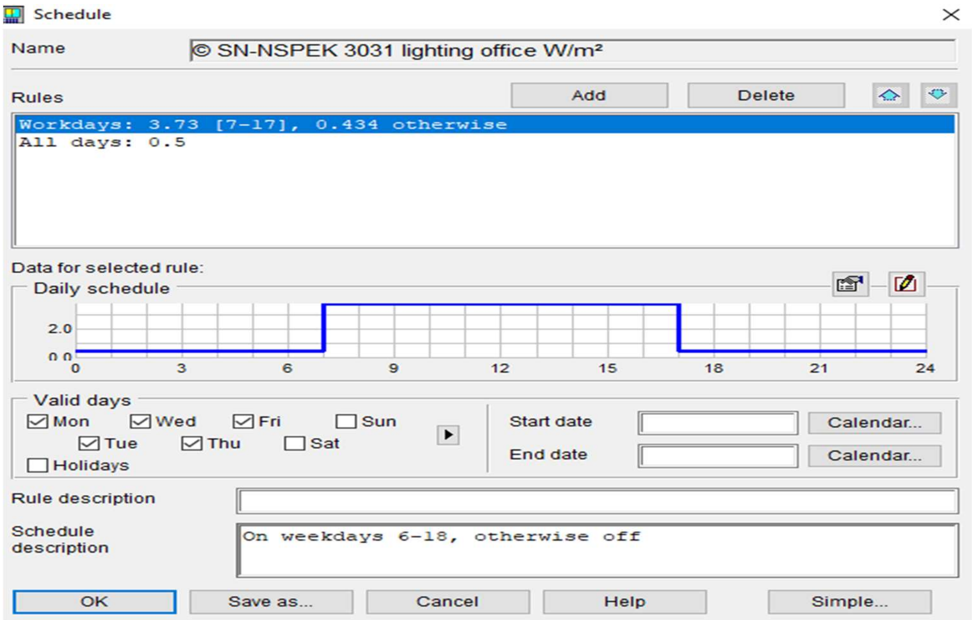


Figure 8.1.8 Schedule for internal gains for lighting

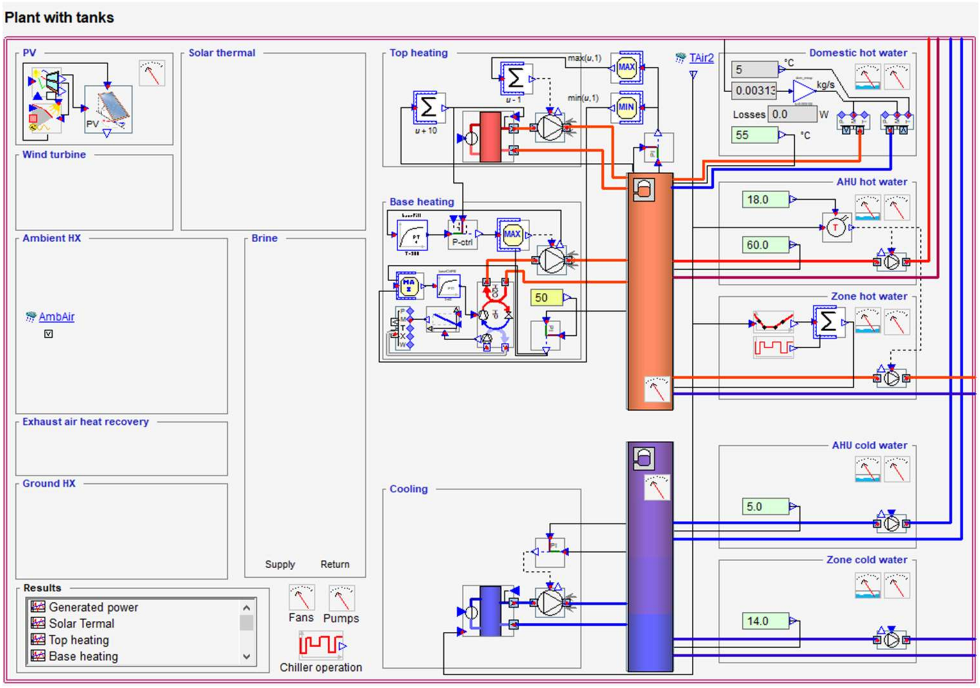


Figure 8.1.9 Plant unit

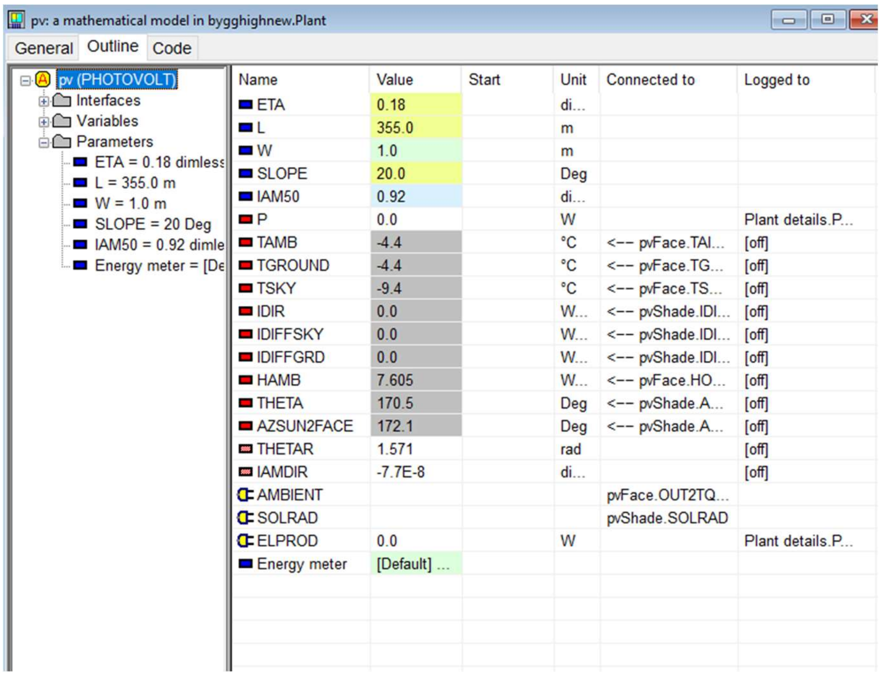


Figure 8.1.10 Parameters for PV panel

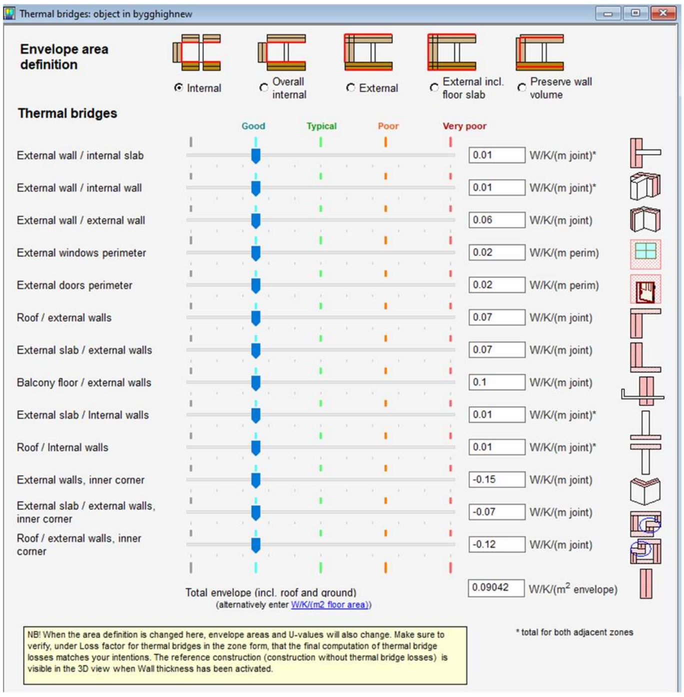


Figure 8.1.11 Thermal bridges

8.2 Building with high thermal mass

Details

○ Zones ○ Zone totals ○ Zone setpoints ◉ Surfaces ○ Windows ○ Openings ○ Leaks ○ Internal gains ○ Wall constructions ○ Time schedules ○ Materials ○ Room units

Name	Group	Type	Wetted area, m2	Connected to	Azimuth, Deg	Slope, Deg	Construction	U-value, W/(m2 K)	Thickness, m	Layer material	Layer thickness, m	Layer material	Layer thickness, m	Layer material	Layer thickness, m	Layer material	Layer thickness, m	Layer materia
2nd-s2.FLOOR1	direct-i...	Int. floor	303.8	None		0.0	[Defaul...	1.181	0.574	Linole...	0.004	© Con...	0.15	air gap...	0.4	© Hea...	0.02	
2nd-s2.Wall 1	direct-i...	Ext. wall	101.2	Buildin...	0.0	90.0	[Defaul...	0.1144	0.71	© Stee...	0.01	© Con...	0.3	© Light...	0.3	© Con...	0.1	
2nd-s2.Wall 2	direct-i...	Ext. wall	9.916	Buildin...	90.0	90.0	[Defaul...	0.1144	0.71	© Stee...	0.01	© Con...	0.3	© Light...	0.3	© Con...	0.1	
2nd-s2.Wall 3	direct-i...	Int. wall	181.2	2nd-s1...	179.8	90.0	[Defaul...	0.6062	0.356	© Gyp...	0.026	© Air in...	0.07	© Gyp...	0.26			
2nd-s2.Wall 4	direct-i...	Ext. wall	10.67	Buildin...	270.0	90.0	[Defaul...	0.1144	0.71	© Stee...	0.01	© Con...	0.3	© Light...	0.3	© Con...	0.1	
2nd-s2.CEILIN...	direct-i...	Int ceili...	303.8	None		180.0	[Defaul...	1.181	0.574	© Hea...	0.02	air gap...	0.4	© Con...	0.15	Linole...	0.004	
2nd-s1-s1.FLO...	direct-i...	Int. floor	317.3	None		0.0	[Defaul...	1.181	0.574	Linole...	0.004	© Con...	0.15	air gap...	0.4	© Hea...	0.02	
2nd-s1-s1.WAL...	direct-i...	Ext. wall	10.97	Buildin...	90.0	90.0	[Defaul...	0.1144	0.71	© Stee...	0.01	© Con...	0.3	© Light...	0.3	© Con...	0.1	
2nd-s1-s1.WAL...	direct-i...	Ext. wall	101.2	Buildin...	180.0	90.0	[Defaul...	0.1144	0.71	© Stee...	0.01	© Con...	0.3	© Light...	0.3	© Con...	0.1	
2nd-s1-s1.WAL...	direct-i...	Ext. wall	10.97	Buildin...	270.0	90.0	[Defaul...	0.1144	0.71	© Stee...	0.01	© Con...	0.3	© Light...	0.3	© Con...	0.1	
2nd-s1-s1.CEIL...	direct-i...	Int ceili...	317.3	None		180.0	[Defaul...	1.181	0.574	© Hea...	0.02	air gap...	0.4	© Con...	0.15	Linole...	0.004	
2nd-s1-s1.CEIL...	direct-i...	Int. wall	181.2	2nd-s1...	4.77E-4	90.01	[Defaul...	0.6062	0.356	© Gyp...	0.026	© Air in...	0.07	© Gyp...	0.26			
2nd-s1-s2.FLO...	direct-i...	Int. floor	528.1	None		0.0	[Defaul...	1.181	0.574	Linole...	0.004	© Con...	0.15	air gap...	0.4	© Hea...	0.02	
2nd-s1-s2.WAL...	direct-i...	Int. wall	181.2	2nd-s1...	180.0	89.99	[Defaul...	0.6062	0.356	© Gyp...	0.026	© Air in...	0.07	© Gyp...	0.26			
2nd-s1-s2.WAL...	direct-i...	Ext. wall	16.46	Buildin...	90.0	90.0	[Defaul...	0.1144	0.71	© Stee...	0.01	© Con...	0.3	© Light...	0.3	© Con...	0.1	
2nd-s1-s2.WAL...	direct-i...	Ext. wall	15.7	Buildin...	270.0	90.0	[Defaul...	0.1144	0.71	© Stee...	0.01	© Con...	0.3	© Light...	0.3	© Con...	0.1	
2nd-s1-s2.WAL...	direct-i...	Int. wall	181.2	2nd-s2	359.8	90.0	[Defaul...	0.6062	0.356	© Gyp...	0.026	© Air in...	0.07	© Gyp...	0.26			
2nd-s1-s2.CEIL...	direct-i...	Int ceili...	528.1	None		180.0	[Defaul...	1.181	0.574	© Hea...	0.02	air gap...	0.4	© Con...	0.15	Linole...	0.004	

Figure 8.2.1 Surfaces

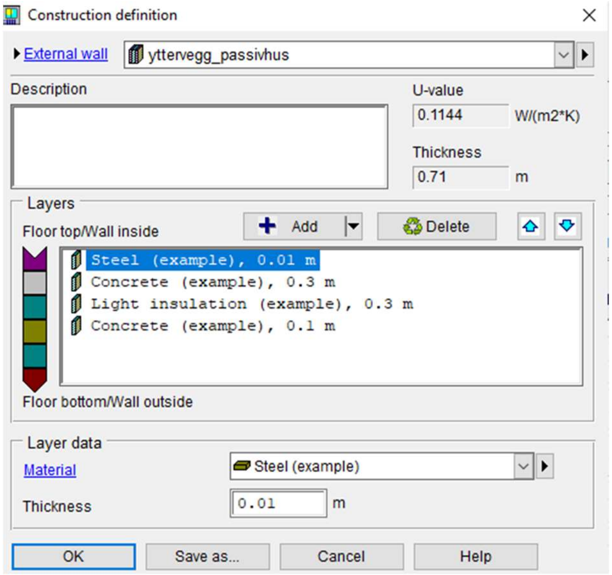


Figure 8.2.2 External wall

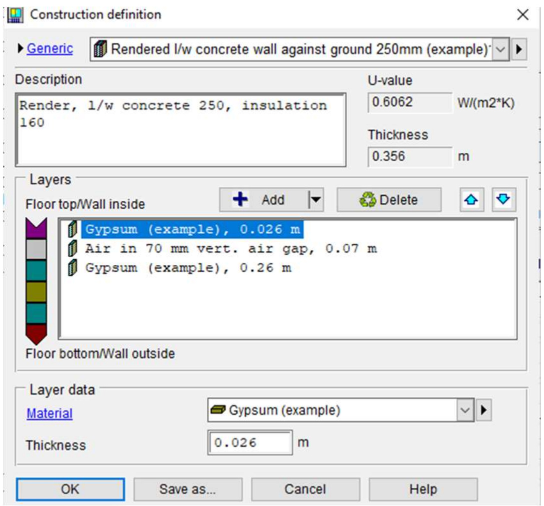


Figure 8.2.3 Internal wall

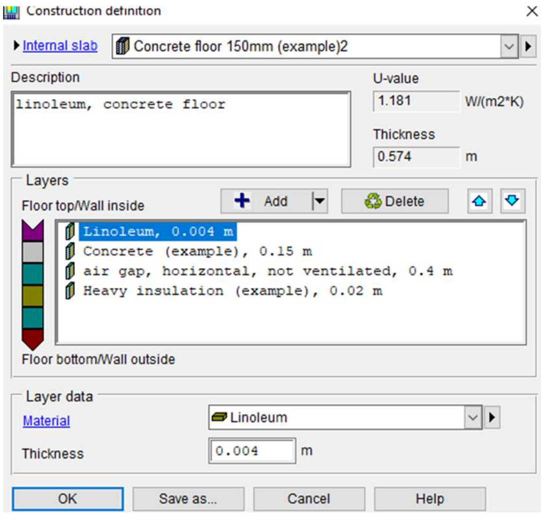


Figure 8.2.4 Internal floor

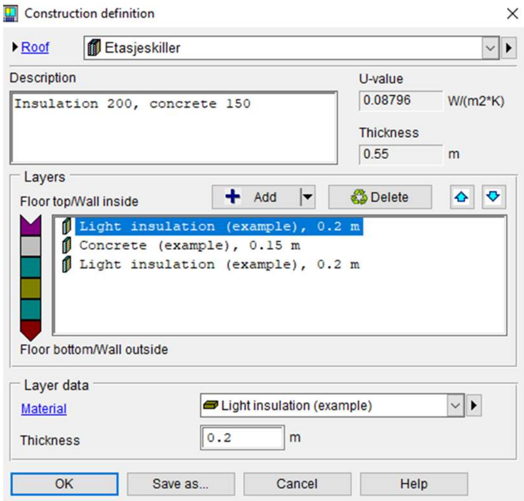
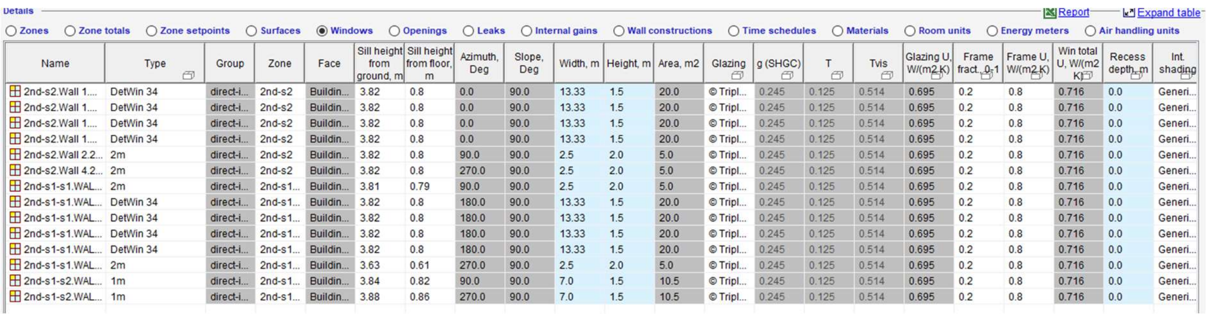


Figure 8.2.5 Floor separator



Name	Type	Group	Zone	Face	Sill height from ground, m	Sill height from floor, m	Azimuth, Deg	Slope, Deg	Width, m	Height, m	Area, m2	Glazing	g (SHGC)	T	Tvis	Glazing U, W/(m2 K)	Frame fract., 0-1	Frame U, W/(m2 K)	Win total U, W/(m2 K)	Recess depth, m	Int. shading
2nd-s2.Wall 1....	DetWin 34	direct-i...	2nd-s2	Buildin...	3.82	0.8	0.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 1....	DetWin 34	direct-i...	2nd-s2	Buildin...	3.82	0.8	0.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 1....	DetWin 34	direct-i...	2nd-s2	Buildin...	3.82	0.8	0.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 1....	DetWin 34	direct-i...	2nd-s2	Buildin...	3.82	0.8	0.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 2.2...	2m	direct-i...	2nd-s2	Buildin...	3.82	0.8	90.0	90.0	2.5	2.0	5.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 4.2...	2m	direct-i...	2nd-s2	Buildin...	3.82	0.8	270.0	90.0	2.5	2.0	5.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	2m	direct-i...	2nd-s1...	Buildin...	3.81	0.79	90.0	90.0	2.5	2.0	5.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	DetWin 34	direct-i...	2nd-s1...	Buildin...	3.82	0.8	180.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	DetWin 34	direct-i...	2nd-s1...	Buildin...	3.82	0.8	180.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	DetWin 34	direct-i...	2nd-s1...	Buildin...	3.82	0.8	180.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	DetWin 34	direct-i...	2nd-s1...	Buildin...	3.82	0.8	180.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	2m	direct-i...	2nd-s1...	Buildin...	3.63	0.61	270.0	90.0	2.5	2.0	5.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s2.WAL...	1m	direct-i...	2nd-s1...	Buildin...	3.84	0.82	90.0	90.0	7.0	1.5	10.5	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s2.WAL...	1m	direct-i...	2nd-s1...	Buildin...	3.88	0.86	270.0	90.0	7.0	1.5	10.5	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...

