Preparations for the pilots

(D5.1)

Preparations for the pilots including permits - MOdular REtrofitting and CONNECTions (MORE-CONNECT)

H2020-EE-2014-1-PPP (EE-01-2014)

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1 Introduction

The objective of work package 5 is the testing, pilot implementations and demonstration in real settings, as well as in industrial settings (demonstration of production), as in practice (demonstration and testing of the developed modular renovation elements both in real settings as in real life learning lab (RLLL) settings. The testing and demonstration in practice will be organised on six locations:

- Czech Republic (RLLL setting for in deep testing)
- Denmark (full real setting)
- Estonia (full real setting)
- Latvia (full real setting)
- The Netherlands (full real setting and RLLL setting for in deep testing)
- Portugal (partial in real setting)

The work package comprises 6 tasks of which this deliverable presents the results of task:

2 Preliminary and preparation works

The preliminary works within each country varies according to the actual needs for each pilot project. It may consist of a subset of the following activities:

- Preliminary survey of technical condition of pilot building / Selection of and testing construction details, walls, windows, connections to the roof structure, etc.
- Data on building heat consumption and climatic condition for years 2012 – 2015 has been analysed.
- IAQ measurements and airtightness tests were performed.
- 3D scanning has been done and analysed.
- Description of and technical and financial implications of renovation work presented to the tenants for the approval of the renovation
- Building permit application
- Procurement documentation: Tender development

The work within this task carried out for each of the above pilots are described below, country by country:

3 Czech Republic (RLLL setting for in deep testing)

The pilots in Czechia will take place in experimental setting at UCEEB.

The preliminary works within in T5.1 were focused on selection of details that need to be tested. We There is a plan to build a mock-up of a section of a typical building – corner including details of walls with windows, plinth and connections to roof structure. Vertical structures will be made of bricks; horizontal structures will be made of concrete. On the mockup will be applied testing modules.

The small mock-up building will be built on the plot dedicated for experimental structures adjacent to the main UCEEB building. There is general agreement with the local building authority that the temporary structures can be built on the site and only simplified building permission process shall be applied. To date, the technical documentation for the Czech pilot has been approved by the building permission authority – see attachment.

The construction of the mock-up has begun. See photos below and Appendix to 5.1 Photos from the construction of the mock-up for all photos.

4 Denmark

Building 34.6, Korsløkkeparken, Odense

General information.
Korsløkkeparken consist of seven apartment blocks in total in Odense the centre town of the island Fyen. All the seven blocks are being renovated as part of a total renovation plan for the area. The blocks were originally constructed in the years 1961-1981. The apartments are administered by Building association Fyen (FAB), which refer to them as department 34. One of the seven buildings have been selected for the MORE-CONNECT pilot project. This is referred to a building 34.6 – see photo to the right. It has 170 apartments and after the renovation this will be changed to 166 apartments. The building is 205 m long and 13,6 m broad and has 5 stories. The total living area is 13685 m² and the basement area is 2737 m². See an illustration on figure 1. This building was constructed in 1961.

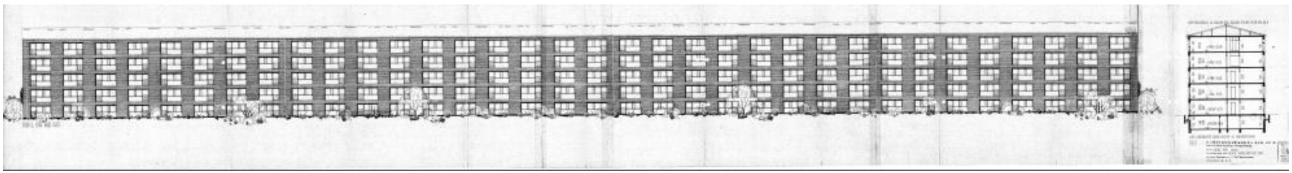


Figure 1. Front façade view and section of the original building

Preliminary survey of technical condition of pilot building – selection of energy renovation measures

The building had new windows installed in 1987, so the U-values were somewhat improved at that time.

An overview of the existing U-values is provided in table 1.

Table 1. Overview of existing and new U-values.

Building part	Ex. U-value, W/K/m²	New U-value, W/K/m²
External walls	1,1	0,2
Roof	0,45	0,1
Windows	2,9	0,81

The buildings was originally designed to be ventilated by natural ventilation – by opening the windows.

The energy renovation encompass the following measures:

- Added insulation to part of the external walls - the gable walls (*)
- Additional insulation of the roof
- New windows
- New mechanical ventilation systems with heat recovery
- PV-system on part of the roof (*)

The measures marked with (*) show that these are to be implemented with the Danish MORE-CONNECT technologies. The new U-values can be seen in table 1.

Data on building heat consumption

An energy performance report according to the Danish implementation of the EUDP was made for the building in February 2016. According to this the building as is performs according to a "C" mark in the Danish EUDP scale. This corresponds to an energy frame consumption of 120 kWh/m²/year. The predicted energy frame consumption is 60 kWh/m²/year corresponding to an energy saving of 50 %, which may be referred to as a deep energy renovation. See table 2.

Table 2. Predicted results of the energy renovation:

Energy demand	kWh/m²/year
Heating energy consumption, before renovation	108 (incl. DHW)
Design target heating energy consumption	47 (incl. DHW)
Electricity consumption, before renovation	4,4
Design electricity consumption (+vent – PV)	5,1
Energy frame calculation, before renovation	120
Energy frame calculation, after renovation	60

Thermography

The buildings were checked by thermography in October 2010. See a couple of the results on figure 2 and 3. It is quite obvious that the windows and the thermal bridges around the windows are large heating energy wasters.

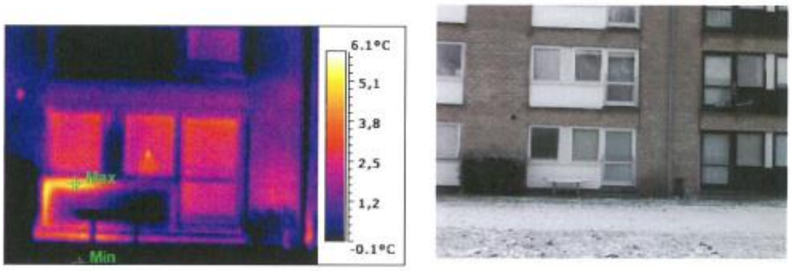


Figure 2. West façade.

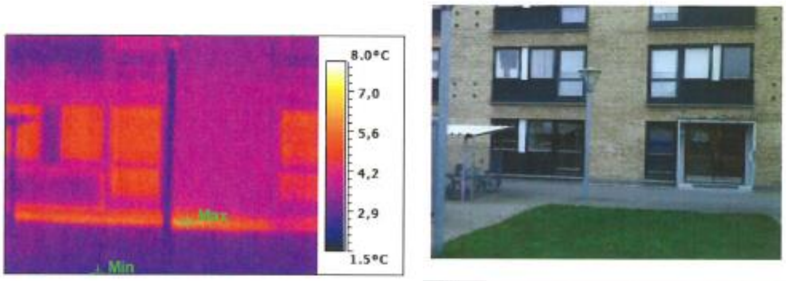


Figure 3. East façade.

Building permit application and tenants approval

The renovation project was illustrated to the tenants through architectural drawings and the economic consequences explained. The renovation also includes the combination of and addition to some of the apartments (new extensions of the building in each end provides space for bigger apartments). The tenants accepted the renovation and the official building permit was achieved from the authorities. See below some of the many illustrations.

Figure 4. Architectural illustrations of new east façade.

Figure 5. Architectural illustration of the new entrance part of the east façade.