Figure 8.2.6 Windows

8.3 Building with low thermal mass

Details — Zones | Zone totals | Zone setpoints | (•) Surfaces | Windows | Openings | Leaks | Internal gains | Wall constructions | Time schedules | Materials | Room units | Energy meters | Air handling units — Report — Expand tal

Name	Group	Type	Wetted area, m2	Connected to	Azimuth, Deg	Slope, Deg	Construction	U-value, W/(m2 K)	Thickness, m	Layer material	Layer thickness, m	Layer material	Layer thickness, m	Layer material	Layer thickness, m	Layer material	Layer thickness, m	Layer material	Layer thickness, m	Layer material	Layer thickness, m	Laye materi
2nd-s2.FLOOR1	direct-i...	Int. floor	303.8	None		0.0	[Defaul...	0.1936	0.273	Woo...	0.01	L/W ...	0.025	Fra...	0.2	Chip...	0.012	Gyp...	0.026			
2nd-s2.Wall 1	direct-i...	Ext. wall	101.2	Buildin...	0.0	90.0	[Defaul...	0.1423	0.3665	Woo...	0.03	Air in...	0.002	Light...	0.06	Chip...	0.012	Fra...	0.25	Gyp...	0.0125	
2nd-s2.Wall 2	direct-i...	Ext. wall	9.916	Buildin...	90.0	90.0	[Defaul...	0.1423	0.3665	Woo...	0.03	Air in...	0.002	Light...	0.06	Chip...	0.012	Fra...	0.25	Gyp...	0.0125	
2nd-s2.Wall 3	direct-i...	Int. wall	181.2	2nd-s1...	179.8	90.0	[Defaul...	0.4401	0.28	Ren...	0.015	L/W ...	0.25	Light...	0.015							
2nd-s2.Wall 4	direct-i...	Ext. wall	10.67	Buildin...	270.0	90.0	[Defaul...	0.1423	0.3665	Woo...	0.03	Air in...	0.002	Light...	0.06	Chip...	0.012	Fra...	0.25	Gyp...	0.0125	
2nd-s2.CEILIN...	direct-i...	Int ceili...	303.8	None		180.0	[Defaul...	0.1936	0.273	Gyp...	0.026	Chip...	0.012	Fra...	0.2	L/W ...	0.025	Woo...	0.01			
2nd-s1-s1.FLO...	direct-i...	Int. floor	317.3	None		0.0	[Defaul...	0.1936	0.273	Woo...	0.01	L/W ...	0.025	Fra...	0.2	Chip...	0.012	Gyp...	0.026			
2nd-s1-s1.WAL...	direct-i...	Ext. wall	10.97	Buildin...	90.0	90.0	[Defaul...	0.1423	0.3665	Woo...	0.03	Air in...	0.002	Light...	0.06	Chip...	0.012	Fra...	0.25	Gyp...	0.0125	
2nd-s1-s1.WAL...	direct-i...	Ext. wall	101.2	Buildin...	180.0	90.0	[Defaul...	0.1423	0.3665	Woo...	0.03	Air in...	0.002	Light...	0.06	Chip...	0.012	Fra...	0.25	Gyp...	0.0125	
2nd-s1-s1.WAL...	direct-i...	Ext. wall	10.97	Buildin...	270.0	90.0	[Defaul...	0.1423	0.3665	Woo...	0.03	Air in...	0.002	Light...	0.06	Chip...	0.012	Fra...	0.25	Gyp...	0.0125	
2nd-s1-s1.CEIL...	direct-i...	Int ceili...	317.3	None		180.0	[Defaul...	0.1936	0.273	Gyp...	0.026	Chip...	0.012	Fra...	0.2	L/W ...	0.025	Woo...	0.01			
2nd-s1-s1.CEIL...	direct-i...	Int. wall	181.2	2nd-s1...	4.77E-4	90.01	[Defaul...	0.4401	0.28	Ren...	0.015	L/W ...	0.25	Light...	0.015							
2nd-s1-s2.FLO...	direct-i...	Int. floor	528.1	None		0.0	[Defaul...	0.1936	0.273	Woo...	0.01	L/W ...	0.025	Fra...	0.2	Chip...	0.012	Gyp...	0.026			
2nd-s1-s2.WAL...	direct-i...	Int. wall	181.2	2nd-s1...	180.0	89.99	[Defaul...	0.4401	0.28	Ren...	0.015	L/W ...	0.25	Light...	0.015							
2nd-s1-s2.WAL...	direct-i...	Ext. wall	16.46	Buildin...	90.0	90.0	[Defaul...	0.1423	0.3665	Woo...	0.03	Air in...	0.002	Light...	0.06	Chip...	0.012	Fra...	0.25	Gyp...	0.0125	
2nd-s1-s2.WAL...	direct-i...	Ext. wall	15.7	Buildin...	270.0	90.0	[Defaul...	0.1423	0.3665	Woo...	0.03	Air in...	0.002	Light...	0.06	Chip...	0.012	Fra...	0.25	Gyp...	0.0125	
2nd-s1-s2.WAL...	direct-i...	Int. wall	181.2	2nd-s2	359.8	90.0	[Defaul...	0.4401	0.28	Ren...	0.015	L/W ...	0.25	Light...	0.015							
2nd-s1-s2.CEIL...	direct-i...	Int ceili...	528.1	None		180.0	[Defaul...	0.1936	0.273	Gyp...	0.026	Chip...	0.012	Fra...	0.2	L/W ...	0.025	Woo...	0.01			

Figure 8.3.1 Surfaces

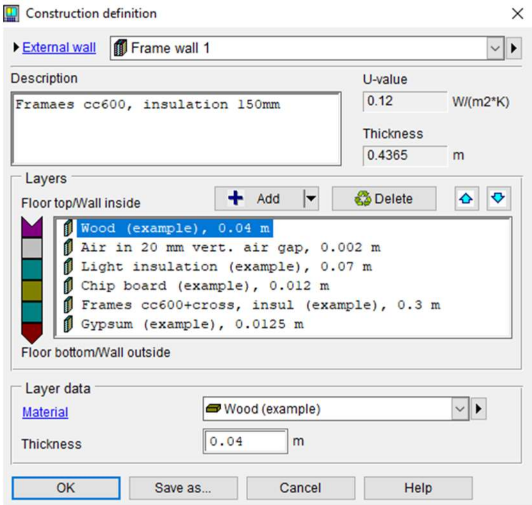


Figure 8.3.2 External walls

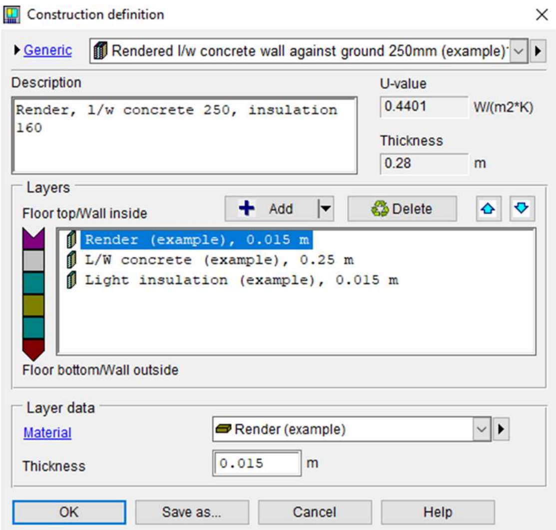


Figure 8.3.3 Internal walls

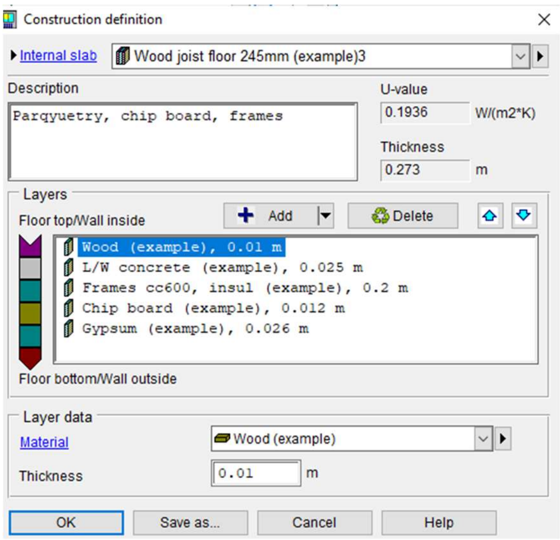


Figure 8.3.4 Internal floor

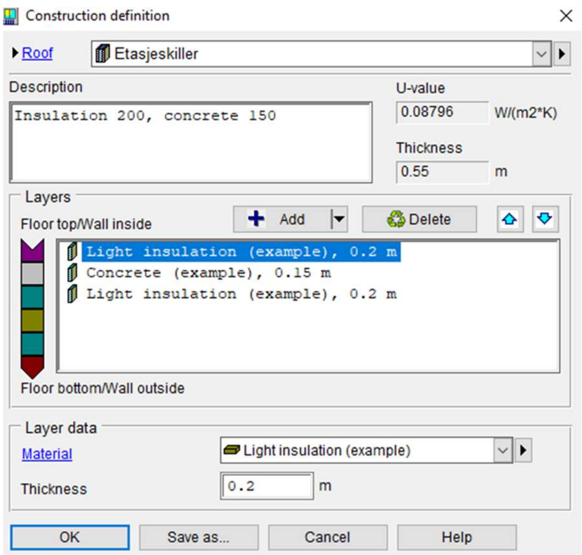
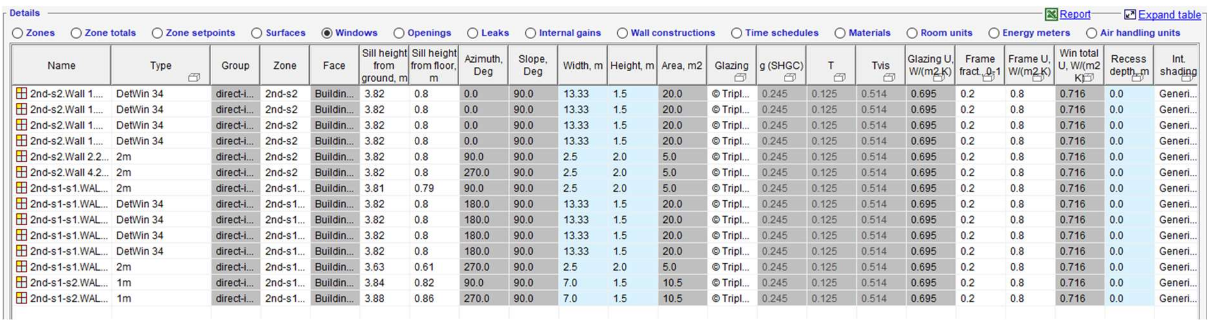


Figure 8.3.5 Floor separator



Details — Zones | Zone totals | Zone setpoints | Surfaces | Windows | Openings | Leaks | Internal gains | Wall constructions | Time schedules | Materials | Room units | Energy meters | Air handling units — Report — Expand table

Name	Type	Group	Zone	Face	Sill height from ground, m	Sill height from floor, m	Azimuth, Deg	Slope, Deg	Width, m	Height, m	Area, m2	Glazing	g (SHGC)	T	Tvis	Glazing U, W/(m2 K)	Frame fract., 0-1	Frame U, W/(m2 K)	Win total U, W/(m2 K)	Recess depth, m	Int. shading
2nd-s2.Wall 1....	DetWin 34	direct-i...	2nd-s2	Buildin...	3.82	0.8	0.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 1....	DetWin 34	direct-i...	2nd-s2	Buildin...	3.82	0.8	0.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 1....	DetWin 34	direct-i...	2nd-s2	Buildin...	3.82	0.8	0.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 1....	DetWin 34	direct-i...	2nd-s2	Buildin...	3.82	0.8	0.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 2.2...	2m	direct-i...	2nd-s2	Buildin...	3.82	0.8	90.0	90.0	2.5	2.0	5.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s2.Wall 4.2...	2m	direct-i...	2nd-s2	Buildin...	3.82	0.8	270.0	90.0	2.5	2.0	5.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	2m	direct-i...	2nd-s1...	Buildin...	3.81	0.79	90.0	90.0	2.5	2.0	5.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	DetWin 34	direct-i...	2nd-s1...	Buildin...	3.82	0.8	180.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	DetWin 34	direct-i...	2nd-s1...	Buildin...	3.82	0.8	180.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	DetWin 34	direct-i...	2nd-s1...	Buildin...	3.82	0.8	180.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	DetWin 34	direct-i...	2nd-s1...	Buildin...	3.82	0.8	180.0	90.0	13.33	1.5	20.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s1.WAL...	2m	direct-i...	2nd-s1...	Buildin...	3.63	0.61	270.0	90.0	2.5	2.0	5.0	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s2.WAL...	1m	direct-i...	2nd-s1...	Buildin...	3.84	0.82	90.0	90.0	7.0	1.5	10.5	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...
2nd-s1-s2.WAL...	1m	direct-i...	2nd-s1...	Buildin...	3.88	0.86	270.0	90.0	7.0	1.5	10.5	© Tripl...	0.245	0.125	0.514	0.695	0.2	0.8	0.716	0.0	Generi...

Figure 8.3.6 Windows

8.4 Survey for experts

Fra: Yekaterina Artyukova <s315766@oslomet.no>
Sendt: 24. mars 2021 10:28
[redacted]
Kopi: Peter Schild <petsch@oslomet.no>
Emne: Utprøving av klimadata for effektdimensjonering

Hei!

Jeg tar master i energi og miljø i bygg ved OsloMet. Nå skriver jeg masteroppgave om temaet «Utprøving av klimadata for effektdimensjonering». For å få de beste resultatene for prosjektering VVS installasjoner er det viktig å velge en passende dimensjoneringssikkerhet.

Oppgaven min går ut på dimensjonering av dynamiske energi beregninger med timesverdier for å dimensjonere både vinter og sommer forhold.

Spørsmål til deg:

Hvilket dimensjonerende forhold mener du ønskelig å beregne:

1. Den kaldeste/varmeste døgn (24 times middelverdi)
2. Den som ikke overskrider 50 timer per år
3. Den enkelte kaldeste/varmeste timen
4. En bestemt persentil (for eksempel 99%)
5. Hvis ingen av disse passer, hva er ditt forslag. Jeg ville hatt en timeberegning over et helt døgn (kaldeste/varmeste) i løpet av ett normalt år for bygninger hvor innvendige temperatursvingninger er sterk avhengig av utetemperatur (eldre bygg med lite isolasjon og lite termisk masse). For andre bygninger ville jeg hatt en timeberegning over tre hele døgn (kaldeste/varmeste) i løpet av ett normalt år. Altså en beregning over enten 24 eller 72 timer. Jeg mener at en dimensjonering over kun en time vil gi for store dimensjoner. Hvis du har tid, hadde det vært spennende å se nærmere på hvor mye betydning tidsintervallet har for resultatet.

Hvilke parametere ønsker at jeg vurderer i min oppgave:

1. Dimensjonere varmebehov for varmebatteri Ja
2. Dimensjonere kjølebatteri Ja
3. Dimensjonere det totale elektrisk effektbehov for bygning Nei, fordi behovet er sterk avhengig av brukeren. Det er vanskelig å komme frem til et tall som er relevant. Jeg ville brukt faste forutsetninger for det totale elektrisk effektbehov.
4. Nevn gjerne flere parametere som jeg skal vurdere. Dimensjonere varmebehov for romoppvarmingsanlegget (som vil dekkes av for eksempel radiatorer, gulvvarme, aerotempere eller luftgardiner)

Figure 8.4.1 Respondent 1

[redacted]
to. 25.03.2021 10:41
Til: Yekaterina Artyukova
Kopi: Peter Schild

Hei Yekaterina.

Takk for at du spør.

Her noen kjappe svar. Send gjerne en oppfølgnings e-post hvis du lurer på noe mer, eller hva jeg mener med noe av det jeg skriver nedenfor.

Hvilket dimensjonerende forhold mener du ønskelig å beregne:

1. Den kaldeste/varmeste døgn (24 times middelverdi)
    1. Kan være av interesse.
2. Den som ikke overskrider 50 timer per år
    1. Sommertid ja. Er tradisjonell denne.
3. Den enkelte kaldeste/varmeste timen
    1. Nei, denne er ikke stor interesse for.
4. En bestemt persentil (for eksempel 99%)
    1. Ja, dette kunne vært interessant. Men tror veldig mange mennesker sliter med å forholde seg til slike begreper. Så teknisk sett fint, men en pedagogisk utfordring kanskje.
5. Hvis ingen av disse passer, hva er ditt forslag
    1. Litt uklart for meg om du tenker å se på et helt år, eller snapshots som beskrevet over. Tror at dynamikken bygget kan være av interesse i dette, og ser ikke bort fra å kjøre en helårssimulering med passende klimadata og inndata kan være en god løsning.

Hvilke parametere ønsker at jeg vurderer i min oppgave:

1. Dimensjonere varmebehov for varmebatteri
    1. Ja.
2. Dimensjonere kjølebatteri
    1. Ja, dette er viktig.
    2. Men også tørrkjølere.
3. Dimensjonere det totale elektrisk effektbehov for bygning
    1. Ville vært fint, men vanskelig å finne godt underlag.
4. Nevn gjerne flere parametere som jeg skal vurdere.
    1. Romvarmebehov.

Figure 8.4.2 Respondent 2

Fra: Yekaterina Artyukova
Sendt: onsdag 24. mars 2021 10:39
Til: [redacted]>
Kopi: Peter Schild <petsch@oslomet.no>
Emne: Utprøving av klimadata for effektdimensjonering

Hei!

Jeg tar master i energi og miljø i bygg ved OsloMet. Nå skriver jeg masteroppgave om temaet «Utprøving av klimadata for effektdimensjonering». For å få de beste resultatene for prosjektering VVS installasjoner er det viktig å velge en passende dimensjoneringssikkerhet.

Oppgaven min går ut på dimensjonering av dynamiske energi beregninger med timesverdier for å dimensjonere både vinter og sommer forhold.

Spørsmål til deg:

Hvilket dimensjonerende forhold mener du ønskelig å beregne:

1. Den kaldeste/varmeste døgn (24 times middelverdi)
2. Den som ikke overskrider 50 timer per år
3. Den enkelte kaldeste/varmeste timen For oppvarming, men også for kjøling kan anlegg som mangler kapasitet få problemer. Korriger ift nøkkel tall basert på praktisk erfaring. Med god systemløsning og utnyttelse av passive tiltak blir effektbehov til både oppvarming 10-20 W/m2 og kjøling 30-35 W/m2
4. En bestemt persentil (for eksempel 99%)
5. Hvis ingen av disse passer, hva er ditt forslag

Hvilke parametere ønsker at jeg vurderer i min oppgave:

1. Dimensjonere varmebehov for varmebatteri + evt lokal varme
2. Dimensjonere kjølebatteri + evt lokal kjøling
3. Dimensjonere det totale elektrisk effektbehov for bygning (gjerne det, men brukerutstyr er vanskelig å beregne)

...

Figure 8.4.2 Respondent 3

[redacted]>
on. 21.04.2021 11:54
Til: Yekaterina Artyukova
Kopi: Peter Schild

Hei

Jeg beklager sen respons på denne. (Hadde ikke mulighet til å prioritere dette før påske, og så gikk det beklageligvis i glemmeboka).

Jeg tror du vil få bedre svar av andre enn meg, - andre som jobber med dimensjonering av VVS-anlegg i det daglige. Og forhåpentligvis har du fått svar fra andre...
Men jeg kan likevel dele noen tanker.

For dimensjonerende vinter i dag benyttes 3-døgnsmiddel som middeltemperatur over døgnet, og med en døgnvariasjon i form av en sinuskurve med bestemt temperaturamplitude. Etter hva jeg kjenner til foreslås det å videreføre dette i kommende effektberegningsstandard NS 3032.
Og det er vel vanlig å kjøre en vintersimulering over 8-10 døgn (eller en arbeidsuke) slik som foreslås i simuleringsprogrammet SIMIEN for å være sikker på at stasjonære tilstander inntreffer.
Overført til dynamiske energiberegninger tenker jeg at alt. 4 «En bestemt persentil (for eksempel 99%)» er mest aktuelt. Vet at EN 16798-1 og TR 16798-2 sier noe om tillatte temperaturavvik og -intervall for romtemperatur, men har ikke satt meg inn i disse standardene.
Dimensjonerende oppvarmingsbehov (romoppvarming + ventilasjonsvarme) er vel de relevante parameterne å beregne i denne sammenhengen, evt. for varierende internlaster (størrelse og driftstider).

For dimensjonerende sommer i dag benyttes ulik tilnærming i TEK §13-4 og i arbeidstilsynets veileder, og det er generelt stor usikkerhet omkring hvordan dette skal gjøres. Etter hva jeg kjenner til foreslås det i kommende effektberegningsstandard NS 3032 å regne på samme måte som for vinter, dvs. 3-døgnsmiddel (evt. også 4- og 5-døgns middel) som middeltemperatur over døgnet, og med en døgnvariasjon i form av en sinuskurve med bestemt temperaturamplitude.
Og det er vel vanlig å kjøre en sommersimulering over 8-10 døgn (eller en arbeidsuke) slik som foreslås i simuleringsprogrammet SIMIEN for å være sikker på at stasjonære tilstander inntreffer.
Overført til dynamiske energiberegninger tenker jeg også her at alt. 4 «En bestemt persentil (for eksempel 99%)» er mest aktuelt.
Dimensjonerende klimakjølebehov (ventilasjonskjøling + evt. romkjøling) er vel de relevante parameterne å beregne i denne sammenhengen, evt. for varierende internlaster (størrelse og driftstider), varierende solskjerming og soltilskudd.

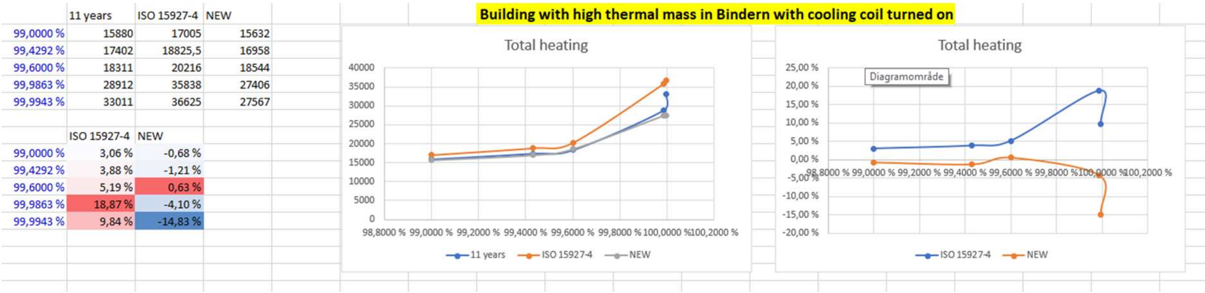
Håper mine små innspill kan være nyttige.

Lykke til!

Mvh
[redacted]
Senior energirådgiver

Figure 8.4.2 Respondent 4

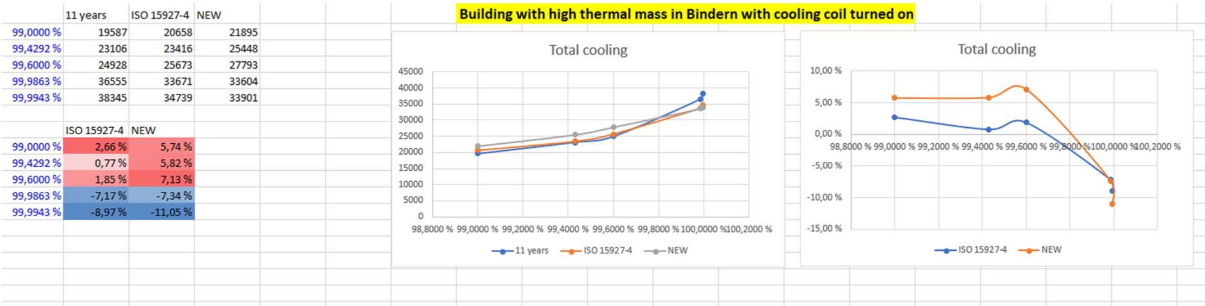
8.5 Results for building with high thermal mass in Blindern



	11 years	ISO 15927-4	NEW
99,0000 %	15880	17005	15632
99,4292 %	17402	18825,5	16958
99,6000 %	18311	20216	18544
99,9863 %	28912	35838	27406
99,9943 %	33011	36625	27567

	ISO 15927-4	NEW
99,0000 %	3,06 %	-0,68 %
99,4292 %	3,88 %	-1,21 %
99,6000 %	5,19 %	0,63 %
99,9863 %	18,87 %	-4,10 %
99,9943 %	9,84 %	-14,83 %

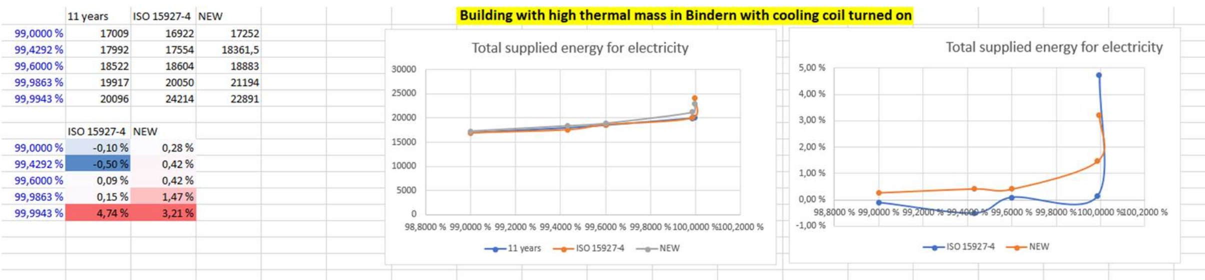
Figure 8.5.1 Total heating in Watt and in percent difference for building with high thermal mass in Blindern



	11 years	ISO 15927-4	NEW
99,0000 %	19587	20658	21895
99,4292 %	23106	23416	25448
99,6000 %	24928	25673	27793
99,9863 %	36555	33671	33604
99,9943 %	38345	34739	33901

	ISO 15927-4	NEW
99,0000 %	2,66 %	5,74 %
99,4292 %	0,77 %	5,82 %
99,6000 %	1,85 %	7,13 %
99,9863 %	-7,17 %	-7,34 %
99,9943 %	-8,97 %	-11,05 %

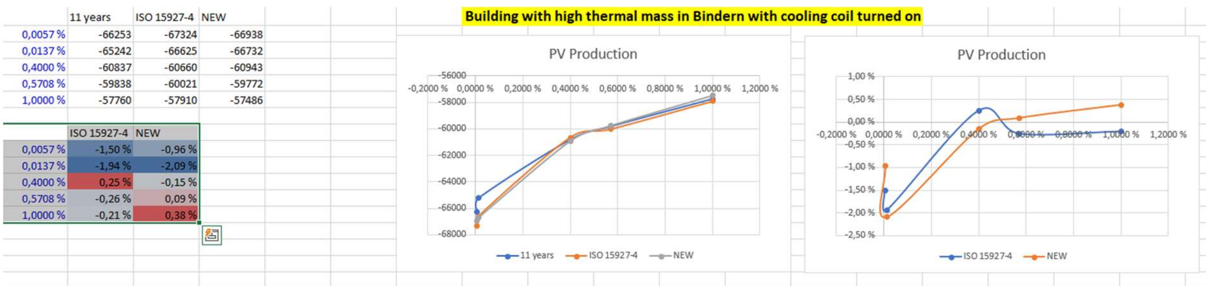
Figure 8.5.2 Total cooling in Watt and in percent difference for building with high thermal mass in Blindern



	11 years	ISO 15927-4	NEW
99,0000 %	17009	16922	17252
99,4292 %	17992	17554	18361,5
99,6000 %	18522	18604	18883
99,9863 %	19917	20050	21194
99,9943 %	20096	24214	22891

	ISO 15927-4	NEW
99,0000 %	-0,10 %	0,28 %
99,4292 %	-0,50 %	0,42 %
99,6000 %	0,09 %	0,42 %
99,9863 %	0,15 %	1,47 %
99,9943 %	4,74 %	3,21 %

Figure 8.5.3 Total supplied electricity use in Watt and in percent difference for building with high thermal mass in Blindern



	11 years	ISO 15927-4	NEW
0,0057 %	-66253	-67324	-66938
0,0137 %	-65242	-66625	-66732
0,4000 %	-60837	-60660	-60943
0,5708 %	-59838	-60021	-59772
1,0000 %	-57760	-57910	-57486

	ISO 15927-4	NEW
0,0057 %	-1,50 %	-0,96 %
0,0137 %	-1,94 %	-2,09 %
0,4000 %	0,25 %	-0,15 %
0,5708 %	-0,26 %	0,09 %
1,0000 %	-0,21 %	0,38 %

Figure 8.5.4 PV Production in Watt and in percent difference for building with high thermal mass in Blindern

	11 years	ISO 15927-4	NEW
99,0000 %	24,01	24,01	24,01
99,4292 %	24,012	24,013	24,0125
99,6000 %	24,014	24,015	24,014
99,9863 %	24,182	24,059	24,132
99,9943 %	24,495	24,103	24,163

	ISO 15927-4	NEW
99,0000 %	0,00 %	0,00 %
99,4292 %	0,02 %	0,01 %
99,6000 %	0,02 %	0,00 %
99,9863 %	-2,73 %	-1,11 %
99,9943 %	-8,70 %	-7,37 %

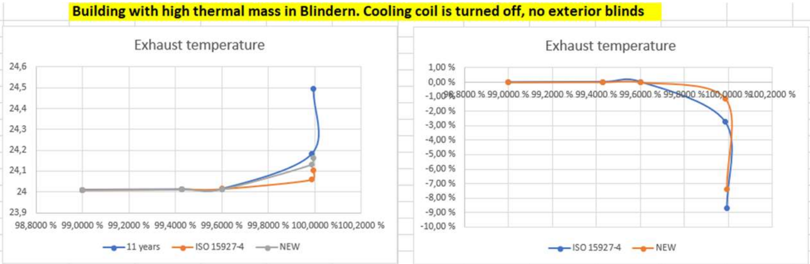


Figure 8.5.5 Exhaust temperature in degrees Celsius and in percent difference for building with high thermal mass in Blindern

	11 years	ISO 15927-4	NEW
99,0000 %	25,088	25,077	25,065
99,4292 %	25,139	25,116	25,119
99,6000 %	25,172	25,149	25,146
99,9863 %	25,36	25,345	25,315
99,9943 %	25,375	25,368	25,323

	ISO 15927-4	NEW
99,0000 %	-0,24 %	-0,50 %
99,4292 %	-0,50 %	-0,44 %
99,6000 %	-0,50 %	-0,57 %
99,9863 %	-0,33 %	-0,99 %
99,9943 %	-0,15 %	-1,14 %

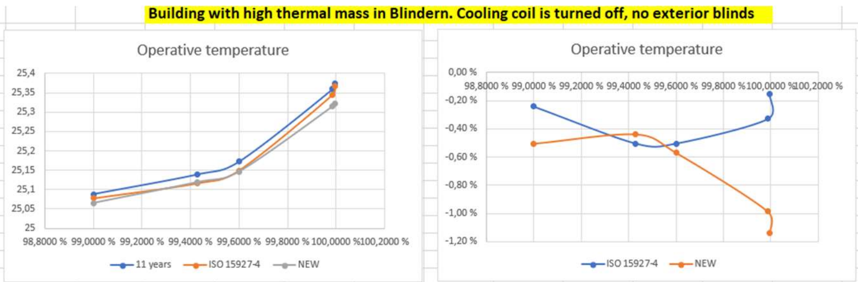


Figure 8.5.6 Operative temperature in degrees Celsius and in percent difference for building with high thermal mass in Blindern

8.6 Results for building with low thermal mass in Blindern

	11 years	ISO 15927-4	NEW
99,0000 %	15964	17001	15730
99,4292 %	17489	18974	17089,5
99,6000 %	18382	19920	18499
99,9863 %	29215	36428	27864
99,9943 %	33239	36993	27870

	ISO 15927-4	NEW
99,0000 %	2,80 %	-0,63 %
99,4292 %	4,01 %	-1,08 %
99,6000 %	4,16 %	0,32 %
99,9863 %	19,49 %	-3,65 %
99,9943 %	10,15 %	-14,51 %

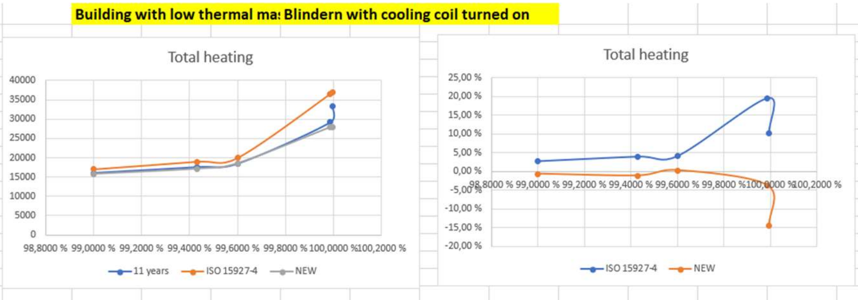
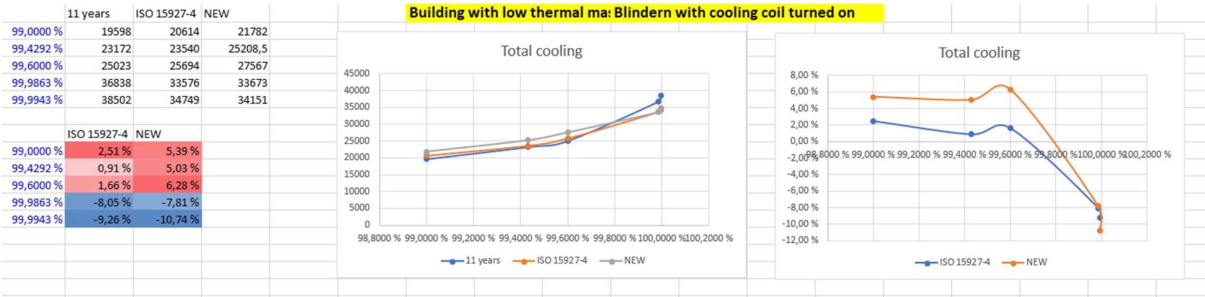


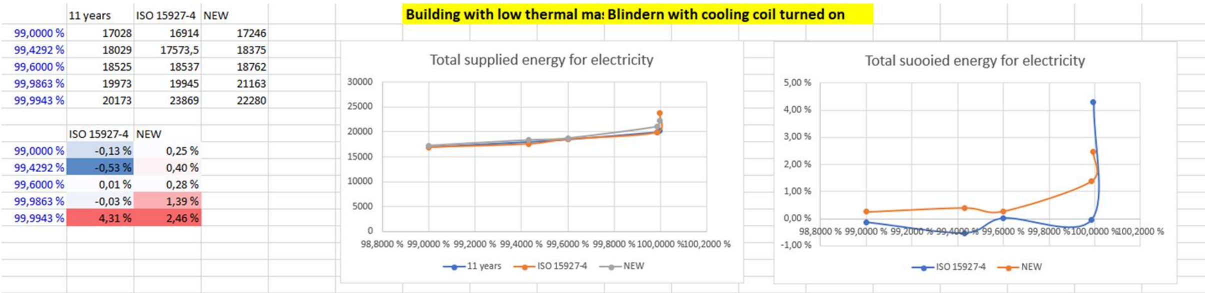
Figure 8.6.1 Total heating in Watt and in percent difference for building with low thermal mass in Blindern



	11 years	ISO 15927-4	NEW
99,0000 %	19598	20614	21782
99,4292 %	23172	23540	25208,5
99,6000 %	25023	25694	27567
99,9863 %	36838	33576	33673
99,9943 %	38502	34749	34151

	ISO 15927-4	NEW
99,0000 %	2,51 %	5,39 %
99,4292 %	0,91 %	5,03 %
99,6000 %	1,66 %	6,28 %
99,9863 %	-8,05 %	-7,81 %
99,9943 %	-9,26 %	-10,74 %

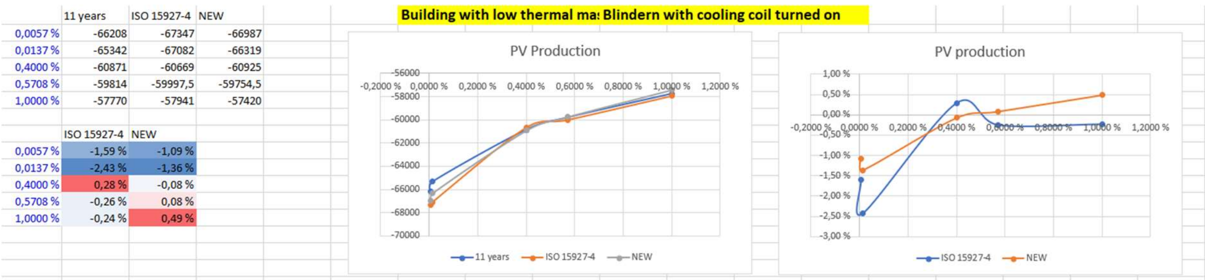
Figure 8.6.2 Total cooling in Watt and in percent difference for building with low thermal mass in Blindern



	11 years	ISO 15927-4	NEW
99,0000 %	17028	16914	17246
99,4292 %	18029	17573,5	18375
99,6000 %	18525	18537	18762
99,9863 %	19973	19945	21163
99,9943 %	20173	23869	22280

	ISO 15927-4	NEW
99,0000 %	-0,13 %	0,25 %
99,4292 %	-0,53 %	0,40 %
99,6000 %	0,01 %	0,28 %
99,9863 %	-0,03 %	1,39 %
99,9943 %	4,31 %	2,46 %

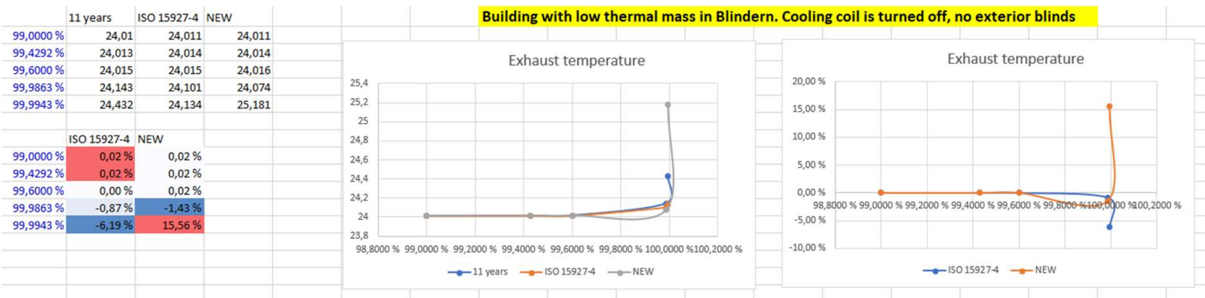
Figure 8.6.3 Total supplied electricity use in Watt and in percent difference for building with low thermal mass in Blindern



	11 years	ISO 15927-4	NEW
0,0057 %	-66208	-67347	-66987
0,0137 %	-65342	-67082	-66319
0,4000 %	-60871	-60669	-60925
0,5708 %	-59814	-59997,5	-59754,5
1,0000 %	-57770	-57941	-57420

	ISO 15927-4	NEW
0,0057 %	-1,59 %	-1,09 %
0,0137 %	-2,43 %	-1,36 %
0,4000 %	0,28 %	-0,08 %
0,5708 %	-0,26 %	0,08 %
1,0000 %	-0,24 %	0,49 %

Figure 8.6.4 PV production in Watt and in percent difference for building with low thermal mass in Blindern



	11 years	ISO 15927-4	NEW
99,0000 %	24,01	24,011	24,011
99,4292 %	24,013	24,014	24,014
99,6000 %	24,015	24,015	24,016
99,9863 %	24,143	24,101	24,074
99,9943 %	24,432	24,134	25,181

	ISO 15927-4	NEW
99,0000 %	0,02 %	0,02 %
99,4292 %	0,02 %	0,02 %
99,6000 %	0,00 %	0,02 %
99,9863 %	-0,87 %	-1,43 %
99,9943 %	-6,19 %	15,56 %

Figure 8.6.5 Exhaust temperature in degrees Celsius and percent difference for building with low thermal mass in Blindern

	11 years	ISO 15927-4	NEW
99,0000 %	25,317	25,308	25,292
99,4292 %	25,381	25,351	25,365
99,6000 %	25,415	25,374	25,4
99,9863 %	25,628	25,572	25,586
99,9943 %	25,652	25,597	25,634

	ISO 15927-4	NEW
99,0000 %	-0,19 %	-0,52 %
99,4292 %	-0,62 %	-0,33 %
99,6000 %	-0,85 %	-0,31 %
99,9863 %	-1,16 %	-0,87 %
99,9943 %	-1,14 %	-0,37 %

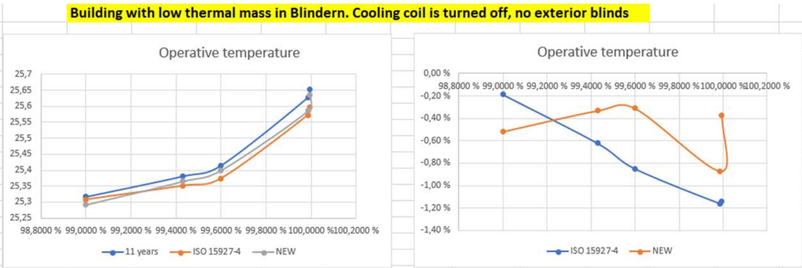


Figure 8.6.6 Operative temperature in degrees Celsius and percent difference for building with low thermal mass in Blindern

8.7 Results for building with high thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	10382	10377	11250
99,4292 %	11708	12329,5	12603,5
99,6000 %	12495	13817	13817
99,9863 %	17392	20061	19455
99,9943 %	18266	20300	19530

	ISO 15927-4	NEW
99,0000 %	-0,02 %	4,28 %
99,4292 %	3,06 %	4,41 %
99,6000 %	6,52 %	6,52 %
99,9863 %	13,15 %	10,17 %
99,9943 %	10,02 %	6,23 %

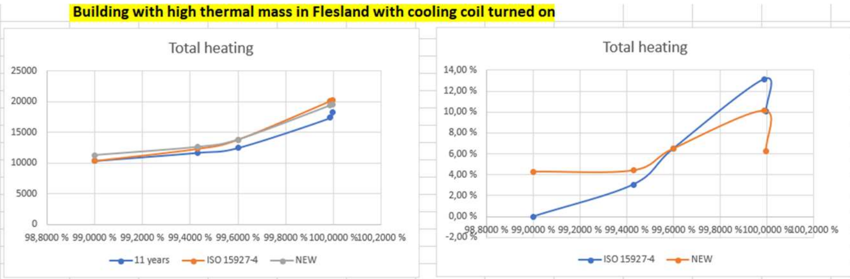


Figure 8.7.1 Total heating in Watt and in percent difference difference for building with high thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	12402	12450	12026
99,4292 %	17304	17353,5	16353,5
99,6000 %	19576	20023	18392
99,9863 %	33366	32922	26629
99,9943 %	35290	34260	28260

	ISO 15927-4	NEW
99,0000 %	0,13 %	-1,01 %
99,4292 %	0,13 %	-2,56 %
99,6000 %	1,20 %	-3,18 %
99,9863 %	-1,19 %	-18,11 %
99,9943 %	-2,77 %	-18,90 %

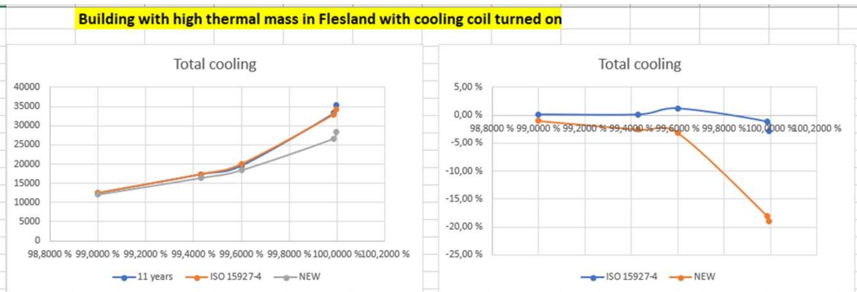


Figure 8.7.2 Total cooling in Watt and in percent difference difference for building with high thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	17201	16970	17323
99,4292 %	17761	17488,5	17941,5
99,6000 %	18187	18128	18288
99,9863 %	19894	19240	20120
99,9943 %	20029	19961	20182

	ISO 15927-4	NEW
99,0000 %	-0,26 %	0,14 %
99,4292 %	-0,31 %	0,21 %
99,6000 %	-0,07 %	0,12 %
99,9863 %	-0,75 %	0,26 %
99,9943 %	-0,08 %	0,18 %

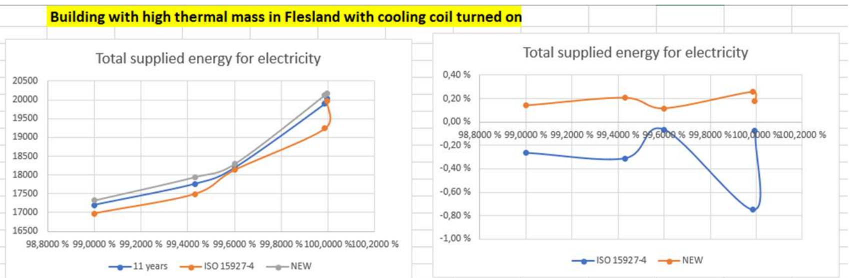


Figure 8.7.3 Total supplied electricity use in Watt and in percent difference difference for building with high thermal mass in Flesland

	11 years	ISO 15927-4	NEW
0,0057 %	-69340	-69928	-67960
0,0137 %	-67860	-66376	-67529
0,4000 %	-61758	-61995	-61851
0,5708 %	-60380	-61055	-60490
1,0000 %	-57728	-58276	-58029

	ISO 15927-4	NEW
0,0057 %	-0,82 %	1,92 %
0,0137 %	2,06 %	0,46 %
0,4000 %	-0,33 %	-0,13 %
0,5708 %	-0,94 %	-0,15 %
1,0000 %	-0,76 %	-0,42 %

Building with high thermal mass in Flesland with cooling coil turned on

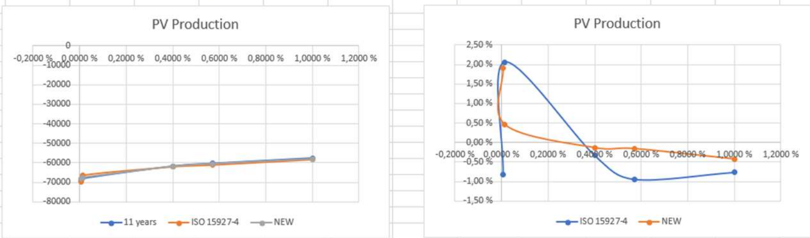


Figure 8.7.4 PV production in Watt and in percent difference for building with high thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	24,005	24,006	24,006
99,4292 %	24,008	24,008	24,008
99,6000 %	24,01	24,009	24,01
99,9863 %	24,12	24,036	24,068
99,9943 %	24,163	24,172	24,694