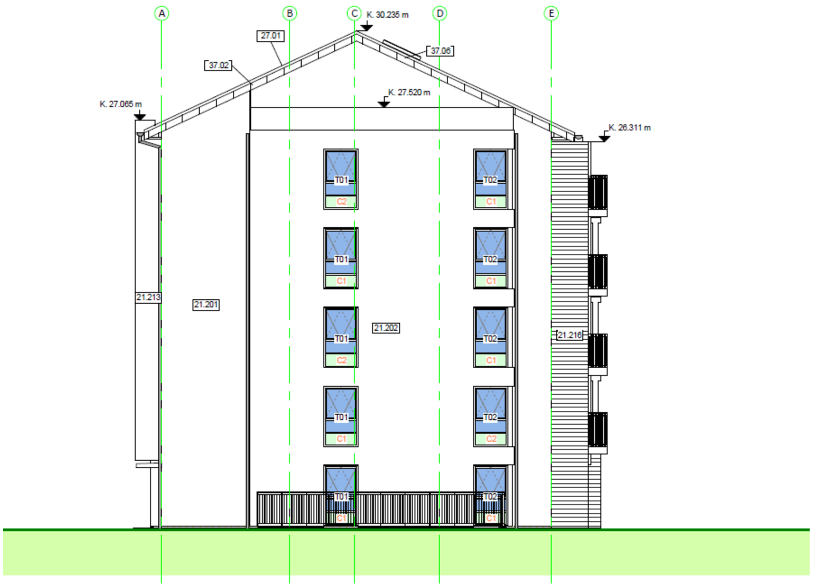


Figure 6. Architectural illustration of the new north facing gable wall

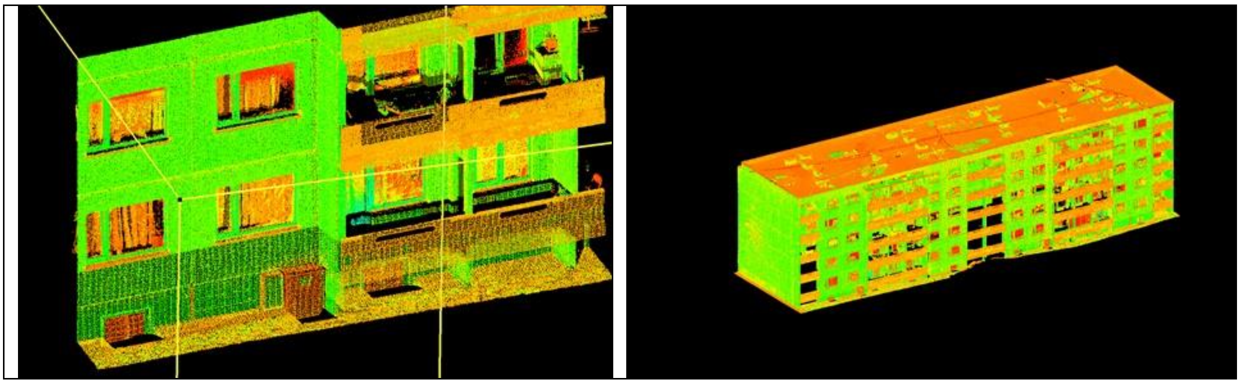
5 Estonia

Preliminary survey of technical condition of pilot building:

Was done by TUT and design company specialists on 2015-2016.

TUT studied the pilot building envelope geotechnical state with help of geomatics measurements and 3D scanning. In result of that the 3D model of pilot building was placed to design company, to give assumption of real envelope situation (deviations on evenness; differences of openings, windows locations).

Figure 1. Examples of 3D model of Estonian pilot



Also, the thermography of the certain parts of a building was made by TUT. Results showed big deviations of condition of external envelope and heat leakages through the joists of existing prefabricated large panels. The calculations of temperature factor (f_{Rsi}) showed the current situation under the level accepted (accepted for this type of building and occupancy f_{Rsi}>0.90.

Figure 2. Some samples of thermography images of Estonian pilot (left) and calculated temperature factor (right)

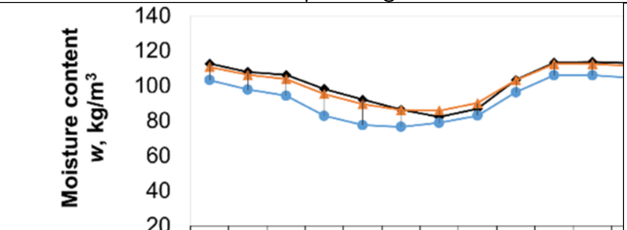
$$f_{Rsi} = \frac{t_{si} - t_e}{t_i - t_e} < 0.80$$

With help of heat flux plates inside the building envelope and T/RH sensors on the both sides of the building envelope, thermal transmittance was calculated. The results showed some variations of thermal transmittance of building envelope. Thermal transmittance of existing concrete wall U_{wall} = 0.8...1.1 W/(m^2·K)

Figure 3. Location of sensors and flux plates (left) and installed heat flux plate and T/RH sensor (right) at the Estonian pilot

Hygrothermal calculations and simulations were made at TUT to consider the state of external concrete envelope and to choose correct vapour control layer between existing concrete core and designed modular panels. Analysis of moisture content and its redistribution verified that most critical are the last quarter and the first months of the year, where moisture content in the external concrete slab is the highest (137 kg/m^3 as maximum, 110 kg/m^3 as 90th percentile). According to initial moisture content of the existing external concrete large panel, the smart vapour retarder as working solution was chosen for further design.

Figure 4A. Example of dynamic simulation results (left), to calculate the initial moisture content of external concrete slab in different depths (right)



Month	01	02	03	04	05	06	07	08	09	10	11	1
90% level pt. C	113	108	106	98	92	86	82	87	103	113	114	1
90% level pt. B	111	106	104	95	90	86	86	90	103	112	112	1
90% level pt. A	103	98	94	83	77	77	79	83	96	106	106	1
90% level {A-B-C}	108	104	101	91	84	80	80	85	99	109	110	1

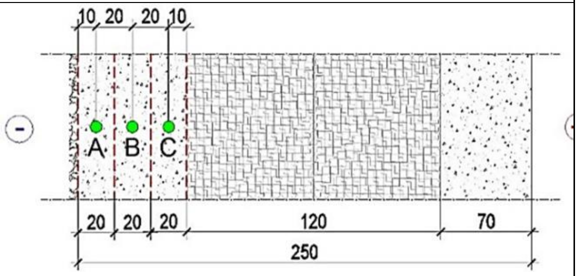
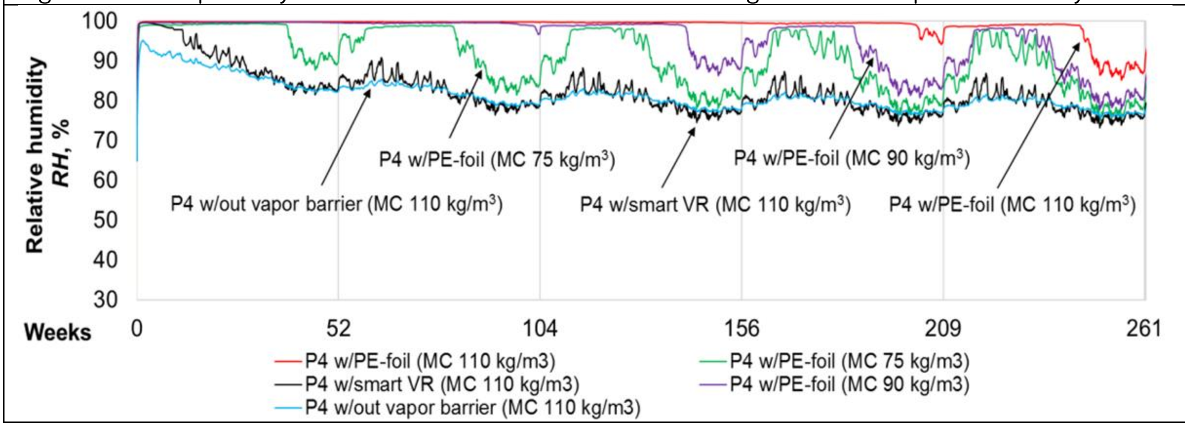


Figure 4B. Example of dynamic simulation results, to find a working solution of vapour control layer



The design company has made a survey of the whole pilot building and ventilation shafts condition as well. The results were considered in a process of design of main structures, as well of the ventilation ducts placement possibilities into the existing shafts.

Figure 5. The examples of existing ventilation shafts at Estonian pilot

Building permit application

Building permit application is placed to authorities and is waiting for approval from city government.

Procurement documentation

Tender URLhttps://riigihanked.riik.ee/register/hange/175642

Building contractors have placed their offers and the owner of the building has made a decision to proceed with one contractor negotiations to conclude the contract and start with the works designed, latest by the end of the 2016.

6 Latvia

Task 5.1 Preliminary and preparation works

Latvian pilot building is typical brick multi apartment building built in 1967. The pilot building is silicate brick residential house with a lateral bearing system. The house has a wooden roof structure with slate covering. The building has simple, rectangular floor plan. It has two floors with similarly designed flats. The house has a hip roof with a number of chimneys. All old wooden windows are replaced by PVC windows 7 – 10 year ago.