	ISO 15927-4	NEW
99,0000 %	0,02 %	0,02 %
99,4292 %	0,00 %	0,00 %
99,6000 %	-0,02 %	0,00 %
99,9863 %	-2,06 %	-1,27 %
99,9943 %	0,22 %	13,00 %

Building with high thermal mass in Flesland. Cooling coil is turned off, no exterior blinds

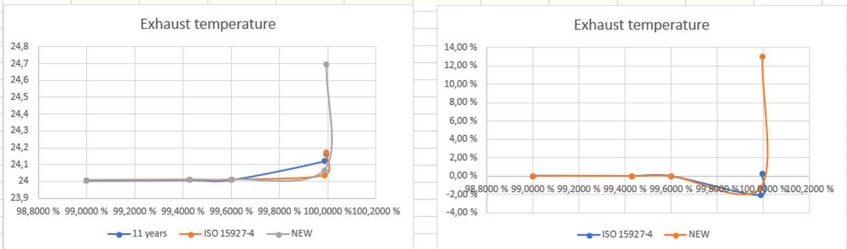


Figure 8.7.5 Exhaust temperature in degrees Celsius and in percent difference for building with high thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	25,027	24,986	25,076
99,4292 %	25,097	25,0405	25,148
99,6000 %	25,132	25,079	25,174
99,9863 %	25,382	25,353	25,387
99,9943 %	25,436	25,362	25,387

	ISO 15927-4	NEW
99,0000 %	-0,90 %	1,07 %
99,4292 %	-1,23 %	1,11 %
99,6000 %	-1,16 %	0,92 %
99,9863 %	-0,63 %	0,11 %
99,9943 %	-1,62 %	-1,07 %

Building with high thermal mass in Flesland. Cooling coil is turned off, no exterior blinds

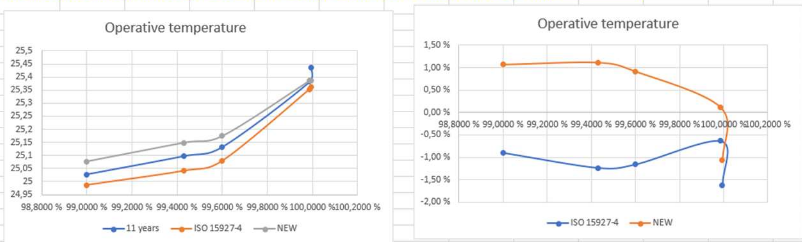


Figure 8.7.6 Operative temperature in degrees Celsius and in percent difference for building with high thermal mass in Flesland

8.8 Results for building with low thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	10469	10503	11297
99,4292 %	11863	12465	12739,5
99,6000 %	12594	13960	14025
99,9863 %	17482	20361	19739
99,9943 %	18304	20535	19748

	ISO 15927-4	NEW
99,0000 %	0,17 %	4,04 %
99,4292 %	2,93 %	4,27 %
99,6000 %	6,66 %	6,98 %
99,9863 %	14,03 %	11,00 %
99,9943 %	10,87 %	7,04 %

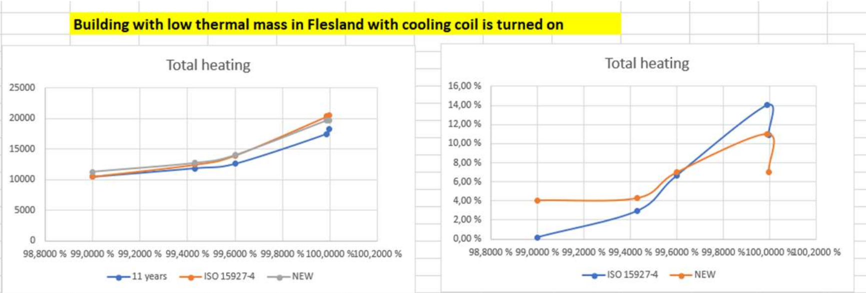


Figure 8.8.1 Total heating in Watt and in percent difference for building with low thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	12420	12230	12018
99,4292 %	17365	17314,5	16646
99,6000 %	19708	19919	18410
99,9863 %	33286	33644	26628
99,9943 %	35407	34197	28262

	ISO 15927-4	NEW
99,0000 %	-0,51 %	-1,08 %
99,4292 %	-0,14 %	-1,94 %
99,6000 %	0,57 %	-3,49 %
99,9863 %	0,96 %	-17,92 %
99,9943 %	-3,26 %	-19,24 %

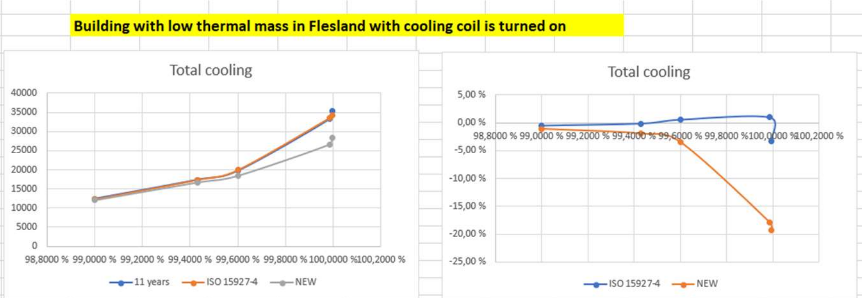


Figure 8.8.2 Total cooling in Watt and in percent difference for building with low thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	17233	16977	17357
99,4292 %	17805	17602,5	17987
99,6000 %	18237	18114	18390
99,9863 %	19884	19372	20128
99,9943 %	20041	19885	20156

	ISO 15927-4	NEW
99,0000 %	-0,29 %	0,14 %
99,4292 %	-0,23 %	0,21 %
99,6000 %	-0,14 %	0,18 %
99,9863 %	-0,59 %	0,28 %
99,9943 %	-0,18 %	0,13 %

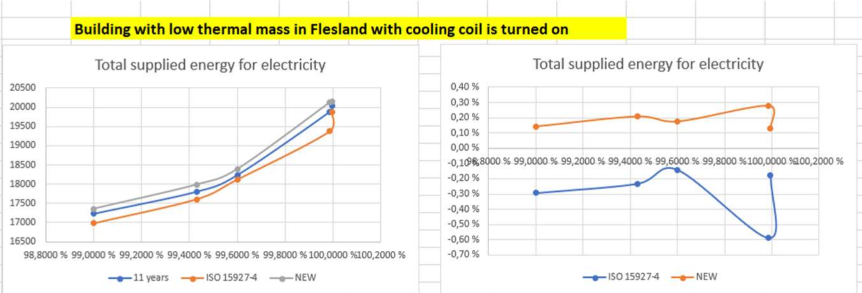


Figure 8.8.3 Total supplied electricity use in Watt and in percent difference for building with low thermal mass in Flesland

	11 years	ISO 15927-4	NEW
0,0057 %	-69326	-69950	-67960
0,0137 %	-67861	-66385	-67520
0,4000 %	-61757	-62010	-61897
0,5708 %	-60379	-61087,5	-60555
1,0000 %	-57728	-58317	-58052

	ISO 15927-4	NEW
0,0057 %	-0,86 %	1,88 %
0,0137 %	2,03 %	0,47 %
0,4000 %	-0,35 %	-0,19 %
0,5708 %	-0,98 %	-0,24 %
1,0000 %	-0,81 %	-0,45 %

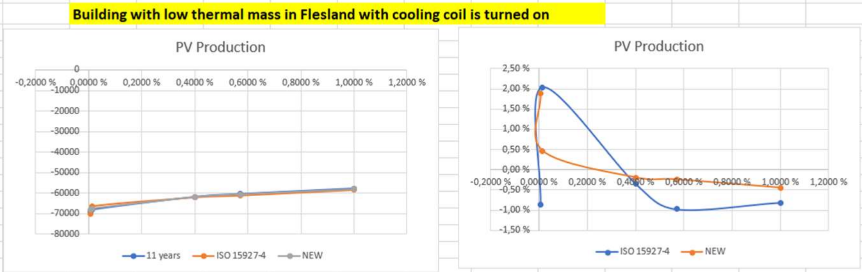


Figure 8.8.4 PV Production in Watt and in percent difference for building with low thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	24,004	24,005	24,005
99,4292 %	24,008	24,009	24,0095
99,6000 %	24,011	24,011	24,012
99,9863 %	24,228	24,27	24,071
99,9943 %	24,56	24,393	24,96

	ISO 15927-4	NEW
99,0000 %	0,02 %	0,02 %
99,4292 %	0,02 %	0,03 %
99,6000 %	0,00 %	0,02 %
99,9863 %	0,91 %	-3,40 %
99,9943 %	-3,61 %	8,65 %

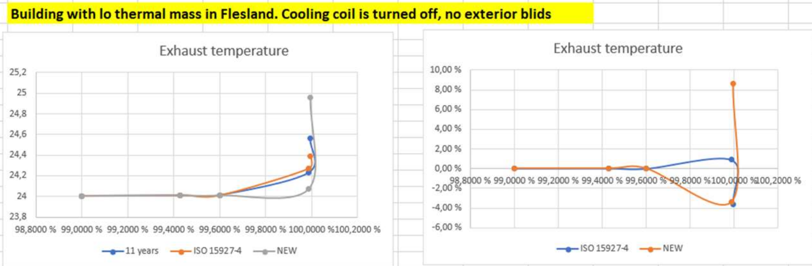


Figure 8.8.5 Exhaust temperature in degrees Celsius and in percent difference for building with low thermal mass in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	25,271	25,242	25,323
99,4292 %	25,347	25,3015	25,394
99,6000 %	25,388	25,34	25,444
99,9863 %	25,669	25,625	25,697
99,9943 %	25,704	25,673	25,698

	ISO 15927-4	NEW
99,0000 %	-0,59 %	1,06 %
99,4292 %	-0,93 %	0,96 %
99,6000 %	-0,98 %	1,14 %
99,9863 %	-0,90 %	0,57 %
99,9943 %	-0,63 %	-0,12 %

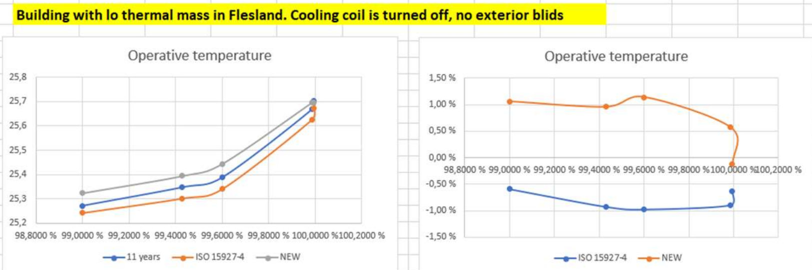


Figure 8.8.6 Operative temperature in degrees Celsius and in percent difference for building with low thermal mass in Flesland

8.9 Results for building with high thermal mass in Kirkenes

	11 years	ISO 15927-4	NEW
99,0000 %	32425	28687	31048
99,4292 %	38719	33087	36799,5
99,6000 %	42097	34487	41055
99,9863 %	58799	63447	59615
99,9943 %	61043	63739	60188

	ISO 15927-4	NEW
99,0000 %	-5,92 %	-2,18 %
99,4292 %	-8,93 %	-3,04 %
99,6000 %	-12,06 %	-1,65 %
99,9863 %	7,37 %	1,29 %
99,9943 %	4,27 %	-1,36 %

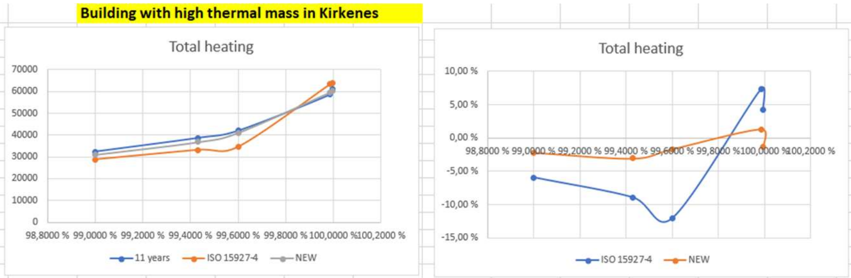


Figure 8.9.1 Total heating in Watt and in percent difference for building with high thermal mass in Kirkenes

	11 years	ISO 15927-4	NEW
99,0000 %	7533,9	8680,9	8248,4
99,4292 %	13042	16338	15103,5
99,6000 %	16084	19753	17471
99,9863 %	30875	26673	27811
99,9943 %	34848	26816	28662

	ISO 15927-4	NEW
99,0000 %	3,11 %	1,94 %
99,4292 %	8,95 %	5,60 %
99,6000 %	9,96 %	3,77 %
99,9863 %	-11,41 %	-8,32 %
99,9943 %	-21,81 %	-16,80 %

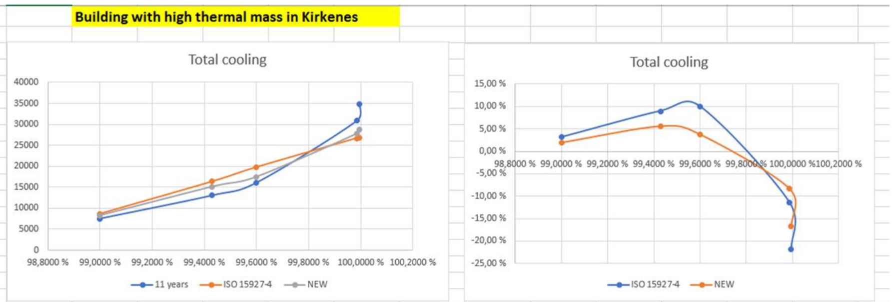


Figure 8.9.2 Total cooling in Watt and in percent difference for building with high thermal mass in Kirkenes

	11 years	ISO 15927-4	NEW
99,0000 %	19511	19603	19553
99,4292 %	19832	19873,5	19831,5
99,6000 %	19980	20012	19937
99,9863 %	20376	20384	20404
99,9943 %	20404	20442	20418

	ISO 15927-4	NEW
99,0000 %	0,10 %	0,05 %
99,4292 %	0,05 %	0,00 %
99,6000 %	0,04 %	-0,05 %
99,9863 %	0,01 %	0,03 %
99,9943 %	0,04 %	0,02 %

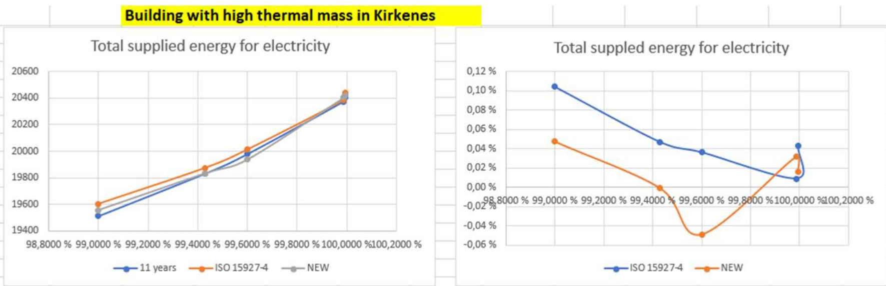


Figure 8.9.3 Total supplied electricity use in Watt and in percent difference for building with high thermal mass in Kirkenes

	11 years	ISO 15927-4	NEW
0,0057 %	-69193	-68365	-70259
0,0137 %	-67218	-68203	-69496
0,4000 %	-61283	-61579	-61022
0,5708 %	-59924	-60259,5	-59642
1,0000 %	-56890	-57110	-57221

	ISO 15927-4	NEW
0,0057 %	1,14 %	-1,47 %
0,0137 %	-1,36 %	-3,15 %
0,4000 %	-0,41 %	0,36 %
0,5708 %	-0,46 %	0,39 %
1,0000 %	-0,30 %	-0,46 %

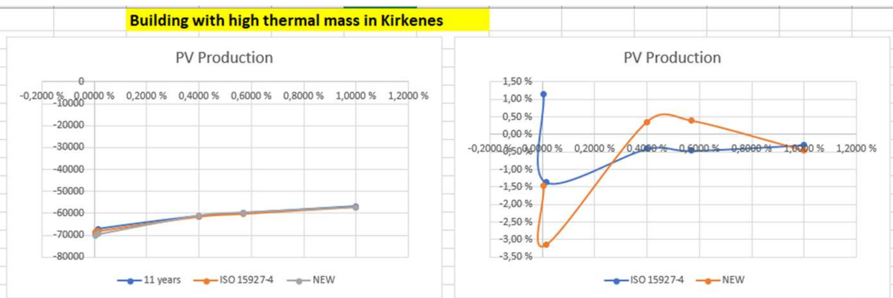


Figure 8.9.4 PV Production in Watt and in percent difference for building with high thermal mass in Kirkenes

8.10 Results for building with low thermal mass in Kirkenes

	11 years	ISO 15927-4	NEW
99,0000 %	32340	28967	30814
99,4292 %	38862	33228	36958
99,6000 %	42195	34738	41197
99,9863 %	58768	63107	59502
99,9943 %	61057	63359	59949

	ISO 15927-4	NEW
99,0000 %	-5,36 %	-2,42 %
99,4292 %	-8,95 %	-3,02 %
99,6000 %	-11,84 %	-1,58 %
99,9863 %	6,89 %	1,17 %
99,9943 %	3,66 %	-1,76 %

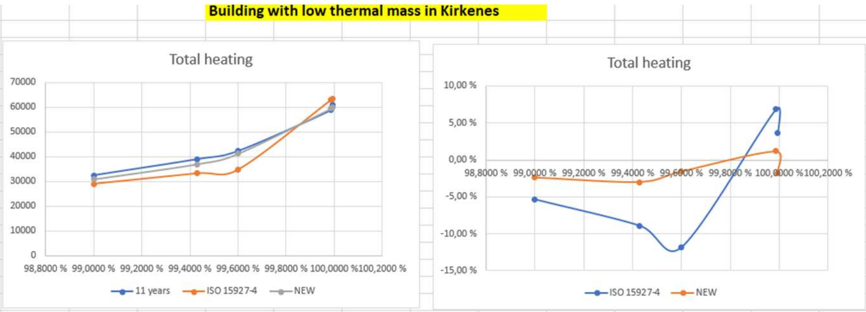


Figure 8.10. 1 Total heating in Watt and in percent difference for building with low thermal mass in Kirkenes

	11 years	ISO 15927-4	NEW
99,0000 %	7549,3	8702,1	8118,6
99,4292 %	13159	16301,5	15088
99,6000 %	16087	19787	17450
99,9863 %	30869	26623	28018
99,9943 %	34805	27126	28894

	ISO 15927-4	NEW
99,0000 %	3,13 %	1,55 %
99,4292 %	8,54 %	5,24 %
99,6000 %	10,06 %	3,71 %
99,9863 %	-11,54 %	-7,75 %
99,9943 %	-20,88 %	-16,07 %

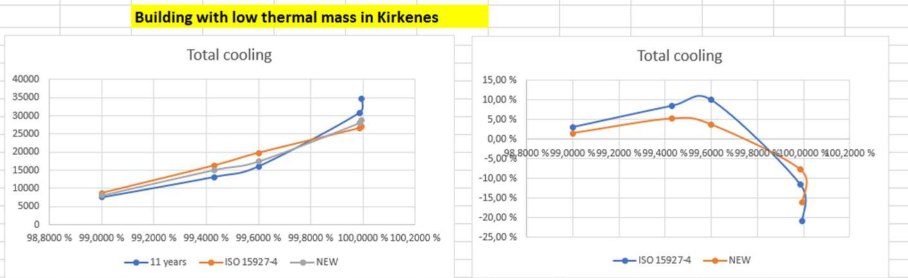


Figure 8.10.2 Total cooling in Watt and in percent difference for building with low thermal mass in Kirkenes

	11 years	ISO 15927-4	NEW
99,0000 %	19517	19561	19554
99,4292 %	19831	19846,5	19820
99,6000 %	19976	20011	19979
99,9863 %	20363	20384	20349
99,9943 %	20391	21001	20447

	ISO 15927-4	NEW
99,0000 %	0,05 %	0,04 %
99,4292 %	0,02 %	-0,01 %
99,6000 %	0,04 %	0,00 %
99,9863 %	0,02 %	-0,02 %
99,9943 %	0,69 %	0,06 %

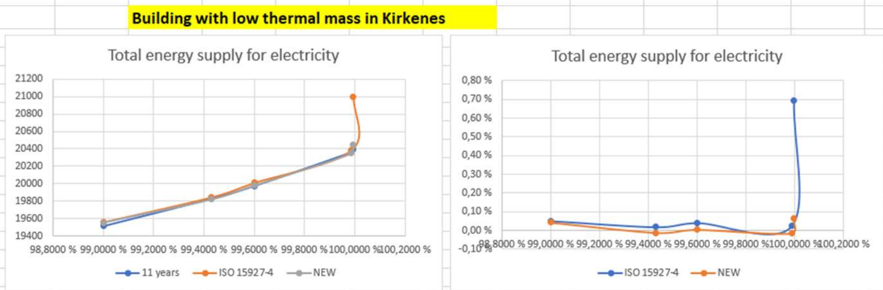


Figure 8.10.3 Total supplied electricity use in Watt and in percent difference for building with low thermal mass in Kirkenes

	11 years	ISO 15927-4	NEW
0,0057 %	-68674	-68287	-70910
0,0137 %	-67817	-67270	-69917
0,4000 %	-61260	-61716	-61102
0,5708 %	-59767	-60303	-59784
1,0000 %	-56848	-57001	-57349

	ISO 15927-4	NEW
0,0057 %	0,54 %	-3,09 %
0,0137 %	0,76 %	-2,91 %
0,4000 %	-0,63 %	0,22 %
0,5708 %	-0,74 %	-0,02 %
1,0000 %	-0,21 %	-0,69 %

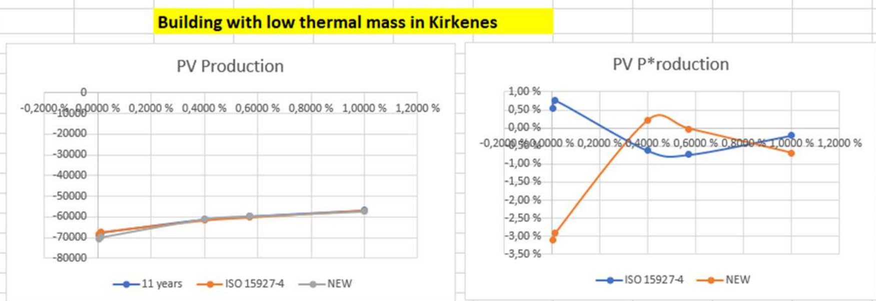


Figure 8.10.4 PV Production in Watt and in percent difference for building with low thermal mass in Kirkenes

8.11 Results for building with high thermal mass in Kise

	11 years	ISO 15927-4	NEW
99,0000 %	19999	20650	20663
99,4292 %	24261	27592	25434
99,6000 %	27015	30378	28213
99,9863 %	42586	56814	41884
99,9943 %	43585	57129	42033

	ISO 15927-4	NEW
99,0000 %	1,22 %	1,25 %
99,4292 %	6,25 %	2,20 %
99,6000 %	6,31 %	2,25 %
99,9863 %	26,70 %	-1,32 %
99,9943 %	25,42 %	-2,91 %

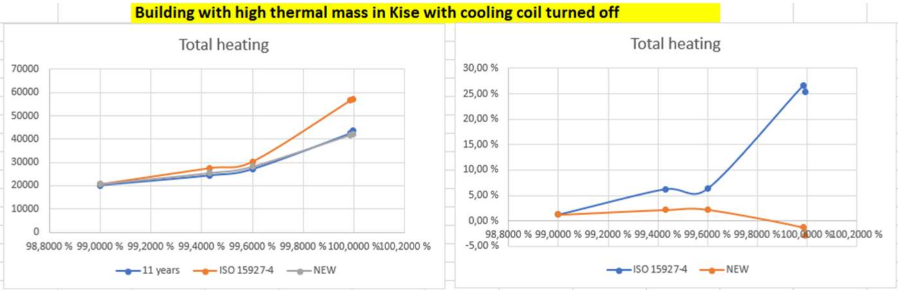


Figure 8.11.1 Total heating in Watt and in percent difference for building with high thermal mass in Kise

	11 years	ISO 15927-4	NEW
99,0000 %	17469	17469	16485
99,4292 %	19957,5	19957,5	19458,5
99,6000 %	21090	21090	20775
99,9863 %	27255	27255	29579
99,9943 %	28514	28514	30716

	ISO 15927-4	NEW
99,0000 %	3,75 %	1,38 %
99,4292 %	-0,15 %	-1,35 %
99,6000 %	-2,69 %	-3,45 %
99,9863 %	-18,61 %	-13,02 %
99,9943 %	-18,38 %	-13,09 %

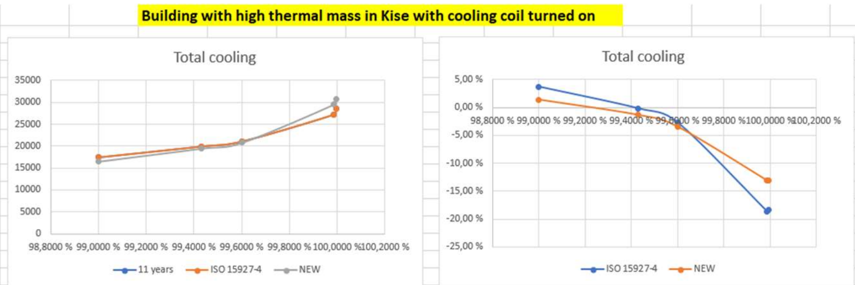


Figure 8.11.2 Cooling in Watt and in percent difference for building with high thermal mass in Kise

	11 years	ISO 15927-4	NEW
0,0057 %	-70587	-69888	-73397
0,0137 %	-69295	-67464	-67951
0,4000 %	-63551	-63775	-63336
0,5708 %	-62772	-63182	-62807,5
1,0000 %	-60786	-62048	-60975

	ISO 15927-4	NEW
0,0057 %	0,95 %	-3,82 %
0,0137 %	2,49 %	1,83 %
0,4000 %	-0,30 %	0,29 %
0,5708 %	-0,56 %	-0,05 %
1,0000 %	-1,72 %	-0,26 %

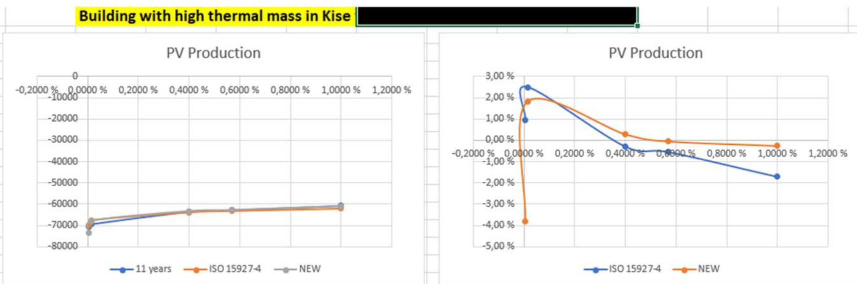


Figure 8.11.3 PV Production in Watt and in percent difference for building with high thermal mass in Kise

	11 years	ISO 15927-4	NEW
99,0000 %	17372	17362	17360
99,4292 %	18653	18888,5	18751
99,6000 %	19076	19195	19200
99,9863 %	20114	20118	20132
99,9943 %	20222	20205	20132

	ISO 15927-4	NEW
99,0000 %	-0,01 %	-0,01 %
99,4292 %	0,25 %	0,10 %
99,6000 %	0,13 %	0,13 %
99,9863 %	0,00 %	0,02 %
99,9943 %	-0,02 %	-0,09 %

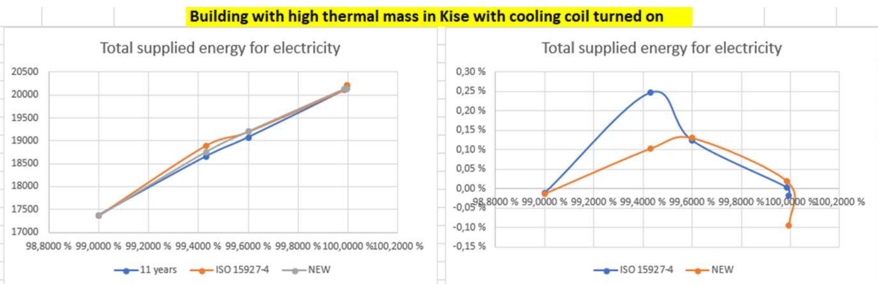


Figure 8.11.4 Total supplied electricity use in Watt and in percent difference for building with high thermal mass in Kise

8.12 Results for building with low thermal mass in Kise

	11 years	ISO 15927-4	NEW
99,0000 %	20037	20799	21063
99,4292 %	24448	27893,5	25581
99,6000 %	27234	30338	28529
99,9863 %	42840	57107	42027
99,9943 %	43976	57607	42183

	ISO 15927-4	NEW
99,0000 %	1,44 %	1,94 %
99,4292 %	6,51 %	2,14 %
99,6000 %	5,86 %	2,45 %
99,9863 %	26,95 %	-1,54 %
99,9943 %	25,75 %	-3,39 %

Building with low thermal mass in Kise with cooling coil turned off

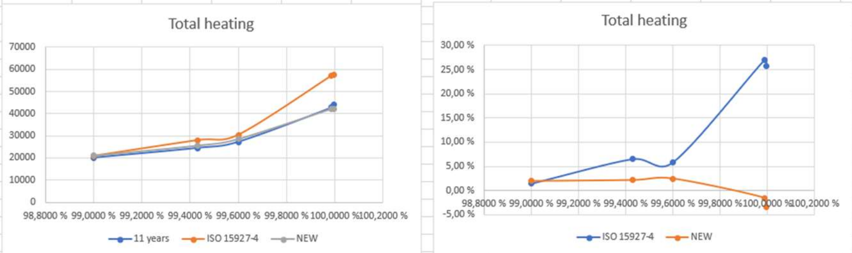


Figure 8.12.1 Total heating in Watt and in percent difference for building with low thermal mass in Kise

	11 years	ISO 15927-4	NEW
99,0000 %	15930	17466	16485
99,4292 %	20074	20023	19401,5
99,6000 %	22216	21119	20812
99,9863 %	34998	27268	29574
99,9943 %	36402	28825	30659

	ISO 15927-4	NEW
99,0000 %	3,69 %	1,33 %
99,4292 %	-0,12 %	-1,62 %
99,6000 %	-2,63 %	-3,37 %
99,9863 %	-18,57 %	-13,03 %
99,9943 %	-18,20 %	-13,79 %

Building with low thermal mass in Kise with cooling coil turned on

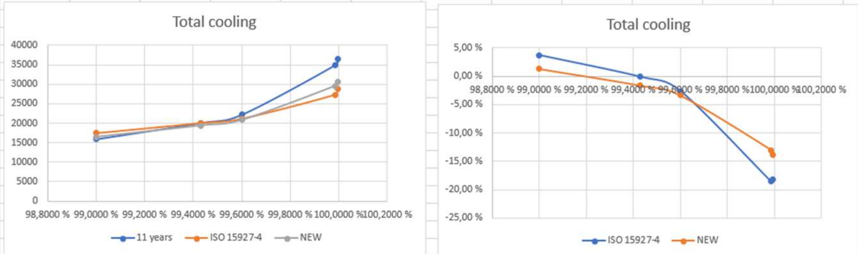


Figure 8.12.2 Total cooling in Watt and in percent difference for building with low thermal mass in Kise

	11 years	ISO 15927-4	NEW
99,0000 %	17390	17424	17343
99,4292 %	18672	18938,5	18790
99,6000 %	19070	19277	19236
99,9863 %	20128	20071	20074
99,9943 %	20213	20209	20162

	ISO 15927-4	NEW
99,0000 %	0,04 %	-0,05 %
99,4292 %	0,28 %	0,12 %
99,6000 %	0,22 %	0,17 %
99,9863 %	-0,06 %	-0,06 %
99,9943 %	0,00 %	-0,05 %

Building with low thermal mass in Kise with cooling coil turned on

Figure 8.12.3 Total supplied electricity use in Watt and in percent difference for building with low thermal mass in Kise

	11 years	ISO 15927-4	NEW
0,0057 %	-70814	-69866	-73738
0,0137 %	-69297	-67485	-68389
0,4000 %	-63538	-63775	-63265
0,5708 %	-62772	-63131,5	-62719,5
1,0000 %	-60766	-62180	-60711

	ISO 15927-4	NEW
0,0057 %	1,29 %	-3,99 %
0,0137 %	2,47 %	1,24 %
0,4000 %	-0,32 %	0,37 %
0,5708 %	-0,49 %	0,07 %
1,0000 %	-1,93 %	0,07 %

Building with low thermal mass in Kise v[redacted]

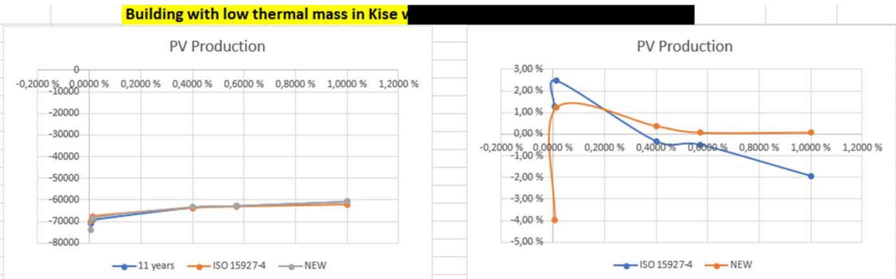


Figure 8.12.4 PV Production in Watt and in percent difference for building with low thermal mass in Kise

8.13 Summary for climate data files

Table 8.12.1 Arithmetic mean values for reference climate data file with 11 years raw data

Location	Type of thermal mass	Heating demand [W]	Cooling demand [W]	Total supplied electricity use[W]	PV Production [W]
Blindern	high	1200,58	758,80	-1584,96	-7670,86
Blindern	low	1212,96	759,06	-1530,64	-7671
Flesland	high	736,29	326,10	-605	-6396,69
Flesland	low	749,074	326,49	-541,44	-6396,78
Kirkenes	high	2716,25	186,73	357,87	-5580,35
Kirkenes	low	2728,42	187,08	431,60	-5580,25
Kise	high	1607,5	516,42	-1765,01	-7704,47
Kise	low	1618,45	515,97	-1710,52	-7770,4

Table 8.13.2 Arithmetic mean values for EN-ISO 15927

Location	Type of thermal mass	Heating demand [W]	Cooling demand [W]	Total supplied electricity use[W]	PV Production [W]
Blindern	high	1286,93	864,06	-1877,73	-8030,5
Blindern	low	1301,9	683,49	-1828,96	-8031,34
Flesland	high	816,9	348,39	-558,89	-6407,5
Flesland	low	828,92	347,52	-487,10	-6402,08
Kirkenes	high	2537,41	212,49	375,52	-5604,7
Kirkenes	low	2550,7	212,56	431,4	-5606,5
Kise	high	1626,08	634,13	-1880,15	-7973,78
Kise	low	1636,63	633,83	-1828,25	-7973,07

Table 8.13.3 Arithmetic mean values for new one-year compact

Location	Type of thermal mass	Heating demand [W]	Cooling demand [W]	Total supplied electricity use [W]	PV Production [W]
Blindern	high	1158,93	880,58	-1493,81	-7633,59
Blindern	low	1172,11	878,93	-1443,15	-7633,72
Flesland	high	769,8	332,53	-497,24	-6312,27
Flesland	low	781,92	332,40	-433,96	-6313,43
Kirkenes	high	2652,3	201,10	468,65	-5521,56
Kirkenes	low	2663,92	200,09	520,31	-5524,88
Kise	high	1597,84	544,84	-1689,99	-7728,37
Kise	low	1607,52	545,26	-1632,99	-7725,94

Table 8.13.4 24- hours mean difference in percent between reference climate data file and EN-ISO 15927-4

Location	Type of thermal mass	Annual 24- hours mean difference	Heating demand %	Cooling demand %	Total supplied electricity use %	PV Production %
Blindern	high	max	8,57	-6,09	-0,03	0,01
Blindern	high	min	0,00	0,00	-0,73	-0,68
Blindern	low	max	8,91	-5,76	-0,02	0,01
Blindern	low	min	0,00	0,00	-0,91	-0,66
Flesland	high	max	9,74	2,41	-0,17	-0,03
Flesland	high	min	0,00	0,00	1,36	0,43
Flesland	low	max	10,13	2,46	-0,13	-0,03
Flesland	low	min	0,00	0,00	1,29	0,43
Kirkenes	high	max	-2,70	0,84	0,02	0,00
Kirkenes	high	min	0,00	0,00	1,22	2,69

Kirkenes	low	max	-3,20	0,56	0,03	0,00
Kirkenes	low	min	0,00	0,00	1,14	2,74
Kise	high	max	7,80	-9,97	0,00	0,00
Kise	high	min	0,00	0,00	-0,15	0,16
Kise	low	max	7,90	-9,85	0,01	0,00
Kise	low	min	0,00	0,00	-0,25	0,13

Table 8.13.5 24- hours mean difference in percent between reference climate data file and new one-year compact

Location	**Type of thermal mass**	**Annual 24- hours mean difference**	**Heating demand %**	**Cooling demand %**	**Total supplied electricity %**	**PV Production %**
Blindern	high	max	-0,85	-5,33	0,23	-0,01
Blindern	high	min	0,0	0,00	-0,17	1,06
Blindern	low	max	-0,50	-5,58	0,26	0,01
Blindern	low	min	0,00	0,00	-0,32	1,10
Flesland	high	max	5,23	-14,71	0,37	-0,02
Flesland	high	min	0,00	0,00	0,74	0,24
Flesland	low	max	6,34	-14,78	0,38	-0,02
Flesland	low	min	0,00	0,00	0,83	0,24
Kirkenes	high	max	-8,26	-7,11	0,01	0,00
Kirkenes	high	min	0,00	0,00	2,59	3,52
Kirkenes	low	max	-8,64	-7,16	0,01	0,00
Kirkenes	low	min	0,00	0,00	2,92	3,56
Kise	high	max	-3,23	-12,30	0,01	-0,02

Kise	high	min	0,00	0,00	2,37	-0,64
Kise	low	max	-3,07	12,17	0,00	-0,02
Kise	low	min	0,00	0,00	2,47	-0,75

8.13.1 99,6000 percentiles for buildings with high and low thermal masses

Table 8.13.1.1 99,6000 percentiles, which is equivalent to 35 hours per year for reference climate data file with 11 years raw data

Location	**Type of thermal mass**	**Heating demand [W]**	**Cooling demand [W]**	**Total supplied electricity [W]**	**PV Production [W]**	**Exhaust temperature [°C]**	**Operative temperature [°C]**
Blindern	high	18311	24928	18522	-60837	24,014	25,17
Blindern	low	18382	25023	18525	-60871	24,015	25,41
Flesland	high	12495	19576	18187	-61758	24,01	25,13
Flesland	low	12594	19708	18237	-61757	24,01	25,38
Kirkenes	high	42097	16084	19980	-61283		
Kirkenes	low	42195	16087	19976	-61260		
Kise	high	27084	22210	19976	-63551		
Kise	low	27234	22216	19070	-63538		

Table 8.13.1.2 99,6000 percentiles, which is equivalent to 35 hours per year for EN-ISO 15927-4

Location	Type of thermal mass	Heating demand [W]	Cooling demand [W]	Total supplied electricity use [W]	PV Production [W]	Exhaust temperature [°C]	Operative temperature [°C]
Blindern	high	20216	25673	18604	-60660	24,014	25,14
Blindern	low	19920	25694	18537	-60669	24,014	25,37
Flesland	high	13817	20023	18128	-61995	24,009	25,079
Flesland	low	13960	19919	18114	-62010	24,010	25,34
Kirkenes	high	34487	19753	20012	-61579		
Kirkenes	low	34738	19787	20011	-61716		
Kise	high	30390	21090	19195	-63775		
Kise	low	30153	21119	19277	-63775		

Table 8.13.1.3 99,6000 percentiles, which is equivalent to 35 hours per year for New one-year compact climate data file

Location	Type of thermal mass	Heating demand [W]	Cooling demand [W]	Total supplied electricity use [W]	PV Production [W]	Exhaust temperature [°C]	Operative temperature [°C]
Blindern	high	18544	27793	18883	-60943	24,014	25,14
Blindern	low	18499	27567	18761	-60925	24,016	25,4
Flesland	high	13817	18392	18288	-61851	24,01	25,17
Flesland	low	14025	18410	18390	-61897	24,012	25,44
Kirkenes	high	41055	17471	19937	-61022		
Kirkenes	low	41197	17450	19979	-61102		
Kise	high	28624	20775	19200	-63336		
Kise	low	28757	20812	19236	-63265		

8.13.2 99,943 percentiles for buildings with high and low thermal masses

Table 8.13.2.1 99,9943 percentiles, which is equivalent to peak load for reference climate data file with 11 years raw data

Location	Type of thermal mass	Heating demand [W]	Cooling demand [W]	Total supplied electricity use [W]	PV Production [W]	Exhaust temperature [°C]	Operative temperature [°C]
Blindern	high	33011	38345	20096	-66253	24,49	25,36
Blindern	low	33239	38502	220173	-66208	24,32	25,65
Flesland	high	18266	35290	20029	-69340	24,16	25,36
Flesland	low	18304	35407	20041	-69326	24,56	25,70
Kirkenes	high	61043	34848	20404	-69193		
Kirkenes	low	61057	34805	20391	-68674		
Kise	high	43585	36158	20222	-70587		
Kise	low	43976	36402	20213	-70814		

Table 8.13.2.2 99,9943 percentiles, which is equivalent to peak load for EN-ISO 15927-4 climate data file

Location	Type of thermal mass	Heating demand [W]	Cooling demand [W]	Total supplied electricity use [W]	PV Production [W]	Exhaust temperature [°C]	Operative temperatur e [°C]
Blindern	high	36625	34739	24214	-67324	24,16	25,32
Blindern	low	36993	34749	23869	-67347	24,13	25,59
Flesland	high	20300	34260	19961	-69928	24,17	25,36
Flesland	low	20535	34197	19885	-69950	24,39	25,67
Kirkenes	high	63739	26816	20442	-68365		
Kirkenes	low	63359	27126	21001	-68287		
Kise	high	57126	28514	20205	-69888		
Kise	low	57601	28825	20209	-69866		

Table 8.13.2.3 99,9943 percentiles, which is equivalent to peak load for New one-year compact climate data file

Location	Type of thermal mass	Heating demand [W]	Cooling demand [W]	Total supplied electricity use[W]	PV Production [W]	Exhaust temperature [°C]	Operative temperature [°C]
Blindern	high	27657	33901	22891	-66938	24,16	25,32
Blindern	low	27870	34151	22280	-66987	25,18	25,63
Flesland	high	19530	28260	20182	-67960	24,69	25,38
Flesland	low	19748	28262	20156	-67960	24,96	25,69
Kirkenes	high	60188	28662	20418	-70259		
Kirkenes	low	59949	28894	20447	-70910		
Kise	high	42033	30716	20132	-73397		
Kise	low	42143	30659	20162	-73738		