Figure 1Latvian case building

Building represents typical building constructed in 50ies – 60ies last century. This type of building is very common in rural areas and small cities.

All initial data for technical project development was gathered during the first part of work package. At the early beginning, the agreement between homeowners, housing company and Riga Technical University was signed (see Annex 1).

Before the preparation of technical project the IAQ measurements, thermography and Blowerdoor test were performed.

Figure 2 Installation of blower door

Indoor air temperature and relative humidity monitoring was performed in three apartments. Example of the results are shown in Figure 3

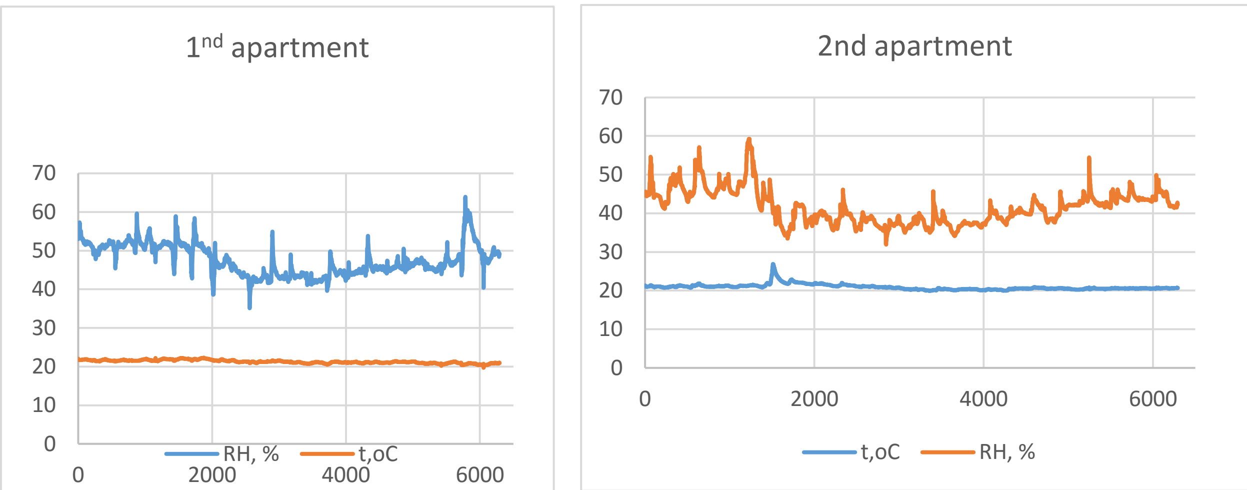


Figure 3 Temperature and relative humidity monitoring

At it can be seen from above shown picture, the indoor air temperature is 20°C and slightly varies. This temperature is a set point for individual heat substation. Heat-substation provides operation of heating system in accordance to outdoor temperature and does not take into consideration indoor temperature.

The Blowerdoor tast results have shown that the actual air leakage rate test is 4.8 $m^3/h/m^2$ that is approximately 3 times higher than requirement of Latvian building codes.

Table 1 Blowerdoor test results

Air flow at 50 Pa, V_{50} [m³/h]	2550
Air changes at 50 Pa, n_{50} [/h]	4,40
Permeability at 50 Pa, q_{50} [m³/h/m²]	4,803
Specific leakage at 50 Pa, w_{50} [m³/h/m²]	11,808
Effective leakage area at 50 Pa, A_L [cm²]	777,5
Equivalent leakage area at 50 Pa, A_L [cm²]	1275
Normalized Leakage Area [cm²/m²]:	1,464

In addition to Blowerdoor test the infrared inspection was done (*Figure 4*).

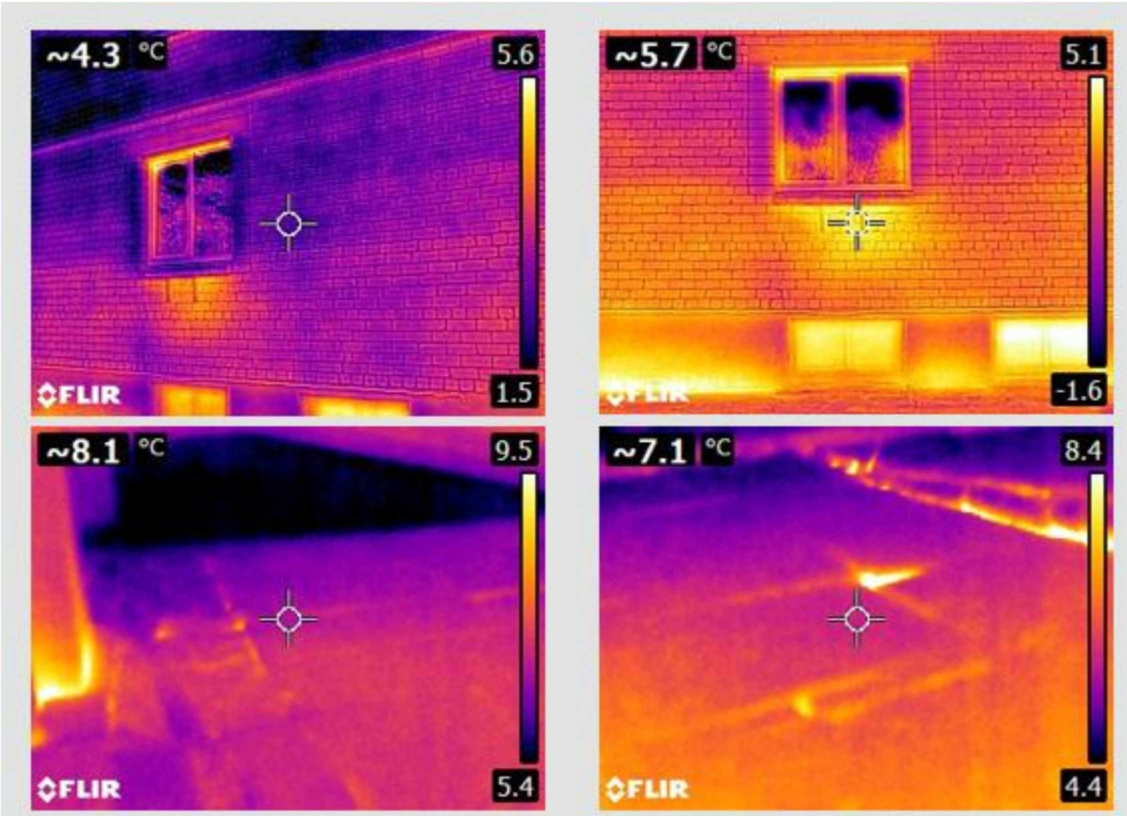


Figure 4 Infrared images

All necessary audits measure were done during the preparation phase. On the basis of gathered data the energy calculations were performed in accordance to Latvian low on energy certification.

In order to provide precise data on building dimensions and to reduce time spent for architecture project development as well as to ensure data accuracy the 3D building scan was done.

Figure 5 Point cloud

On the basis of point cloud, 3D building model was developed in Autocad and REVIT. As the result .IFC fail was available to dynamic simulations.

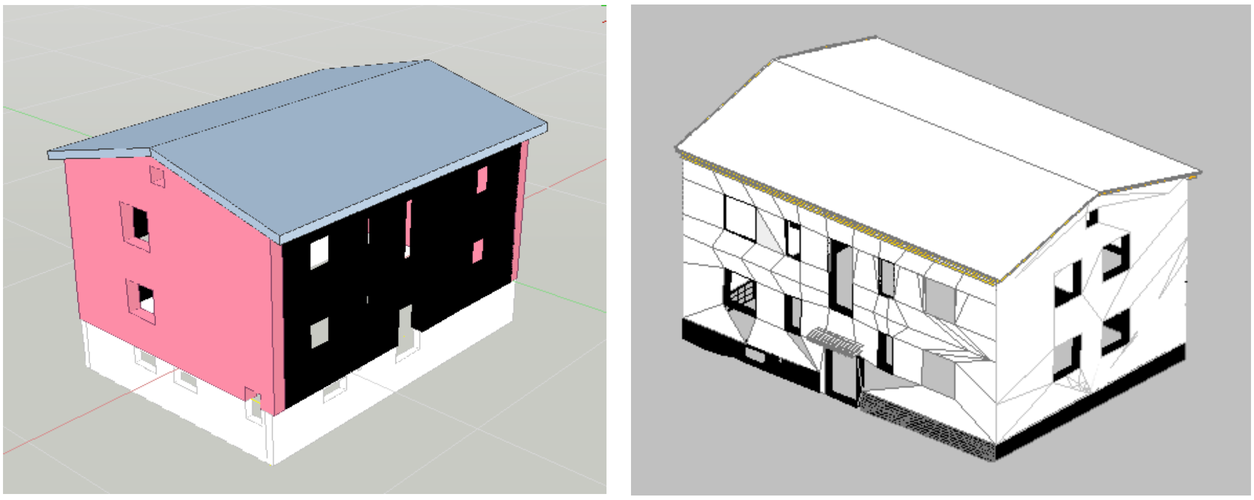


Figure 6 Building 3D building model

3D scanning gave the possibility to evaluate facades vertical deviations, which is critical for prefabricated modules development.