8.14 Standard deviation and peak for random years started with different weekdays

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	-0,13313	0,0792907	0,0552285	0,00706	-0,62858	-0,30469	-0,03067
3	0,0109014	0,0022541	0,0075618	-0,0067059	-0,0393769	-0,0280069	-0,0162505
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0,0008374	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
16	9,225E-06	0,00126117	0,0019365	7,0705E-05	-0,00060134	0,00017045	0,00175476
17	0,00202965	0,0016202	0,00065165	0,0001436	-0,0005316	0,00448675	0,0045939
18	-0,00067595	-0,0034319	-0,00288885	-0,00280125	-0,0007019	0,0028734	0,0023058
19	-0,0023453	-0,0022549	-0,00085175	-0,00147025	-0,00260415	0,0012773	0,0009811
20	0,000425	-0,00074	-0,003855	-0,00373	-0,001175	0,00162	0,00198
21	-5,5E-05	-0,00011	-0,00812	-0,007625	0,001435	0,00667	0,00426
22	0,001355	-0,00674	-0,01513	-0,014685	-0,00804	0,002505	0,00905
23	-119,1	-344,32	-491,805	-485,76	-144,1	54,85	-158,6
24	-3	82,9	-119,4	-328,4	-197,65	-387,9	-212,8
25	-69,15	-87,5	251,8	15,2	-223,35	-297,85	-181,6
26	-527	452	960	838	573	-248	-807
27	-502,5	1005	1680	1501,5	1164	-444	-985
28	-705	1299	1630	1648	1310	233	-1207
29	-3007	73	167	59	134	-1506	-4258
30	-2583	-2266	-2293	-2391	-2257	-5444	-7378
31	0,0177236	0,00628702	0,00305019	4,9844E-05	0,39511282	0,092836	0,00094065
32	0,00011884	5,081E-06	5,7181E-05	4,4969E-05	0,00155054	0,00078439	0,00026408
33	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0
40	0	0	0	7,0123E-07	0	0	0
41	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0
45	8,5101E-11	1,5905E-06	3,75E-06	4,9992E-09	3,6161E-07	2,9053E-08	3,0792E-06
46	4,1195E-06	2,625E-06	4,2465E-07	2,0621E-08	2,826E-07	2,0131E-05	2,1104E-05
47	4,5691E-07	1,1778E-05	8,3455E-06	7,847E-06	4,9266E-07	8,2564E-06	5,3167E-06
48	5,5004E-06	5,0846E-06	7,2548E-07	2,1616E-06	6,7816E-06	1,6315E-06	9,6256E-07
49	1,8062E-07	5,476E-07	1,4861E-05	1,3913E-05	1,3806E-06	2,6244E-06	3,9204E-06
50	3,025E-09	1,21E-08	6,5934E-05	5,8141E-05	2,0592E-06	4,4489E-05	1,8148E-05
51	1,836E-06	4,5428E-05	0,00022892	0,00021565	6,4642E-05	6,275E-06	8,1903E-05
52	14184,81	118556,262	241872,158	235962,778	20764,81	3008,5225	25153,96
53	9	6872,41	14256,36	107846,56	39065,5225	150466,41	45283,84
54	4781,7225	7656,25	63403,24	231,04	49885,2225	88714,6225	32978,56
55	277729	204304	921600	702244	328329	61504	651249
56	252506,25	1010025	2822400	2254502,25	1354896	197136	970225
57	497025	1687401	2656900	2715904	1716100	54289	1456849
58	9042049	5329	27889	3481	17956	2268036	18130564
59	6671889	5134756	5257849	5716881	5094049	29637136	54434884
60	577937,028	281893,101	414005,854	404725,953	297277,447	1119320,37	2611971,98

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	760,221696	530,936061	643,432867	636,180755	545,231553	1057,97938	1616,15964
PEAK	2583	2266	2293	2391	2257	5444	7378

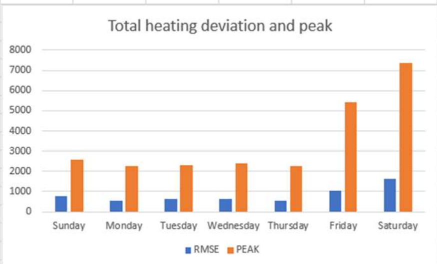


Figure 8.14.1 Standard deviation and peak for total heating in Watt for building with high thermal mass in Blindern. New one-year compact climate data file

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
-0,0096	-0,00956879	-0,01325307	-0,01358688	-0,0036543	0,00169289	-0,00414636
0,00173923	0,00173923	-0,00339941	-0,00894152	-0,00532674	-0,01059624	-0,00675248
-0,00232807	-0,00232807	0,00752941	0,00042799	-0,00593875	-0,00799421	-0,00491511
0,01316693	0,01316693	0,02622481	0,02289901	0,01567491	-0,0067334	-0,02213571
0,0272062	0,0272062	0,04609788	0,04076841	0,03141798	-0,01229459	-0,02709716
0,03552072	0,03552072	0,04459854	0,04508923	0,03587511	0,00643353	-0,03282191
0,00190825	0,00190825	0,0045798	0,00160838	0,00370746	-0,04108191	-0,11604889
-0,06812454	-0,06812454	-0,06084593	-0,06040976	-0,06013715	-0,14914341	-0,20115686
0,00009216	9,1562E-05	0,00017564	0,0001846	1,3354E-05	2,8659E-06	1,7192E-05
3,0249E-06	3,0249E-06	1,1556E-05	7,9951E-05	2,8374E-05	0,00011228	4,5596E-05
5,4199E-06	5,4199E-06	5,6692E-05	1,8318E-07	3,5269E-05	6,3907E-05	2,4158E-05
0,00017337	0,00017337	0,00068774	0,00052436	0,0002457	4,5339E-05	0,00048999
0,00074018	0,00074018	0,00212501	0,00166206	0,00098709	0,00015116	0,00073426
0,00126172	0,00126172	0,00198903	0,00203304	0,00128702	4,139E-05	0,00107728
3,6414E-06	3,6414E-06	2,0975E-05	2,5869E-06	1,3745E-05	0,00168772	0,01346735
0,00464095	0,00464095	0,00370223	0,00364934	0,00361648	0,02224376	0,04046408
0,00086506	0,00086498	0,00109611	0,00101702	0,00077838	0,00304355	0,00703999

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	0,02941187	0,0294106	0,03310755	0,03189069	0,02789945	0,0551684	0,08390463
PEAK	0,06812454	0,06812454	0,06084593	0,06040976	0,06013715	0,14914341	0,14914341

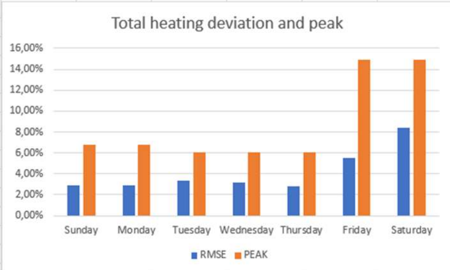


Figure 8.14.2 Standard deviation and peak for total heating in percent for building with high thermal mass in Blindern. New one-year compact climate data file

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	-0,00207605	-0,0031316	-0,00203565	0,00088205	-0,00074415	-0,0019944	-0,002517
24	0,001035	-0,00234	0,003315	-0,000285	0,00908	0,016335	0,0101
25	376,05	468,7	705,9	245	830,4	1597,75	1250,6
26	1272	-311	-477	-342	645	2296	2912
27	1291	416	482,5	1302	1747	2231	2023
28	1394	248	1599	1803	1779	2775	1870
29	-3121	-2803	-2851	-3001	-2987	-2896	-2994
30	-4395	-4561	-4627	-4658	-4680	-4458	-4361
31	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0
52	4,31E-06	9,8069E-06	4,1439E-06	7,7801E-07	5,5376E-07	3,9776E-06	6,3353E-06
53	1,0712E-06	5,4756E-06	1,0989E-05	8,1225E-08	8,2446E-05	0,00026683	0,00010201
54	141413,603	219679,69	498294,81	60025	689564,16	2552805,06	1564000,36
55	1617984	96721	227529	116964	416025	5271616	8479744
56	1666681	173056	232806,25	1695204	3052009	4977361	4092529
57	1943236	61504	2556801	3250809	3164841	7700625	3496900
58	9740641	7856809	8128201	9006001	8922169	8386816	8964036
59	19316025	20802721	21409129	21696964	21902400	19873764	19018321
60	1187102,78	1007258,3	569786,094	1235378,17	1315414,07	1681482,31	1572949,32

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	1089,54246	1003,62259	754,841768	1111,47567	1146,91502	1296,71983	1254,17276
PEAK	4395	4561	4627	4658	4680	4458	4361

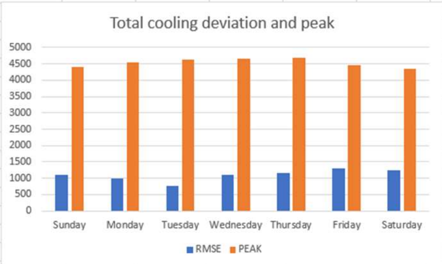


Figure 8.14.3 Standard deviation and peak for total cooling in Watt for building with high thermal mass in Blindern. New one-year compact climate data file

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
-5,1631E-08	-0,00937938	-0,01339692	-0,01323225	-0,00392533	0,00149413	-0,00432031
2,5741E-08	0,00225822	-0,00325249	-0,00894572	-0,00538405	-0,01056651	-0,00579674
0,00935238	-0,00238353	0,00685911	0,00041405	-0,00608412	-0,00811352	-0,00494684
0,03163471	0,01231262	0,02615069	0,02282737	0,01560869	-0,0067556	-0,02198293
0,03210724	0,02737651	0,04576371	0,04090132	0,03170771	-0,01209469	-0,0268317
0,03466886	0,03538515	0,0444017	0,04489202	0,0356848	0,00634699	-0,03287905
-0,07761944	0,00198854	0,00454913	0,00160718	0,0036502	-0,0410239	-0,11598921
-0,10930389	-0,06172653	-0,06246202	-0,06513157	-0,06148137	-0,14829621	-0,20097896
2,6658E-15	8,7973E-05	0,00017948	0,00017509	1,5408E-05	2,2324E-06	1,8665E-05
6,6257E-16	5,0996E-06	1,0579E-05	8,0026E-05	2,8988E-05	0,00011165	3,3602E-05
8,7467E-05	5,6812E-06	4,7047E-05	1,7144E-07	3,7017E-05	6,5829E-05	2,4471E-05
0,00100075	0,0001516	0,00068386	0,00052109	0,00024363	4,5638E-05	0,00048325
0,00103087	0,00074947	0,00209432	0,00167292	0,00100538	0,00014628	0,00071994
0,00120193	0,00125211	0,00197151	0,00201529	0,0012734	4,0284E-05	0,00108103
0,00602478	3,9543E-06	2,0695E-05	2,583E-06	1,3324E-05	0,00168296	0,0134535
0,01194734	0,00381016	0,0039015	0,00424212	0,00377996	0,02199177	0,04039254
0,00266164	0,00075826	0,00111362	0,00108866	0,00079964	0,00301083	0,00702588

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	0,05159111	0,02753646	0,033371	0,03299487	0,02827789	0,05487104	0,08382049
PEAK	0,10930389	0,06172653	0,06246202	0,06513157	0,06148137	0,14829621	0,14829621

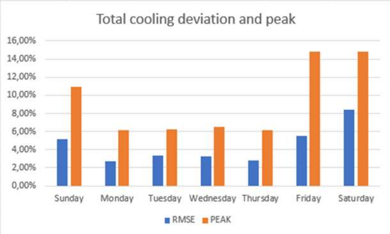


Figure 8.14..4 Standard deviation and peak for total cooling in percent for building with high thermal mass in Blindern. New one-year compact climate data file

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	456	-2407	-2715	-2398	-2187	-2200	-2121
3	-283	-267	-119	316	763	-792	-344
4	794	1740	939	873	2273	1343	-838
5	250	1521	1194	908	2534,5	1682	-487
6	-456	801	993	181	1444	1696	644
7	640,5	300	343,5	107,5	791,5	1291	1050
8	-246	92	69,5	-136	28,5	410,5	163
9	-381,9	-136,5	-74,45	-70,9	-60,1	357,4	259,4
10	-28,35	-44,9	-324,95	-126,35	-41,6	-154,5	8,1
11	-11,775	10,73	-81,005	-25,255	-65,76	-122,69	-94,42
12	35,735	9,27	-22,4	-12,05	-72,23	-128,515	-20,22
13	-0,65	6,4	-20,1	-9,35	-31,9	-46,9	-11,3
14	0,8	-0,6	-1,65	-0,85	-2,3	-2,4	-0,3
15	1,3	-1,1	-3,45	-0,9	-2,7	-4,05	-1,8
16	-1	-0,1	-0,15	0,5	-0,7	-1,5	-1,5
17	-1,9	0,7	0,85	0,45	-2,25	-4,2	-4,1
18	-4,3	-0,8	-1,65	0,8	-3	-6,85	-6,3
19	-14,35	-3,7	-5,6	-1,45	-14,55	-19,15	-19,7
20	-8,45	-9,7	-17,15	15,35	-17,25	-29,6	-19
21	2,5	-30,15	-41,05	-11,75	-48,5	-60,9	-32,9
22	52,7	-46,8	-83,2	-11,4	-115,3	-243,7	-146,9
23	66	-73,1	-122,15	-130,1	-267,75	-413,05	-211,5
24	187,5	-47	-147,1	-97,1	-181,8	-102,4	22
25	240	120	84,5	72,5	49	5,5	142
26	167	161	106	127	169	208	184
27	348	392	499,5	265,5	344,5	369	598
28	349	345	314	204	262	290	444
29	33	-28	1391	1284	1269	1238	1279
30	36	9	3373	3089	2927	2748	2736

31	207936	5793649	7371225	5750404	4782969	4840000	4498641
32	80089	71289	14161	99856	582169	627264	118336
33	630436	3027600	881721	762129	5166529	1803649	702244
34	62500	2313441	1425636	824464	6423690,25	2829124	237169
35	207936	641601	986049	32761	2085136	2876416	414736
36	410240,25	90000	117992,25	11556,25	626472,25	1666681	1102500
37	60516	8464	4830,25	18496	812,25	168510,25	26569
38	145847,61	18632,25	5542,8025	5026,81	3612,01	127734,76	67288,36
39	803,7225	2016,01	105592,503	15964,3225	1730,56	23870,25	65,61
40	138,650625	115,1329	6561,81003	637,815025	4324,3776	15052,8361	8915,1364
41	1276,99023	85,9329	501,76	145,2025	5217,1729	16516,1052	408,8484
42	0,4225	40,96	404,01	87,4225	1017,61	2199,61	127,69
43	0,64	0,36	2,7225	0,7225	5,29	5,76	0,09
44	1,69	1,21	11,9025	0,81	7,29	16,4025	3,24
45	1	0,01	0,0225	0,25	0,49	2,25	2,25
46	3,61	0,49	0,7225	0,2025	5,0625	17,64	16,81
47	18,49	0,64	2,7225	0,64	9	46,9225	39,69
48	205,9225	13,69	31,36	2,1025	211,7025	366,7225	388,09
49	71,4025	94,09	294,1225	235,6225	297,5625	876,16	361
50	6,25	909,0225	1685,1025	138,0625	2352,25	3708,81	1082,41
51	2777,29	2190,24	6922,24	129,96	13294,09	59389,69	21579,61
52	4356	5343,61	14920,6225	16926,01	71690,0625	170610,303	44732,25
53	35156,25	2209	21638,41	9428,41	33051,24	10485,76	484
54	57600	14400	7140,25	5256,25	2401	30,25	20164
55	27889	25921	11236	16129	28561	43264	33856
56	121104	153664	249500,25	70490,25	118680,25	136161	357604
57	121801	119025	98596	41616	68644	84100	197136
58	1089	784	1934881	1648656	1610361	1532644	1635841
59	1296	81	11377129	9541921	8567329	7551504	7485696
60	75210,2824	423847,298	849800,339	650774,452	1041399,3	847939,568	585378,865

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	274,244931	651,035558	921,846158	806,705927	1020,48974	920,836342	765,100559
PEAK	36	9	3373	3089	2927	2748	2736

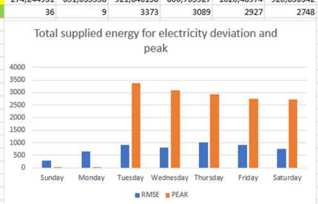


Figure 8.14.5 Standard deviation and peak for total supplied electricity use in Watt for building with high thermal mass in Blindern. New one-year compact climate data file

63	0,00524488	-0,02768512	-0,03122772	-0,02758161	-0,0251547	-0,02530423	-0,02439557
64	-0,00325504	-0,00307101	-0,00136873	0,00363461	0,00877597	-0,00910952	-0,00395666
65	0,00913253	0,02001334	0,0108003	0,01004118	0,02614387	0,01544708	-0,00963861
66	0,00287548	0,01749442	0,01373329	0,01044374	0,02915162	0,01934623	-0,00560144
67	-0,00524488	0,00921304	0,01142141	0,00208185	0,01660877	0,01950726	0,00740724
68	0,00736698	0,00345058	0,00395091	0,00123646	0,00910377	0,01484898	0,01207702
69	-0,00282947	0,00105818	0,00079938	-0,00156426	0,0003278	0,00472154	0,00187481
70	-0,00439258	-0,00157001	-0,00085632	-0,00081549	-0,00069127	0,00411079	0,0029836
71	-0,00032608	-0,00051644	-0,00373755	-0,00145327	-0,00047848	-0,00177705	9,3166E-05
72	-0,00013544	0,00012342	-0,00093171	-0,00029048	-0,00075637	-0,00141117	-0,00108601
73	0,00041102	0,00010662	-0,00025764	-0,0001386	-0,00083078	-0,00147817	-0,00023257
74	-7,4762E-06	7,3612E-05	-0,00023119	-0,00010754	-0,00036691	-0,00053944	-0,00012997
75	9,2015E-06	-6,9012E-06	-1,8978E-05	-9,7766E-06	-2,6454E-05	-2,7605E-05	-3,4506E-06
76	1,4952E-05	-1,2652E-05	-3,9682E-05	-1,0352E-05	-3,1055E-05	-4,6583E-05	-2,0703E-05
77	-1,1502E-05	-1,1502E-06	-1,7253E-06	5,751E-06	-8,0513E-06	-1,7253E-05	-1,7253E-05
78	-2,1854E-05	8,0513E-06	9,7766E-06	5,1759E-06	-2,5879E-05	-4,8308E-05	-4,7158E-05
79	-4,9458E-05	-9,2015E-06	-1,8978E-05	9,2015E-06	-3,4506E-05	-7,8788E-05	-7,2462E-05
80	-0,00016505	-4,2557E-05	-6,4411E-05	-1,6678E-05	-0,00016735	-0,00022026	-0,00022659
81	-9,7191E-05	-0,00011157	-0,00019726	0,00017655	-0,00019841	-0,00034046	-0,00021854
82	2,8755E-05	-0,00034678	-0,00047215	-0,00013515	-0,00055784	-0,00070047	-0,00037841
83	0,00060615	-0,00053829	-0,00095696	-0,00013112	-0,00132617	-0,00280302	-0,00168963
84	0,00075913	-0,00084079	-0,00140496	-0,0014964	-0,00307964	-0,00475087	-0,00243266
85	0,00215661	-0,00054059	-0,00169193	-0,00111684	-0,00209105	-0,0011778	0,00025304
86	0,00276046	0,00138023	0,00097191	0,00083389	0,00056359	6,3261E-05	0,00163327
87	0,00192082	0,00185181	0,0012192	0,00146074	0,00194382	0,0023924	0,00211635
88	0,00400267	0,00450875	0,00574521	0,00305376	0,00396241	0,00424421	0,00687815
89	0,00401417	0,00396816	0,0036116	0,00234639	0,0030135	0,00333556	0,00510685
90	0,00037956	-0,00032205	0,01599917	0,01476847	0,01459594	0,01423938	0,01471096
91	0,00041407	0,00010352	0,03879598	0,03552943	0,03366612	0,03160728	0,03146926
92	2,7509E-05	0,00076647	0,00097517	0,00076074	0,00063276	0,0006403	0,00059514
93	1,0595E-05	9,4311E-06	1,8734E-06	1,321E-05	7,7018E-05	8,2983E-05	1,5655E-05
94	8,3403E-05	0,00040053	0,00011665	0,00010083	0,0006835	0,00023861	9,2903E-05
95	8,2684E-06	0,00030605	0,0001886	0,00010907	0,00084982	0,00037428	3,1376E-05
96	2,7509E-05	8,488E-05	0,00013045	4,3341E-06	0,00027585	0,00038053	5,4867E-05
97	5,4272E-05	1,1906E-05	1,561E-05	1,5288E-06	8,2879E-05	0,00022049	0,00014585
98	8,0059E-06	1,1197E-06	6,3901E-07	2,4469E-06	1,0746E-07	2,2293E-05	3,5149E-06
99	1,9295E-05	2,4649E-06	7,3328E-07	6,6502E-07	4,7785E-07	1,6899E-05	8,9019E-06
100	1,0633E-07	2,6671E-07	1,3969E-05	2,112E-06	2,2894E-07	3,1579E-06	8,6798E-09
101	1,8343E-08	1,5231E-08	8,6809E-07	8,4379E-08	5,7209E-07	1,9914E-06	1,1794E-06
102	1,6894E-07	1,1368E-08	6,638E-08	1,9209E-08	6,902E-07	2,185E-06	5,4088E-08
103	5,5894E-11	5,4188E-09	5,3448E-08	1,1565E-08	1,3462E-07	2,91E-07	1,6893E-08
104	8,4668E-11	4,7626E-11	3,6017E-10	9,5583E-11	6,9984E-10	7,6201E-10	1,1906E-11
105	2,2358E-10	1,6008E-10	1,5746E-09	1,0716E-10	9,6442E-10	2,17E-09	4,2863E-10
106	1,3229E-10	1,3229E-12	2,9766E-12	3,3074E-11	6,4824E-11	2,9766E-10	2,9766E-10
107	4,7758E-10	6,4824E-11	9,5583E-11	2,679E-11	6,6974E-10	2,3337E-09	2,2239E-09
108	2,4461E-09	8,4668E-11	3,6017E-10	8,4668E-11	1,1906E-09	6,2076E-09	5,2508E-09
109	2,7242E-08	1,8111E-09	4,1487E-09	2,7815E-10	2,8007E-08	4,8515E-08	5,1342E-08
110	9,4461E-09	1,2448E-08	3,8911E-08	3,1171E-08	3,9366E-08	1,1591E-07	4,7758E-08
111	8,2684E-10	1,2026E-07	2,2293E-07	1,8265E-08	3,1119E-07	4,9065E-07	1,432E-07
112	3,6742E-07	2,8976E-07	9,1577E-07	1,7193E-08	1,7587E-06	7,8569E-06	2,8549E-06
113	5,7627E-07	7,0693E-07	1,9739E-06	2,2392E-06	9,4842E-06	2,2571E-05	5,9178E-06
114	4,651E-06	2,9224E-07	2,8626E-06	1,2473E-06	4,3725E-06	1,3872E-06	6,403E-08
115	7,6201E-06	1,905E-06	9,4461E-07	6,9537E-07	3,1764E-07	4,0019E-09	2,6676E-06
116	3,6896E-06	3,4292E-06	1,4865E-06	2,1338E-06	3,7785E-06	5,7236E-06	4,479E-06
117	1,6021E-05	2,0329E-05	3,3007E-05	9,3255E-06	1,5701E-05	1,8013E-05	4,7309E-05
118	1,6114E-05	1,5746E-05	1,3044E-05	5,5056E-06	9,0812E-06	1,1126E-05	2,608E-05
119	1,4407E-07	1,0372E-07	0,00025597	0,00021811	0,00021304	0,00020276	0,00021641
120	1,7145E-07	1,0716E-08	0,00150513	0,00126234	0,00113341	0,00099902	0,00099031
121	3,4909E-05	4,5405E-05	0,00187276	0,00170305	0,00168572	0,00158386	0,00156213

	med kjøling						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	0,00590838	0,00673835	0,04327535	0,04126805	0,04105756	0,0397978	0,03952379
PEAK	0,00041407	0,00010352	0,03879598	0,03552943	0,03366612	0,03160728	0,03146926

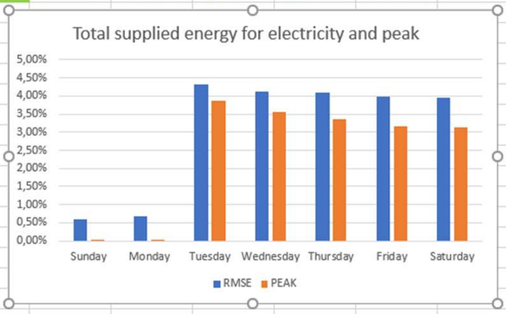


Figure 8.14.6 Standard deviation and peak for total supplied electricity use in percent for building with high thermal mass in Blindern. New one-year compact climate data file

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	-692	-732	-737	-725	-692	-685	-688
3	-1542	-1472	-1535	-1173	-1490	-1490	-1490
4	-177	-86	-199	-136	-158	-88	-111
5	41,5	82	87,5	114,5	89	45,5	79
6	316	293	317	363	297	363	275
7	496,5	570	453,5	432	376	451,5	516
8	-2	55	-124,5	-64	-117	-117	-117
9	68	127	58,5	65	51	54	96
10	-150,5	-83	-73,5	-111	-94	-80	-47
11	-5,15	22,1	-6,65	4,6	10,85	-13,35	21,15
12	-183,1	-148	-158,75	-186	-184,85	-182,4	-153,6
13	39,2	68,9	30,55	37,55	34,7	38,8	75,2
14	31,65	54,3	33,75	29,65	31,45	26,2	49
15	10,01	24,37	9,16	4,975	9	10,035	26,64
16	-6,02	11,575	-7,925	-9,53	-7,905	-5,515	7,33
17	1,211	4,925	0,1395	0,1395	0,1175	2,2425	4,924
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0
27	2,1944E-17	-2,4327E-29	-2,4624E-29	-2,4624E-29	-2,4624E-29	-2,4616E-29	-2,4624E-29
28	4,8908E-15	2,5406E-16	-1,0275E-15	-1,6097E-15	-1,2051E-15	-1,4151E-15	-8,4931E-16
29	110,856	9,643	1,783	-10,1132	-9,4223	195,236	21,028
30	122,762	356,402	-22,762	-35,7696	-31,805	763,032	346,662
31	478864	535824	543169	525625	478864	469225	473344
32	2377764	2166784	2356225	1375929	2220100	2220100	2220100
33	31329	7396	39601	18496	24964	7744	12321
34	1722,25	6724	7656,25	13110,25	7921	2070,25	6241
35	99856	85849	100489	131769	88209	131769	75625
36	246512,25	324900	205662,25	186624	141376	203852,25	266256
37	4	3025	15500,25	4096	13689	13689	13689
38	4624	16129	3422,25	4225	2601	2916	9216
39	22650,25	6889	5402,25	12321	8836	6400	2209
40	26,5225	488,41	44,2225	21,16	117,7225	178,2225	447,3225
41	33525,61	21904	25201,5625	34596	34169,5225	33269,76	23592,96
42	1536,64	4747,21	933,3025	1410,0025	1204,09	1505,44	5655,04
43	1001,7225	2948,49	1139,0625	879,1225	989,1025	686,44	2401
44	100,2001	593,8969	83,9056	24,750625	81	100,701225	709,6896
45	36,2404	133,980625	62,805625	90,8209	62,489025	30,415225	53,7289
46	1,466521	24,255625	0,01946025	0,01946025	0,01380625	5,02880625	24,245776
47	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0
56	4,8154E-34	5,9178E-58	6,0633E-58	6,0633E-58	6,0633E-58	6,0594E-58	6,0633E-58
57	2,392E-29	6,4546E-32	1,0557E-30	2,5911E-30	1,4523E-30	2,0025E-30	7,2132E-31
58	12289,0527	92,987449	3,179089	102,276814	88,7797373	38117,0957	442,176784
59	15070,5086	127022,386	518,108644	1279,46428	1011,55803	582217,833	120174,542
60	114721,163	114188,814	113969,428	79675,823	104285,665	128064,705	111465,576

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	338,705126	337,918355	337,593584	282,269061	322,932911	357,861293	333,864607
PEAK	122,762	356,402	22,762	35,7696	31,805	763,032	346,662

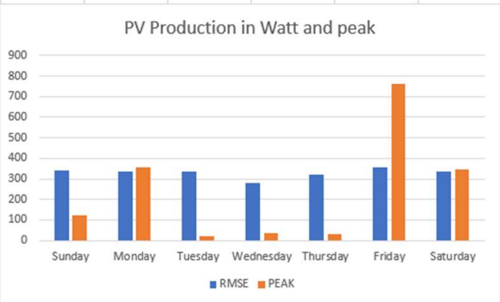


Figure 8.14.7 Standard deviation and peak for PV Production in Watt for building with high thermal mass in Blindern. New one-year compact climate data file

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	-0,00968348	-0,01024322	-0,01031319	-0,01014527	-0,00968348	-0,00958553	-0,00962751
3	-0,02157794	-0,02059839	-0,02147998	-0,01641435	-0,02085028	-0,02085028	-0,02085028
4	-0,00247684	-0,00120344	-0,0027847	-0,00190311	-0,00221097	-0,00123143	-0,00155328
5	0,00058073	0,00114746	0,00122443	0,00160225	0,00124542	0,0006367	0,00110548
6	0,00442194	0,00410009	0,00443593	0,00507963	0,00415606	0,00507963	0,00384821
7	0,00694776	0,00797628	0,00634604	0,00604518	0,00526155	0,00631805	0,00722063
8	-2,7987E-05	0,00076964	-0,00174219	-0,00089558	-0,00163724	-0,00163724	-0,00163724
9	0,00095156	0,00177717	0,00081862	0,00090958	0,00071367	0,00075565	0,00134337
10	-0,00210602	-0,00116146	-0,00102852	-0,00155328	-0,00131539	-0,00111948	-0,00065769
11	-7,2066E-05	0,00030926	-9,3057E-05	6,437E-05	0,00015183	-0,00018681	0,00029596
12	-0,00256221	-0,00207103	-0,00222146	-0,00260279	-0,00258669	-0,00255241	-0,0021494
13	0,00054854	0,00096415	0,0004275	0,00052545	0,00048557	0,00054295	0,00105231
14	0,00044289	0,00075985	0,00047228	0,00041491	0,00044009	0,00036663	0,00068568
15	0,00014007	0,00034102	0,00012818	6,9618E-05	0,00012594	0,00014042	0,00037279
16	-8,4241E-05	0,00016197	-0,0001109	-0,00013336	-0,00011062	-7,7174E-05	0,00010257
17	1,6946E-05	6,8918E-05	1,9521E-06	1,9521E-06	1,6442E-06	3,138E-05	6,8904E-05
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0
27	3,0707E-22	-3,4041E-34	-3,4457E-34	-3,4457E-34	-3,4457E-34	-3,4446E-34	-3,4457E-34
28	6,8439E-20	3,5552E-21	-1,4378E-20	-2,2525E-20	-1,6864E-20	-1,9802E-20	-1,1885E-20
29	0,00155126	0,00013494	2,495E-05	-0,00014152	-0,00013185	0,00273203	0,00029425
30	0,00171787	0,0049873	-0,00031852	-0,00050054	-0,00044506	0,01067747	0,00485101
31	9,377E-05	0,00010492	0,00010636	0,00010293	9,377E-05	9,1882E-05	9,2689E-05
32	0,00046561	0,00042429	0,00046139	0,00026943	0,00043473	0,00043473	0,00043473
33	6,1348E-06	1,4483E-06	7,7546E-06	3,6218E-06	4,8884E-06	1,5164E-06	2,4127E-06
34	3,3725E-07	1,3167E-06	1,4992E-06	2,5672E-06	1,5511E-06	4,0539E-07	1,2221E-06
35	1,9554E-05	1,6811E-05	1,9677E-05	2,5803E-05	1,7273E-05	2,5803E-05	1,4809E-05
36	4,8271E-05	6,3621E-05	4,0272E-05	3,6544E-05	2,7684E-05	3,9918E-05	5,2138E-05
37	7,8327E-10	5,9235E-07	3,0352E-06	8,0207E-07	2,6805E-06	2,6805E-06	2,6805E-06
38	9,0546E-07	3,1583E-06	6,7014E-07	8,2733E-07	5,0932E-07	5,71E-07	1,8047E-06
39	4,4353E-06	1,349E-06	1,0579E-06	2,4127E-06	1,7302E-06	1,2532E-06	4,3256E-07
40	5,1936E-09	9,5639E-08	8,6595E-09	4,1435E-09	2,3052E-08	3,4899E-08	8,7593E-08
41	6,5649E-06	4,2892E-06	4,9349E-06	6,7745E-06	6,691E-06	6,5148E-06	4,6199E-06
42	3,009E-07	9,2959E-07	1,8276E-07	2,761E-07	2,3578E-07	2,9479E-07	1,1074E-06
43	1,9615E-07	5,7737E-07	2,2305E-07	1,7215E-07	1,9368E-07	1,3442E-07	4,7016E-07
44	1,9621E-08	1,163E-07	1,643E-08	4,8466E-09	1,5861E-08	1,9719E-08	1,3897E-07
45	7,0965E-09	2,6236E-08	1,2298E-08	1,7784E-08	1,2236E-08	5,9558E-09	1,0521E-08
46	2,8717E-10	4,7497E-09	3,8107E-12	3,8107E-12	2,7035E-12	9,8473E-10	4,7477E-09
47	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0
56	9,4295E-44	1,1588E-67	1,1873E-67	1,1873E-67	1,1873E-67	1,1865E-67	1,1873E-67
57	4,684E-39	1,2639E-41	2,0672E-40	5,0739E-40	2,8438E-40	3,9212E-40	1,4125E-40
58	2,4064E-06	1,8209E-08	6,2252E-10	2,0028E-08	1,7385E-08	7,464E-06	8,6586E-08
59	2,9511E-06	2,4873E-05	1,0145E-07	2,5054E-07	1,9808E-07	0,00011401	2,3532E-05
60	2,2464E-05	2,236E-05	2,2317E-05	1,5602E-05	2,0421E-05	2,5077E-05	2,1827E-05

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	0,00473966	0,00472865	0,00472411	0,00394992	0,00451895	0,00500772	0,00467193
PEAK	0,00171787	0,0049873	0,00031852	0,00050054	0,00044506	0,01067747	0,00485101

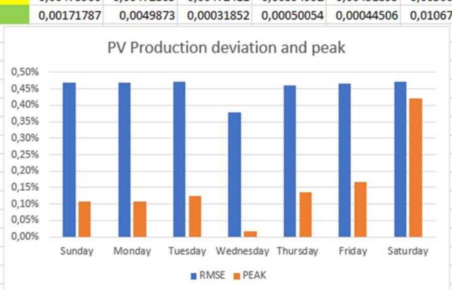


Figure 8.14.8 Standard deviation and peak for PV Production in percent for building with high thermal mass in Blindern. New one-year compact climate data file

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	0,015	0,007	0,007	0,014	0,015	0,008	0,006
3	0,017	0,009	0,006	0,011	0,014	0,016	0,004
4	0,074	0,079	0,08	0,094	0,09	0,09	0,078
5	0,082	0,085	0,089	0,1055	0,102	0,09	0,087
6	0,09	0,081	0,086	0,098	0,099	0,094	0,092
7	0,1095	0,104	0,107	0,124	0,1285	0,128	0,125
8	0,115	0,116	0,1185	0,1285	0,127	0,124	0,119
9	0,1045	0,108	0,115	0,125	0,122	0,115	0,112
10	0,104	0,105	0,104	0,112	0,1075	0,1	0,107
11	0,065	0,064	0,061	0,0695	0,0745	0,0595	0,059
12	0,0885	0,057	0,058	0,07	0,0565	0,07	0,073
13	0,2	0,2	0,186	0,1715	0,207	0,191	0,173
14	0,215	0,199	0,1865	0,184	0,183	0,173	0,169
15	0,2015	0,221	0,198	0,197	0,236	0,2065	0,169
16	0,2015	0,2195	0,196	0,218	0,2365	0,213	0,1795
17	0,186	0,2	0,201	0,198	0,208	0,189	0,173
18	0,156	0,146	0,1835	0,171	0,145	0,164	0,177
19	0,1355	0,1	0,1385	0,142	0,119	0,097	0,143
20	0,099	0,104	0,112	0,116	0,118	0,107	0,118
21	0,047	0,049	0,055	0,054	0,055	0,0565	0,057
22	0,002	0,002	0,002	0,002	0,002	0,002	0,002
23	0,001	0,001	0,001	0,001	0,001	0,001	0,001
24	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0
27	-0,001	-0,001	-0,0005	-0,001	-0,001	-0,0005	-0,001
28	-0,002	-0,002	-0,001	-0,002	-0,001	-0,001	-0,002
29	0,017	0,067	-0,008	-0,011	-0,049	-0,011	0,025
30	-0,231	1,67	0,026	-0,195	-0,312	-0,269	1,081
31	0,000225	4,9E-05	4,9E-05	0,000196	0,000225	6,4E-05	3,6E-05
32	0,000289	8,1E-05	3,6E-05	0,000121	0,000196	0,000256	1,6E-05
33	0,005476	0,006241	0,0064	0,008836	0,0081	0,0081	0,006084
34	0,006724	0,007225	0,007921	0,01113025	0,010404	0,0081	0,007569
35	0,0081	0,006561	0,007396	0,009604	0,009801	0,008836	0,008464
36	0,01199025	0,010816	0,011449	0,015376	0,01651225	0,016384	0,015625
37	0,013225	0,013456	0,01404225	0,01651225	0,016129	0,015376	0,014161
38	0,01092025	0,011664	0,013225	0,015625	0,014884	0,013225	0,012544
39	0,010816	0,011025	0,010816	0,012544	0,01155625	0,01	0,011449
40	0,004225	0,004096	0,003721	0,00483025	0,00555025	0,00354025	0,003481
41	0,00783225	0,003249	0,003364	0,0049	0,00319225	0,0049	0,005329
42	0,04	0,04	0,034596	0,02941225	0,042849	0,036481	0,029929
43	0,046225	0,039601	0,03478225	0,033856	0,033489	0,029929	0,028561
44	0,04060225	0,048841	0,039204	0,038809	0,055696	0,04264225	0,028561
45	0,04060225	0,04818025	0,038416	0,047524	0,05593225	0,045369	0,03222025
46	0,034596	0,04	0,040401	0,039204	0,043264	0,035721	0,029929
47	0,024336	0,021316	0,03367225	0,029241	0,021025	0,026896	0,031329
48	0,01836025	0,01	0,01918225	0,020164	0,014161	0,009409	0,020449
49	0,009801	0,010816	0,012544	0,013456	0,013924	0,011449	0,013924
50	0,002209	0,002401	0,003025	0,002916	0,003025	0,00319225	0,003249
51	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06
52	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06
53	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0
56	1E-06	1E-06	2,5E-07	1E-06	1E-06	2,5E-07	1E-06
57	4E-06	4E-06	1E-06	4E-06	1E-06	1E-06	4E-06
58	0,000289	0,004489	6,4E-05	0,000121	0,002401	0,000121	0,000625
59	0,053361	2,7889	0,000676	0,038025	0,097344	0,072361	1,168561
60	0,01345567	0,10789715	0,01155132	0,01353148	0,01654025	0,01387441	0,05076225

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	0,11599859	0,32847701	0,10747706	0,1163249	0,1286089	0,1177897	0,22530479
PEAK	0,231	1,67	0,026	0,195	0,312	0,269	1,081

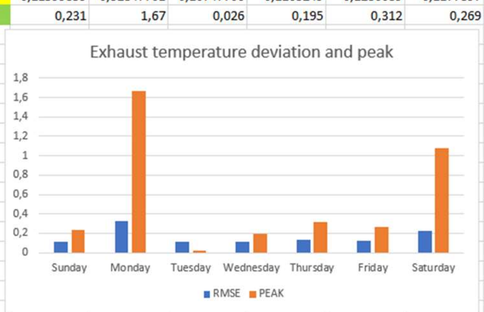


Figure 8.14.9 Standard deviation and peak for exhaust temperature in degrees Celsius for building with high thermal mass in Blindern. New one-year compact climate data file

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	0,00311526	0,00145379	0,00145379	0,00290758	0,00311526	0,00166147	0,00124611
3	0,00353063	0,00186916	0,00124611	0,00228453	0,00290758	0,00332295	0,00083074
4	0,01536864	0,01640706	0,01661475	0,01952233	0,01869159	0,01869159	0,01619938
5	0,01703011	0,01765317	0,0184839	0,0219107	0,0211838	0,01869159	0,01806854
6	0,01869159	0,01682243	0,01786085	0,02035306	0,02056075	0,01952233	0,01910696
7	0,02274143	0,02159917	0,02222222	0,02575286	0,02668744	0,02658359	0,02596054
8	0,0238837	0,02409138	0,02461059	0,02668744	0,02637591	0,02575286	0,02471443
9	0,02170301	0,02242991	0,0238837	0,02596054	0,02533749	0,0238837	0,02326064
10	0,02159917	0,02180685	0,02159917	0,02326064	0,02232606	0,02076843	0,02222222
11	0,01349948	0,0132918	0,01266874	0,01443406	0,01547248	0,01235722	0,01225337
12	0,01838006	0,01183801	0,01204569	0,0145379	0,01173416	0,0145379	0,01516096
13	0,04153686	0,04153686	0,03862928	0,03561786	0,04299065	0,03966771	0,03592939
14	0,04465213	0,04132918	0,03873313	0,03821391	0,03800623	0,03592939	0,03509865
15	0,04184839	0,04589823	0,0411215	0,04091381	0,0490135	0,04288681	0,03509865
16	0,04184839	0,04558671	0,04070613	0,04527518	0,04911734	0,04423676	0,03727934
17	0,03862928	0,04153686	0,04174455	0,0411215	0,04319834	0,03925234	0,03592939
18	0,03239875	0,03032191	0,03811007	0,03551402	0,03011423	0,03406023	0,03676012
19	0,02814123	0,02076843	0,02876428	0,02949117	0,02471443	0,02014538	0,02969886
20	0,02056075	0,02159917	0,02326064	0,02409138	0,02450675	0,02222222	0,02450675
21	0,00976116	0,01017653	0,01142264	0,01121495	0,01142264	0,01173416	0,01183801
22	0,00041537	0,00041537	0,00041537	0,00041537	0,00041537	0,00041537	0,00041537
23	0,00020768	0,00020768	0,00020768	0,00020768	0,00020768	0,00020768	0,00020768
24	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0
27	-0,00020768	-0,00020768	-0,00010384	-0,00020768	-0,00020768	-0,00010384	-0,00020768
28	-0,00041537	-0,00041537	-0,00020768	-0,00041537	-0,00020768	-0,00020768	-0,00041537
29	0,00353063	0,01391485	-0,00166147	-0,00228453	-0,01017653	-0,00228453	0,00519211
30	-0,04797508	0,34683281	0,00539979	-0,04049844	-0,06479751	-0,05586708	0,22450675
31	9,7049E-06	2,1135E-06	2,1135E-06	8,454E-06	9,7049E-06	2,7605E-06	1,5528E-06
32	1,2465E-05	3,4938E-06	1,5528E-06	5,2191E-06	8,454E-06	1,1042E-05	6,9012E-07
33	0,0002362	0,00026919	0,00027605	0,00038112	0,00034938	0,00034938	0,00026242
34	0,00029002	0,00031163	0,00034165	0,00048008	0,00044875	0,00034938	0,00032647
35	0,00034938	0,00028299	0,00031901	0,00041425	0,00042274	0,00038112	0,00036508
36	0,00051717	0,00046652	0,00049383	0,00066321	0,00071222	0,00070669	0,00067395
37	0,00057043	0,00058039	0,00060568	0,00071222	0,00069569	0,00066321	0,0006108
38	0,00047102	0,0005031	0,00057043	0,00067395	0,00064199	0,00057043	0,00054106
39	0,00046652	0,00047554	0,00046652	0,00054106	0,00049845	0,00043133	0,00049383
40	0,00018224	0,00017667	0,0001605	0,00020834	0,0002394	0,0001527	0,00015015
41	0,00033783	0,00014014	0,0001451	0,00021135	0,00013769	0,00021135	0,00022985
42	0,00172531	0,00172531	0,00149222	0,00126863	0,0018482	0,00157353	0,00129092
43	0,00199381	0,0017081	0,00150026	0,0014603	0,00144447	0,00129092	0,00123192
44	0,00175129	0,00210665	0,00169098	0,00167394	0,00240232	0,00183928	0,00123192
45	0,00175129	0,00207815	0,00165699	0,00204984	0,00241251	0,00195689	0,00138975
46	0,00149222	0,00172531	0,00174261	0,00169098	0,0018661	0,00154075	0,00129092
47	0,00104968	0,00091942	0,00145238	0,00126125	0,00090687	0,0011601	0,00135131
48	0,00079193	0,00043133	0,00082738	0,00086973	0,0006108	0,00040584	0,00088202
49	0,00042274	0,00046652	0,00054106	0,00058039	0,00060058	0,00049383	0,00060058
50	9,528E-05	0,00010356	0,00013048	0,00012578	0,00013048	0,00013769	0,00014014
51	1,7253E-07	1,7253E-07	1,7253E-07	1,7253E-07	1,7253E-07	1,7253E-07	1,7253E-07
52	4,3133E-08	4,3133E-08	4,3133E-08	4,3133E-08	4,3133E-08	4,3133E-08	4,3133E-08
53	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0
56	4,3133E-08	4,3133E-08	1,0783E-08	4,3133E-08	4,3133E-08	1,0783E-08	4,3133E-08
57	1,7253E-07	1,7253E-07	4,3133E-08	1,7253E-07	4,3133E-08	4,3133E-08	1,7253E-07
58	1,2465E-05	0,00019362	2,7605E-06	5,2191E-06	0,00010356	5,2191E-06	2,6958E-05
59	0,00230161	0,120293	2,9158E-05	0,00164012	0,00419872	0,00312113	0,05040328
60	0,00058038	0,0046539	0,00049824	0,00058365	0,00071343	0,00059844	0,00218952