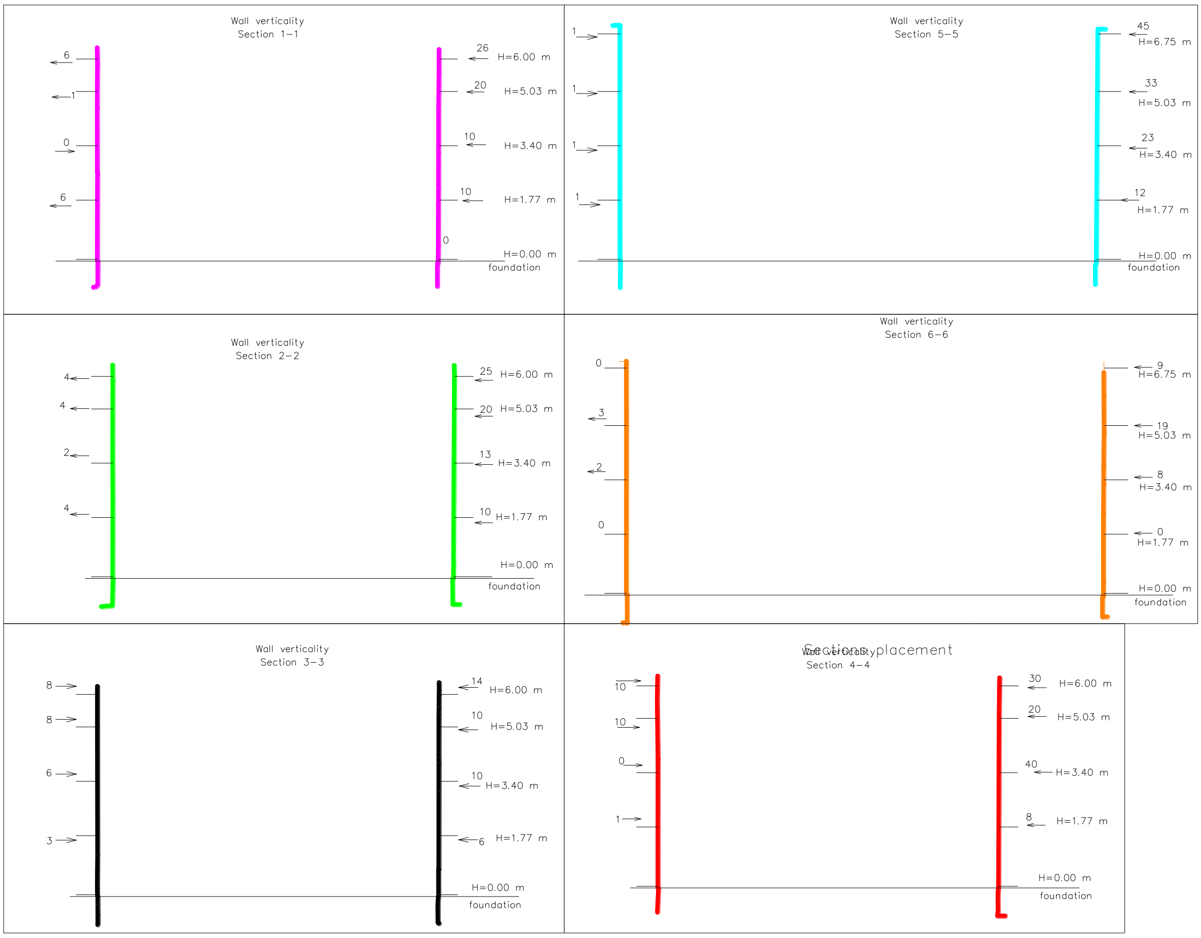


Figure 7 Building facades vertical deviations

7 The Netherlands

<u>Zoetermeer project (Webo and BJW)</u>

Graaf Jan straat Zoetermeer

PRivate
NOM renovation in 10 days
Build in 1974
Energy overshoot

Airtighness Qv10< 0,3l/s.m2
Brine heatpump water-water
PV-cellen and
Heatwatercollector
WTW and boilerbuffer 150l
Rc roof 7, Rc wall, 5 Rc vfloor 5

Opening november 2015 by minister Blok

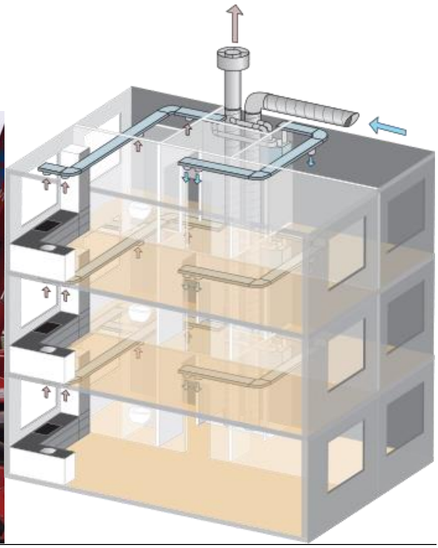
See also

- Attachment to 5.1 energy calculations Zoetermeer
- Attachment to 5.1 deliverables Construction calculations Zoetermeer
- Attachment to 5.1 and 5.2 deliverables Drawings including production Zoetermeer

Deliverables Zoetermeer a.o.:

- Point cloud 3d scanning and conversion to 3d CAD (BIM)
    - Selection of critical areas for the renovation
        - Thermal bridge effect of excisting floors (concrete exposed to outside air)
- 3d design of renovation:
    - removing front and back walls (inner and outer wall)
    - placing new design walls front and back
    - adding insulation and new finish (brick-like tiles) to left and right wall
- demands to the the energy house hold
    - Rc 6 , which is NOM Renovation concept level based on BJW 'NOM-Keur' (Certificate of right design methodology and application)
    - Qv 10 value of 0,25, which is NOM Renovation concept level
    - Windows triple glazed which is NOM Renovation concept level
    - New ventilation system with heat exchange with practical performance of >74%
- Engineering of multifunctional wall panels that meet the energy demands
- Building permit

Presikhaaf project (Webo and BJW)



See also:

- Attachment to 5.1 and 5.2 deliverables Presikhaaf
- Point cloud 3d scanning and conversion to 3d CAD (BIM)
    - Selection of critical areas for the renovation
        - Fi the removal of the excisting balcony because of 'thermal bridge' effect

        - Enhancing the living room with internal loggia because of desired energy house hold and production/realization costs
- 3d design of renovation:
    - removing front and back walls including front side balcony
    - placing new design walls front and back , adding excisting loggia to living room space, adding new balcony at the back side wall
    - adding insulation and new finish (brick-like tiles) to left and right wall
- demands to the the energy house hold
    - Rc 8 , which Passive House level
    - Qv 10 value of 0,15, which is passive house level
    - Windows at passive house level
    - New ventilation system with heat exchange with practical performance of >74%
- Engineering of multifunctional wall panels that meet the energy demands
- Building permit

Breda Kruiskamp project (BJW)

See attachment 'Breda Kruiskamp.pdf' for:

- study excisting situation
- study of the energy demands
- excisting and new design
- energy calculations

- Study of the excisting building conditions
- 3d design of renovation:
    - removing front and back outer walls
    - placing new design walls front and back
    - adding insulation and new finish (brick-like tiles) to left and right wall of the row
- demands to the the energy house hold
    - Rc 6 , which is NOM Renovation concept level based on BJW 'NOM-Keur' (Certificate of right design methodology and application)
    - Qv 10 value of 0,25, which is NOM Renovation concept level

  - Windows triple glazed which is NOM Renovation concept level
  - New ventilation system with heat exchange with practical performance of >74%

For the project Breda Kruiskamp the following is planned to be carried before end of june 2017:

- Building permit
- Presentation to tenants
- Point Cloud and conversion to 3d CAD
- Engineering of multifunctional wall panels that meet the energy demands

- Worked in an interdisciplinary team with producers/suppliers of building and installation components.