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
RMSE	0,02409109	0,06821952	0,0223213	0,02415886	0,02671005	0,02446307
PEAK	0,04797508	0,34683281	0,00539979	0,04049844	0,06479751	0,05586708

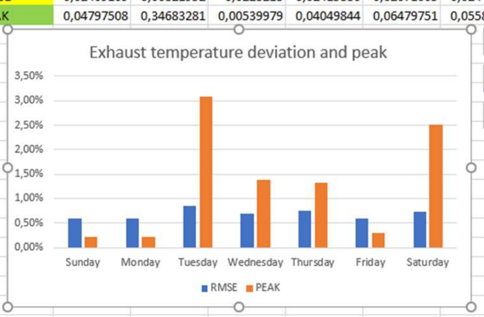


Figure 8.14.10 Standard deviation and peak for exhaust temperature in percent for building with high thermal mass in Blindern. New one-year compact climate data file

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	0,041	0,054	0,03	0,054	0,05	0,032	0,041
3	0,043	0,053	0,058	0,059	0,057	0,038	0,038
4	0,064	0,061	0,061	0,053	0,059	0,053	0,058
5	0,062	0,066	0,064	0,0585	0,059	0,052	0,057
6	0,06	0,063	0,062	0,061	0,06	0,059	0,061
7	0,052	0,054	0,0515	0,049	0,052	0,053	0,052
8	0,052	0,05	0,0485	0,047	0,049	0,05	0,052
9	0,1205	0,102	0,1	0,0955	0,101	0,107	0,11
10	0,0925	0,064	0,069	0,0645	0,055	0,0655	0,094
11	0,353	0,2685	0,262	0,2615	0,246	0,2695	0,315
12	0,502	0,478	0,4865	0,4485	0,463	0,417	0,423
13	0,4815	0,499	0,5025	0,485	0,486	0,451	0,426
14	0,471	0,452	0,4095	0,425	0,4335	0,431	0,406
15	0,397	0,411	0,3665	0,349	0,409	0,344	0,365
16	0,322	0,356	0,3005	0,2945	0,357	0,31	0,272
17	0,262	0,256	0,266	0,2585	0,2515	0,2695	0,223
18	0,1435	0,151	0,169	0,164	0,1565	0,1615	0,147
19	0,0775	0,083	0,092	0,09	0,086	0,0835	0,092
20	0,066	0,064	0,065	0,073	0,068	0,067	0,069
21	0,047	0,043	0,044	0,044	0,0425	0,047	0,049
22	0,01	0,006	0,007	0,004	0,005	0,002	0,009
23	-0,0445	-0,05	-0,047	-0,045	-0,049	-0,053	-0,05
24	-0,106	-0,11	-0,1065	-0,107	-0,1115	-0,1155	-0,112
25	-0,179	-0,191	-0,181	-0,181	-0,181	-0,1875	-0,182
26	-0,228	-0,234	-0,243	-0,229	-0,238	-0,253	-0,237
27	-0,2425	-0,238	-0,2385	-0,2365	-0,2485	-0,264	-0,256
28	-0,257	-0,244	-0,239	-0,247	-0,258	-0,272	-0,26
29	-0,284	-0,251	-0,235	-0,262	-0,33	-0,314	-0,298
30	-0,3	-0,262	-0,237	-0,282	-0,343	-0,329	-0,305
31	0,001681	0,002916	0,0009	0,002916	0,0025	0,001024	0,001681
32	0,001849	0,002809	0,003364	0,003481	0,003249	0,001444	0,001444
33	0,004096	0,003721	0,003721	0,002809	0,003481	0,002809	0,003364
34	0,003844	0,004356	0,004096	0,00342225	0,003481	0,002704	0,003249
35	0,0036	0,003969	0,003844	0,003721	0,0036	0,003481	0,003721
36	0,002704	0,002916	0,00265225	0,002401	0,002704	0,002809	0,002704
37	0,002704	0,0025	0,00235225	0,002209	0,002401	0,0025	0,002704
38	0,01452025	0,010404	0,01	0,00912025	0,010201	0,011449	0,0121
39	0,00855625	0,004096	0,004761	0,00416025	0,003025	0,00429025	0,008836
40	0,124609	0,07209225	0,068644	0,06838225	0,060516	0,07263025	0,099225
41	0,252004	0,228484	0,23668225	0,20115225	0,214369	0,173889	0,178929
42	0,23184225	0,249001	0,25250625	0,235225	0,236196	0,203401	0,181476
43	0,221841	0,204304	0,16769025	0,180625	0,18792225	0,185761	0,164836
44	0,157609	0,168921	0,13432225	0,121801	0,167281	0,118336	0,133225
45	0,103684	0,126736	0,09030025	0,08673025	0,127449	0,0961	0,073984
46	0,068644	0,065536	0,070756	0,06682225	0,06325225	0,07263025	0,049729
47	0,02059225	0,022801	0,028561	0,026896	0,02449225	0,02608225	0,021609
48	0,00600625	0,006889	0,008464	0,0081	0,007396	0,00697225	0,008464
49	0,004356	0,004096	0,004225	0,005329	0,004624	0,004489	0,004761
50	0,002209	0,001849	0,001936	0,001936	0,00180625	0,002209	0,002401
51	0,0001	3,6E-05	4,9E-05	1,6E-05	2,5E-05	4E-06	8,1E-05
52	0,00198025	0,0025	0,002209	0,002025	0,002401	0,002809	0,0025
53	0,011236	0,0121	0,01134225	0,011449	0,01243225	0,01334025	0,012544
54	0,032041	0,036481	0,032761	0,032761	0,032761	0,03515625	0,033124
55	0,051984	0,054756	0,059049	0,052441	0,056644	0,064009	0,056169
56	0,05880625	0,056644	0,05688225	0,05593225	0,06175225	0,069696	0,065536
57	0,066049	0,059536	0,057121	0,061009	0,066564	0,073984	0,0676
58	0,080656	0,063001	0,055225	0,068644	0,1089	0,098596	0,088804
59	0,09	0,068644	0,056169	0,079524	0,117649	0,108241	0,093025
60	0,05620013	0,05317566	0,04933053	0,04831172	0,05479567	0,05037399	0,04751121

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	0,23706566	0,23059849	0,22210476	0,21979928	0,23408475	0,22444151	0,21797066
PEAK	0,3	0,262	0,237	0,282	0,343	0,329	0,305

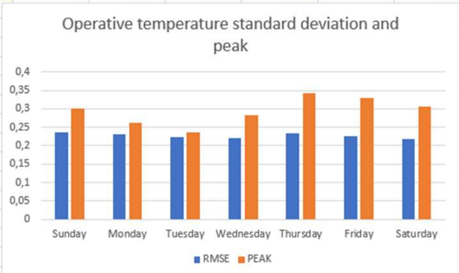


Figure 8.14.11 Standard deviation and peak for operative temperature in degrees Celsius for building with high thermal mass in Blindern. New one-year compact climate data file

1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	0,00849037	0,01118244	0,00621247	0,01118244	0,01035411	0,00662663	0,00849037
3	0,00890454	0,01097536	0,01201077	0,01221785	0,01180369	0,00786912	0,00786912
4	0,01325326	0,01263201	0,01263201	0,01097536	0,01221785	0,01097536	0,01201077
5	0,0128391	0,01366743	0,01325326	0,01211431	0,01221785	0,01076828	0,01180369
6	0,01242493	0,01304618	0,0128391	0,01263201	0,01242493	0,01221785	0,01263201
7	0,01076828	0,01118244	0,01066473	0,01014703	0,01076828	0,01097536	0,01076828
8	0,01076828	0,01035411	0,01004349	0,00973286	0,01014703	0,01035411	0,01076828
9	0,02495341	0,02112239	0,02070822	0,01977635	0,0209153	0,0221578	0,02277904
10	0,0191551	0,01325326	0,01428867	0,0133568	0,01138952	0,01356388	0,01946573
11	0,07310002	0,05560157	0,05425554	0,054152	0,05094222	0,05580866	0,0652309
12	0,10395527	0,0989853	0,1007455	0,09287637	0,09587906	0,08635328	0,08759578
13	0,09971008	0,10333402	0,10405881	0,10043487	0,10064195	0,09339408	0,08821702
14	0,09753572	0,09360116	0,08480017	0,08800994	0,08977014	0,08925243	0,08407538
15	0,08221164	0,08511079	0,07589563	0,07227169	0,08469662	0,07123628	0,07558501
16	0,06668047	0,07372127	0,0622282	0,06098571	0,07392835	0,06419549	0,05632636
17	0,05425554	0,05301305	0,05508387	0,05353075	0,05208118	0,05580866	0,04617933
18	0,0297163	0,03126941	0,03499689	0,03396148	0,03240837	0,03344378	0,03044109
19	0,01604887	0,01718782	0,01905156	0,0186374	0,01780907	0,01729136	0,01905156
20	0,01366743	0,01325326	0,01346034	0,015117	0,01408159	0,01387451	0,01428867
21	0,00973286	0,00890454	0,00911162	0,00911162	0,00880099	0,00973286	0,01014703
22	0,00207082	0,00124249	0,00144958	0,00082833	0,00103541	0,00041416	0,00186374
23	-0,00921516	-0,01035411	-0,00973286	-0,0093187	-0,01014703	-0,01097536	-0,01035411
24	-0,02195071	-0,02277904	-0,02205426	-0,0221578	-0,02308967	-0,023918	-0,02319321
25	-0,03706772	-0,0395527	-0,03748188	-0,03748188	-0,03748188	-0,03882791	-0,03768896
26	-0,04721474	-0,04845724	-0,05032098	-0,04742183	-0,04928557	-0,0523918	-0,04907848
27	-0,05021744	-0,04928557	-0,04938911	-0,04897494	-0,05145993	-0,0546697	-0,05301305
28	-0,05322013	-0,05052806	-0,04949265	-0,05114931	-0,05342721	-0,05632636	-0,05384138
29	-0,05881135	-0,05197764	-0,04866432	-0,05425554	-0,06833713	-0,06502381	-0,0617105
30	-0,06212466	-0,05425554	-0,04907848	-0,05839718	-0,0710292	-0,06813005	-0,06316007

31	7,2086E-05	0,00012505	3,8595E-05	0,00012505	0,00010721	4,3912E-05	7,2086E-05
32	7,9291E-05	0,00012046	0,00014426	0,00014928	0,00013933	6,1923E-05	6,1923E-05
33	0,00017565	0,00015957	0,00015957	0,00012046	0,00014928	0,00012046	0,00014426
34	0,00016484	0,0001868	0,00017565	0,00014676	0,00014928	0,00011596	0,00013933
35	0,00015438	0,0001702	0,00016484	0,00015957	0,00015438	0,00014928	0,00015957
36	0,00011596	0,00012505	0,00011374	0,00010296	0,00011596	0,00012046	0,00011596
37	0,00011596	0,00010721	0,00010087	9,4729E-05	0,00010296	0,00010721	0,00011596
38	0,00062267	0,00044616	0,00042883	0,0003911	0,00043745	0,00049097	0,00051888
39	0,00036692	0,00017565	0,00020417	0,0001784	0,00012972	0,00018398	0,00037891
40	0,00534361	0,00309154	0,00294366	0,00293244	0,00259511	0,00311461	0,00425507
41	0,0108067	0,00979809	0,01014965	0,00862602	0,00919279	0,00745689	0,00767302
42	0,0099421	0,01067792	0,01082824	0,01008716	0,0101288	0,00872245	0,00778224
43	0,00951322	0,00876118	0,00719107	0,00774575	0,00805868	0,007966	0,00706867
44	0,00675875	0,00724385	0,00576015	0,0052232	0,00717352	0,00507461	0,00571309
45	0,00444629	0,00543483	0,00387235	0,00371926	0,0054654	0,00412106	0,00317266
46	0,00294366	0,00281038	0,00303423	0,00286554	0,00271245	0,00311461	0,00213253
47	0,00088306	0,00097778	0,00122478	0,00115338	0,0010503	0,00111849	0,00092666
48	0,00025757	0,00029542	0,00036296	0,00034735	0,00031716	0,00029899	0,00036296
49	0,0001868	0,00017565	0,00018118	0,00022852	0,00019829	0,0001925	0,00020417
50	9,4729E-05	7,9291E-05	8,3022E-05	8,3022E-05	7,7457E-05	9,4729E-05	0,00010296
51	4,2883E-06	1,5438E-06	2,1013E-06	6,8613E-07	1,0721E-06	1,7153E-07	3,4735E-06
52	8,4919E-05	0,00010721	9,4729E-05	8,6838E-05	0,00010296	0,00012046	0,00010721
53	0,00048183	0,00051888	0,00048639	0,00049097	0,00053313	0,00057207	0,00053792
54	0,00137402	0,00156442	0,00140489	0,00140489	0,00140489	0,00150761	0,00142046
55	0,00222923	0,0023481	0,0025322	0,00224883	0,00242907	0,0027449	0,0024087
56	0,00252179	0,00242907	0,00243928	0,00239855	0,00264812	0,00298878	0,00281038
57	0,00283238	0,00255308	0,00244952	0,00261625	0,00285447	0,00317266	0,00289889
58	0,00345877	0,00270167	0,00236822	0,00294366	0,00466996	0,0042281	0,00380819
59	0,00385947	0,00294366	0,0024087	0,00341023	0,00504515	0,0046417	0,0039892
60	0,00241003	0,00228033	0,00211544	0,00207175	0,00234981	0,00216019	0,00203743

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
RMSE	0,04909208	0,04775285	0,04599395	0,04551652	0,04847479	0,04647784	0,04513785
PEAK	0,06212466	0,05425554	0,04907848	0,05839718	0,0710292	0,06813005	0,06316007

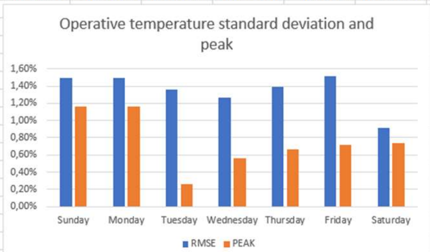


Figure 8.14.12 Standard deviation and peak for operative temperature in percent for building with high thermal mass in Blindern. New one-year compact climate data file

8.15 Summary for results of testing one-year compact climate data file on building with high thermal mass in Blindern

Table 8.15.1 Arithmetic mean values for years started with different weekdays and a reference climate data file with raw data

Weekday	Heating demand [W]	Cooling demand [W]	Total supplied electricity use [W]	PV Production [W]
Sunday	1175,31	795,75	-1540,62	-7632,5
Monday	1206,29	776,54	-1538,45	-7611,31
Tuesday	1219,83	791,33	-1564,31	-7633,64
Wednesday	11,99,71	778,15	-1580,84	-7631,65
Thursday	1186,85	826,28	-1536,54	-7632,4
Friday	1153,78	880,05	-1495,54	-7632,98
Saturday	1146,45	855,322	-1516,4	-7613,18
Raw data	1200,58	758,80	-1584,96	-7670,86

Table 8.15.2 99,6000 percentiles for years started with different weekdays for load and temperature, which is equivalent to 35 hours per year

Weekday	Heating demand [W]	Cooling demand [W]	Total supplied electricity use[W]	PV Production [W]	Exhaust temperature [°C]	Operative temperature [°C]
Sunday	17606	26322	18871	-61014	24,03	25,158
Monday	19610	25176	18867	-52528	24,013	25,171
Tuesday	19941	26527	18491,5	-61036	24,014	15,176
Wednesday	19959	26731	18726	-60973	24,013	25,168
Thursday	19621	26707	18784	-60995	24,014	25,157
Friday	18544	27703	18812	-60925	24,014	24,143
Saturday	17104	26798	18966	-60948	24,013	25,155
Raw data	18311	24928	18522	-65242	24,015	25,415

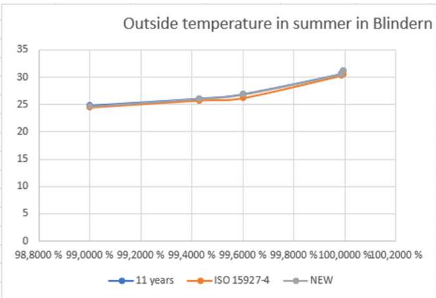
Table 8.15.3 99,9943 percentiles, which is equivalent to peak load and highest temperature during a year for years started with different weekdays

Weekday	Heating demand [W]	Cooling demand [W]	Total supplied electricity use [W]	PV Production [W]	Exhaust temperature [°C]	Operative temperature [°C]
Sunday	30428	33950	20132	-66945	24,201	25,352
Monday	30745	33784	20105	-66985	26,102	25,39
Tuesday	30718	33718	23569	-66990	24,458	25,415
Wednesday	30620	33687	23185	-66978	24,237	25,37
Thursday	30754	33665	23023	-66945	24,12	25,309
Friday	27567	33887	22844	-66938	24,163	25,323
Saturday	25633	33984	22834	-66941	25,513	25,347
Raw data	33011	38345	20096	-66253	24,32	25,652

8.16 Results of comparing outside air temperature in Blindern, Flesland, Kirkenes and Kise

	11 years	ISO 15927-4	NEW
99,0000 %	24,792	24,5	24,7
99,4292 %	26,088	25,7635	26,0835
99,6000 %	26,9	26,22	26,867
99,9863 %	30,657	30,3	30,61
99,9943 %	31,186	30,473	31,2

	11 years	ISO 15927-4	NEW
0,0057 %	-19,91	-20,275	-19,818
0,0137 %	-19,387	-20,2	-19,3
0,4000 %	-14,556	-18,233	-14,455
0,5708 %	-13,747	-16,6835	-13,843
1,0000 %	-12,3	-15,288	-12,28



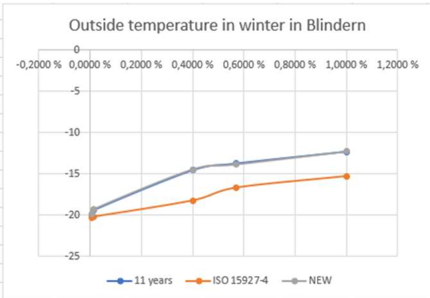
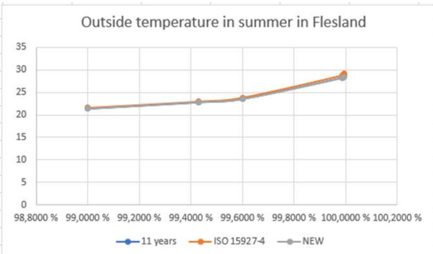


Figure 8.16.1 The highest outside air temperature in summer and the lowest outside air temperature in winter in Blindern

	11 years	ISO 15927-4	NEW
99,0000 %	21,44	21,568	21,435
99,4292 %	22,829	22,956	22,8875
99,6000 %	23,58	23,826	23,58
99,9863 %	28,22	28,746	28,225
99,9943 %	28,83	29,244	28,348

	11 years	ISO 15927-4	NEW
0,0057 %	-12,08	-12,588	-11,675
0,0137 %	-11,47	-12,296	-11,615
0,4000 %	-7,74	-10,3	-7,73
0,5708 %	-7,12	-9,7085	-7,1375
1,0000 %	-6,04	-8,6479	-6,04



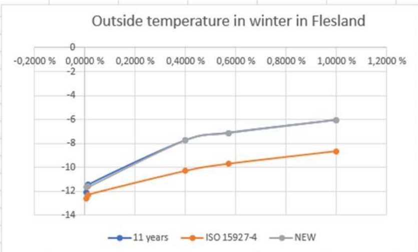


Figure 8.16.2 The highest outside air temperature in summer and the lowest outside air temperature in winter in Flesland

	11 years	ISO 15927-4	NEW
99,0000 %	20,503	20,872	20,5
99,4292 %	22,081	23,9125	22,0535
99,6000 %	22,887	24,591	22,89
99,9863 %	28,093	29,301	28,003
99,9943 %	28,873	29,687	28,602

	11 years	ISO 15927-4	NEW
0,0057 %	-31,288	-31,469	-31,3
0,0137 %	-30,849	-31,382	-30,68
0,4000 %	-25,766	-22,861	-25,788
0,5708 %	-24,899	-22	-24,9
1,0000 %	-23,238	-20,415	-23,295

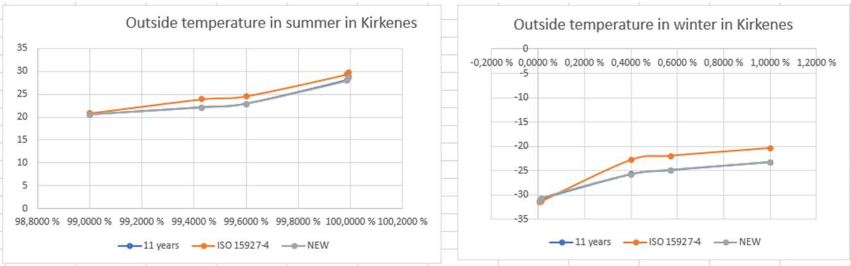


Figure 8.16.3 The highest outside air temperature in summer and the lowest outside air temperature in winter in Kirkenes

	11 years	ISO 15927-4	NEW
99,0000 %	22,546	23,447	22,643
99,4292 %	23,648	24,916	23,738
99,6000 %	24,45	25,321	24,5
99,9863 %	28,996	29,7	28,857
99,9943 %	29,73	29,793	29,713

	11 years	ISO 15927-4	NEW
0,0057 %	-29,24	-29,545	-29,163
0,0137 %	-28,22	-29,073	-27,797
0,4000 %	-20,096	-22,743	-20,218
0,5708 %	-19,114	-21,882	-19,263
1,0000 %	-17,39	-19,498	-17,397

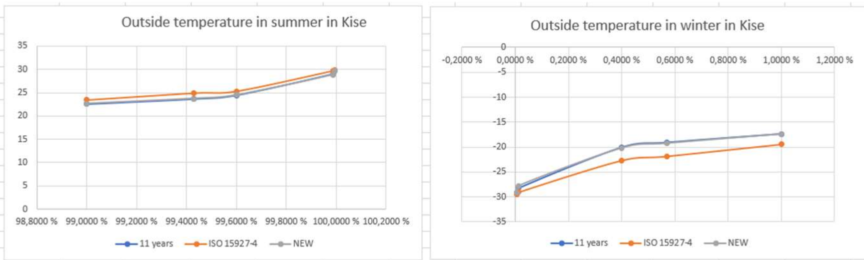


Figure 8.16.4 The highest outside air temperature in summer and the lowest outside air temperature in winter in Kise