- Preparation of renovation propositions that include 'healthy indoor climate', 'Comfort' and energy savings/generation. The energy saving enable (financially) the deep retrofit to a large extend.

- The performance on 'healthy indoor climate', 'Comfort' and energy savings/generation is guaranteed by the supplier. Therefore, pre-calculations on energy needs have been done in PHPP tools.

8 Portugal

Preliminary and preparation works

- Preliminary survey of technical condition of pilot building is being conducted and analysed.
- Data on building heat consumption has been analysed.
- IAQ measurements and airtightness tests were performed. The building is under continuous monitoring (temperature, CO_2, relative humidity) since March 2016.
- Thermal imaging of the building was performed and analysed.
- Illuminance measurements and acoustic tests were performed and analysed.
- Regular meetings between the partners of the project (companies, university and the public company owner of the building) are taking place to discuss technical issues of the renovation.
- Selection of the construction details (roof, walls, and windows) is under development.
- Building permit is assured.
- Procurement documentation -Tender development is under development.

Thermal imaging:

The thermographic analysis was performed in order to identify major heat leakages in the building. The results of the images show that there are significant thermal bridges in the exterior walls. Figures 1-4 present some of the thermal images taken to the building.

Figure 1 – South façade of the building

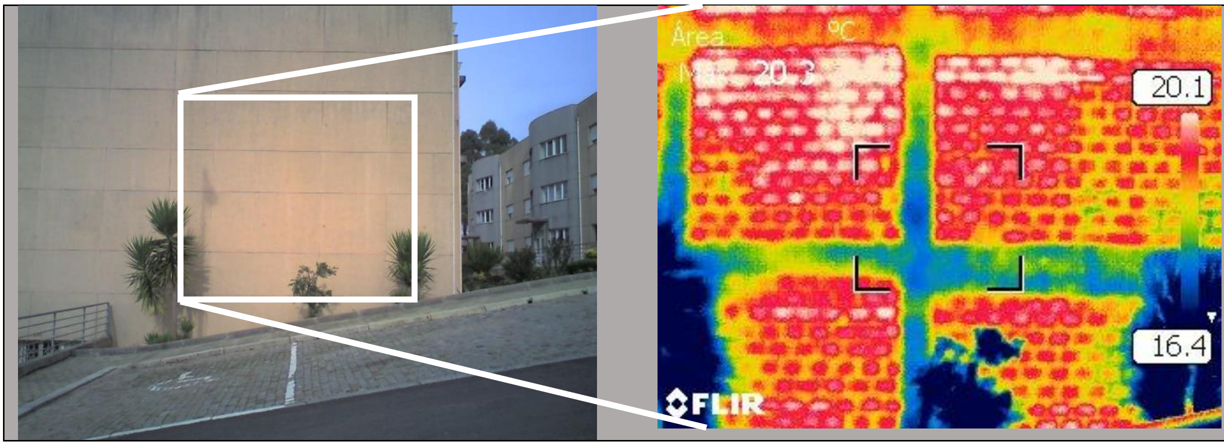


Figure 2 – South façade of the building

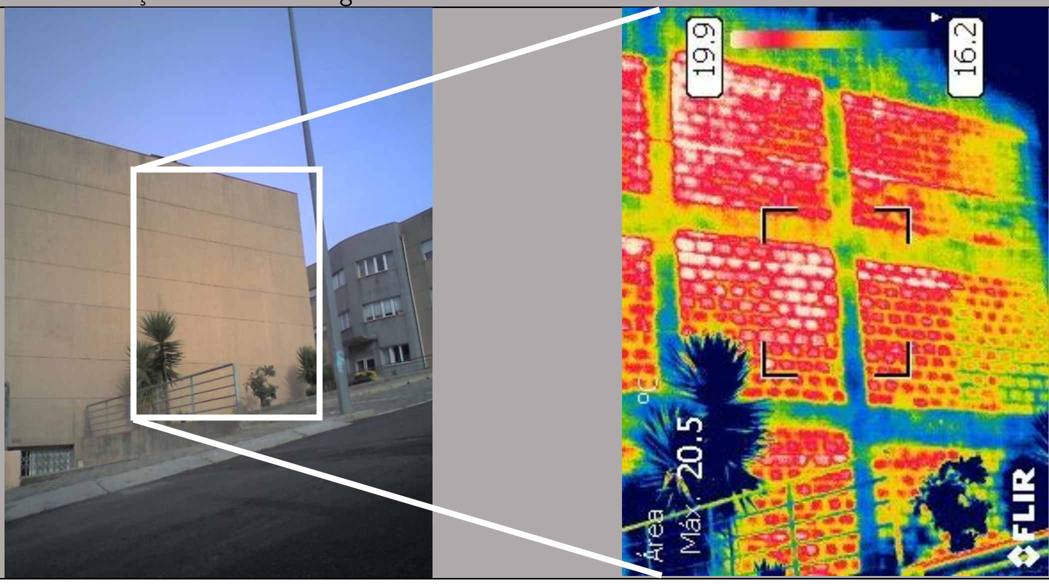


Figure 3 – South façade of the pilot building

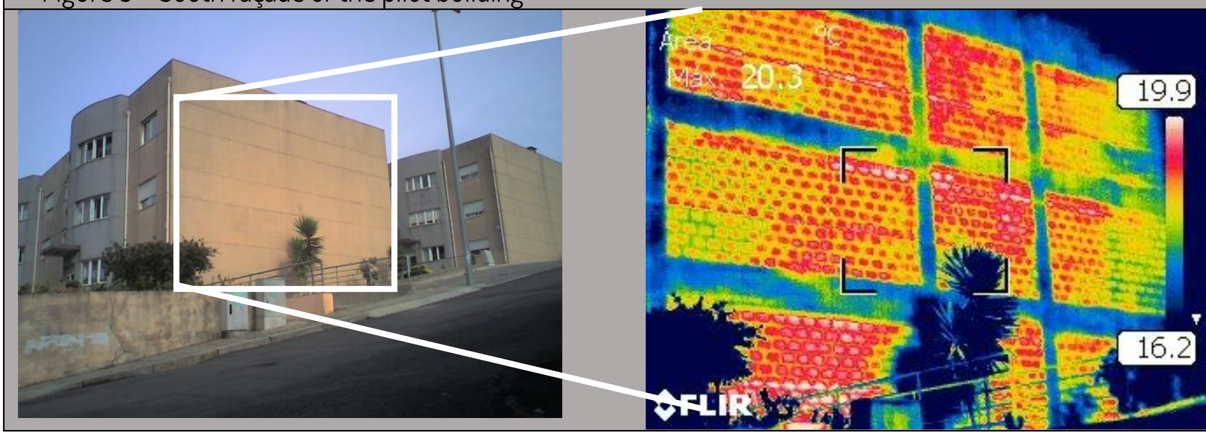


Figure 4 – Main façade (West-facing) of the building

Temperature, CO_2 and relative humidity:

Temperature, carbon dioxide and relative humidity are being monitored in the interior of the apartments of the pilot building since March 2016. From a total of 18 apartments, 9 are being continuously monitored, in the living room and in one of the bedrooms.

Figures 5 to 13 present the measured values for each parameter during approximately two months in 2016 (September 21st – November 10th), two winter months in 2017 (January, 25th – March, 10th) and approximately two summer months in 2017 (June, 2nd – July, 20th) , for the living room of a ground floor apartment located in the North façade of the building. The apartments of the pilot building do not have a centralized heating or cooling system, which means that the internal temperature is not controlled.

Regarding the interior temperature of the living room during the first period, it is possible to observe that, only in the last days of the period the temperature is under the minimum recommended threshold during winter (18°C). However, in the second measurement period, the majority of monitored temperatures were below the threshold suggested by the Portuguese regulation regarding comfort temperatures. In the summer period considered here, the maximum threshold was considered (25°C) as a reference, and although there is some registered temperatures above the maximum threshold, the majority of the measurements remain below the reference.

Figure 5 – Monitored temperature in a ground floor apartment from September, 21st to November, 10th 2016

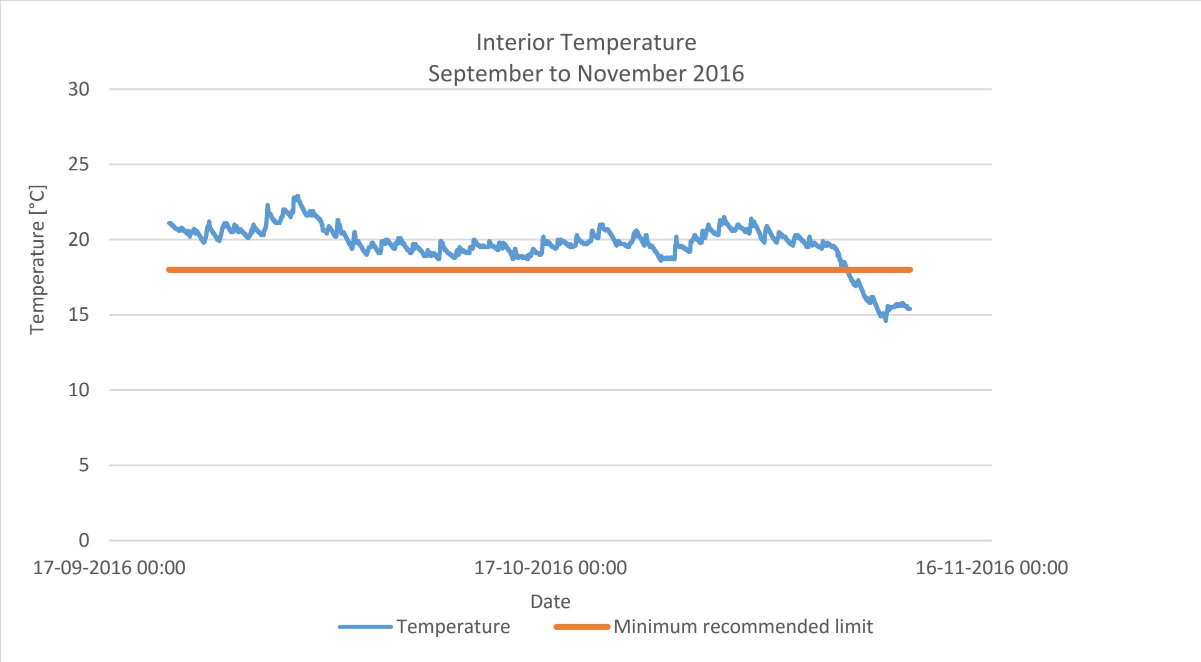


Figure 6 – Monitored temperature in a ground floor apartment from January, 25th to March, 10th 2017

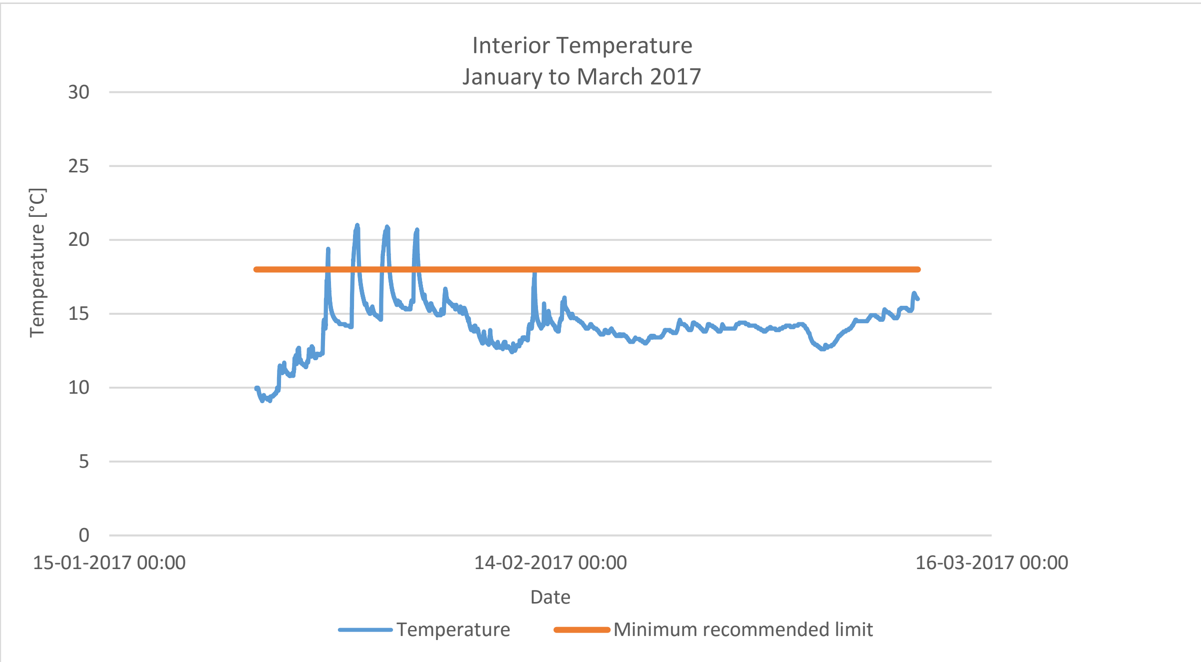
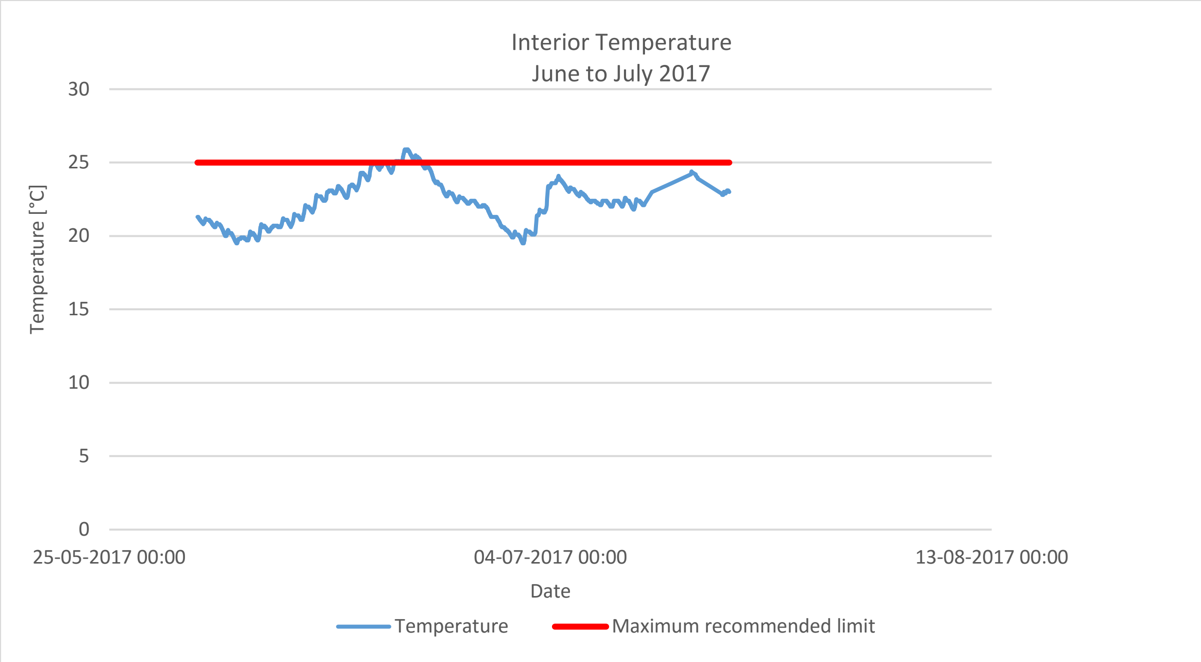


Figure 7 – Monitored temperature in a ground floor apartment from June, 2nd to July, 20th 2017



Regarding C02 concentration, Portuguese regulation recommends the limit of 980 ppm for carbon dioxide concentration in residential buildings. Above this limit, the health of the occupants can be compromised. In Figure 8 to 10 it is possible to observe that during the first two periods considered in this report, this apartment has frequently been above the recommended limit. However, by the end of February, the measurements indicate a significant decrease in carbon dioxide concentration in the apartment, and remaining below the recommended threshold throughout the summer period.

Figure 8– Monitored CO_2 in a ground floor apartment from September 21st to November, 10th 2016

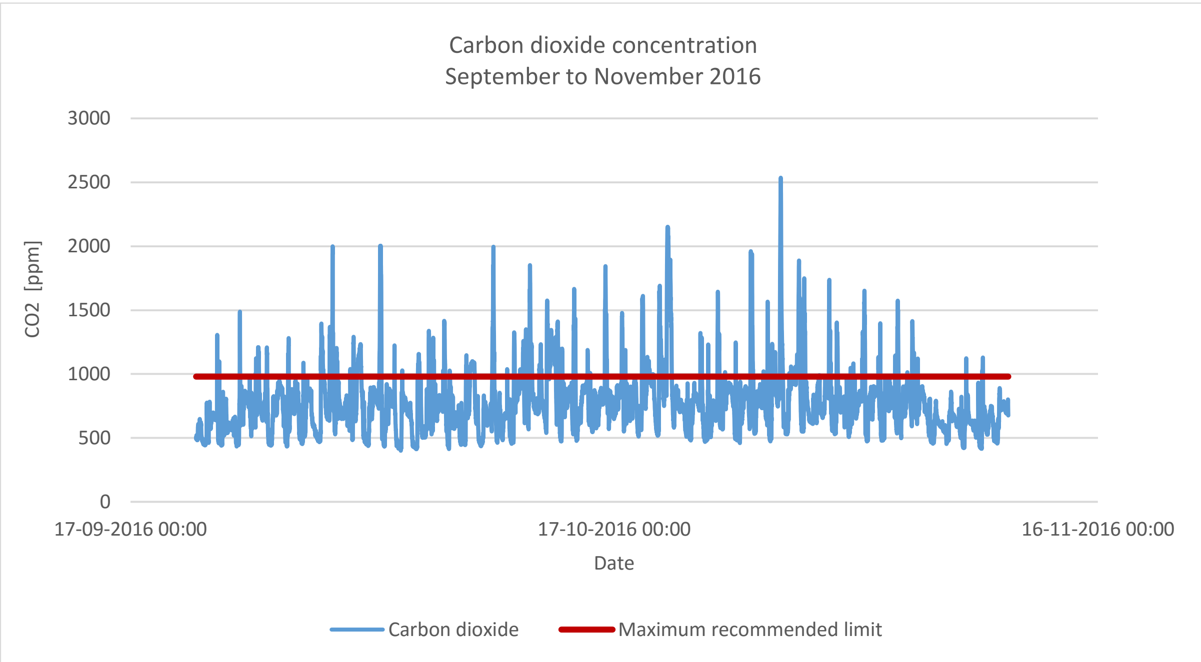


Figure 9– Monitored CO_2 in a ground floor apartment from January, 25th to March, 10th 2017

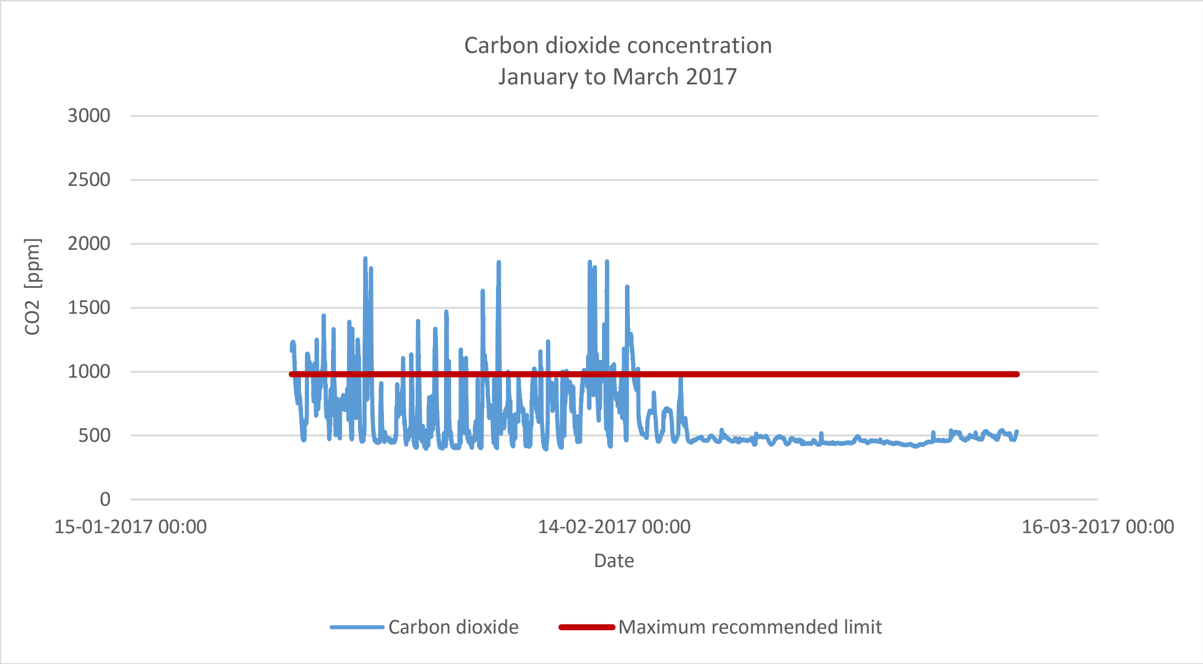
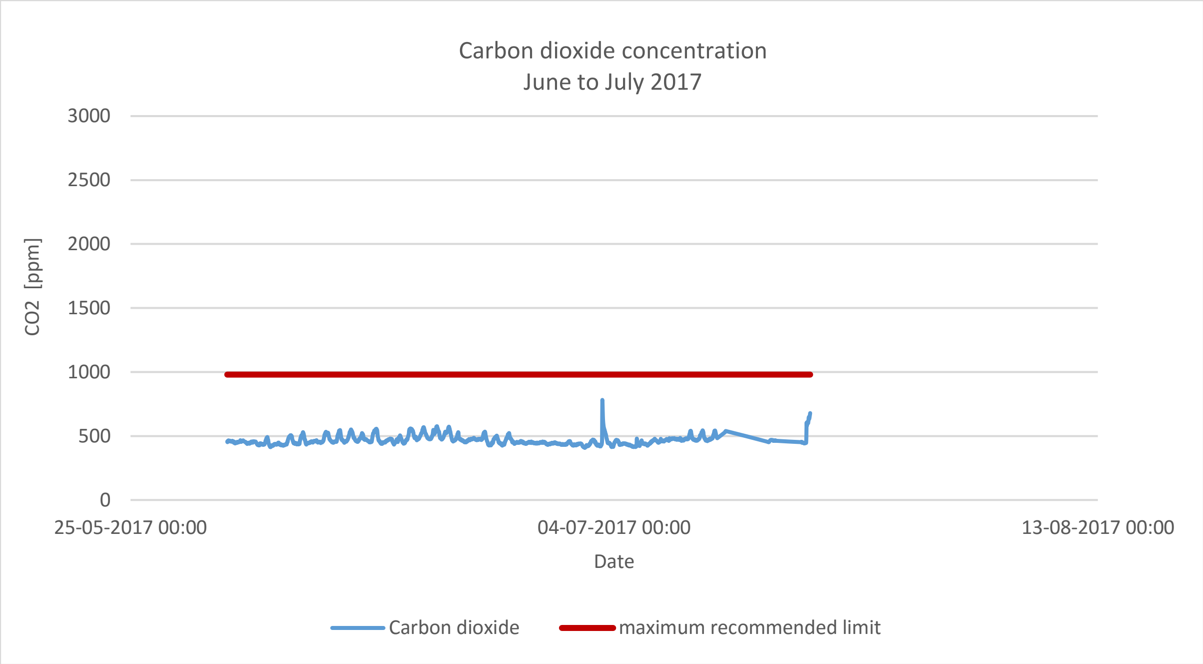


Figure 10– Monitored CO_2 in a ground floor apartment from June, 2nd to July, 20th 2017



General recommendations advise that relative humidity should be kept between 30% and 70%. Out of that range, health and well-being of the occupants starts to be affected. Figures 11 to 13 present the results of relative humidity measurements in the apartment. During the two first periods, relative humidity was frequently above the upper limit. In opposition, in the summer period, measurements indicate that this parameter stays mainly within the recommended limits.

Figure 11 – Monitored relative humidity in a ground floor apartment from September 21st to November, 10th 2016

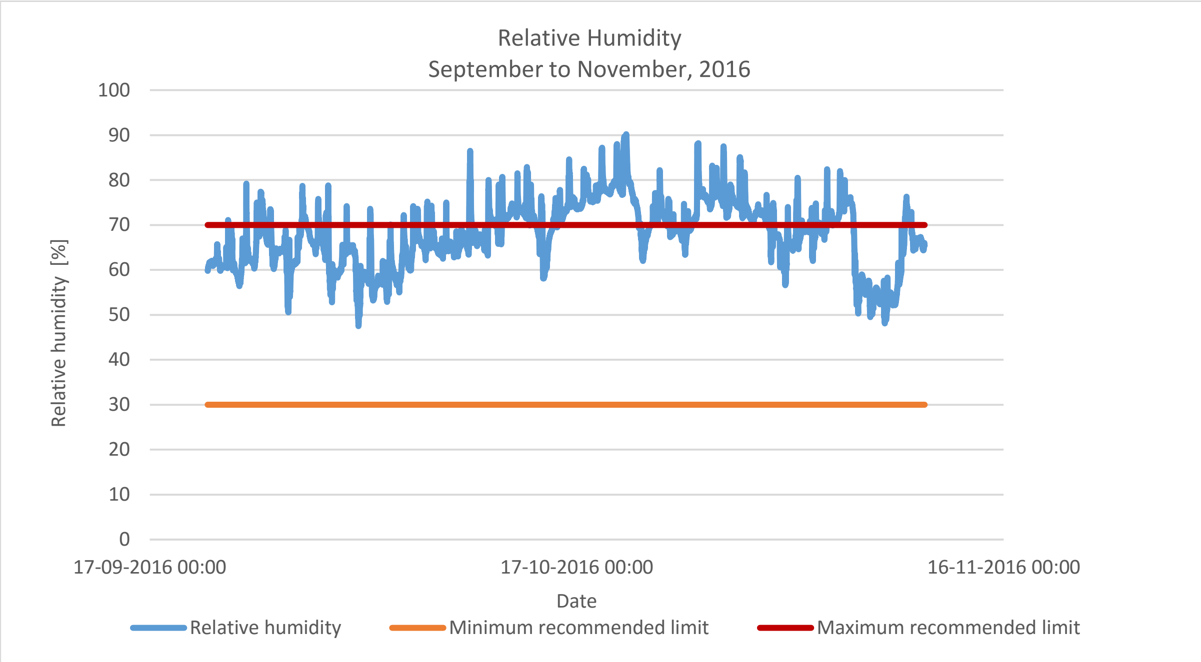


Figure 12 – Monitored relative humidity in a ground floor apartment from January, 25th to March, 10th 2017

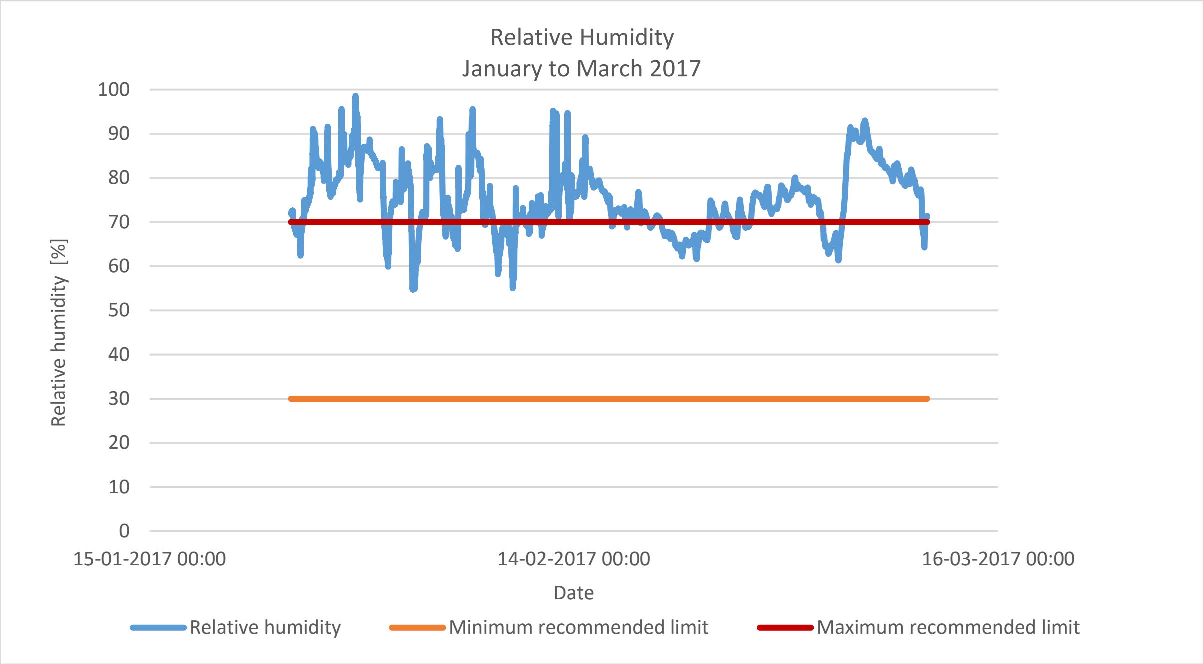
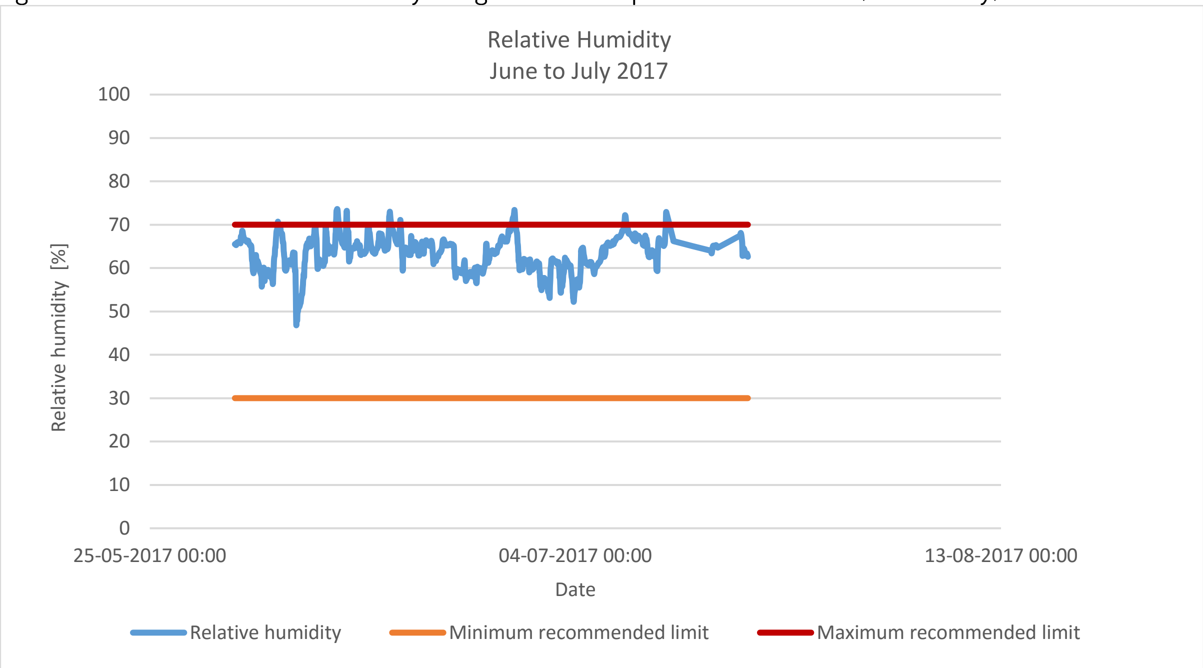


Figure 13 – Monitored relative humidity in a ground floor apartment from June, 2nd to July, 20th 2017



Blower door:

A test designated as blower door was used in order to determine the airtightness in four different apartments. The device was positioned in the exterior doorway and the interior space was depressurized to 50 Pa less than outside conditions. Once this setup was achieved, the airflow that is needed to produce this pressure was measured and the average taken, which equate the airflow leaking into the interior space being tested. In order to complete the test, all windows and remaining external doors were closed and all internal doors were opened. Figure 14 presents one of the tests taking place.

Figure 14 - Blower door test taking place in apartment 1 of the building.

Table 1 presents the obtained results for the four tests.

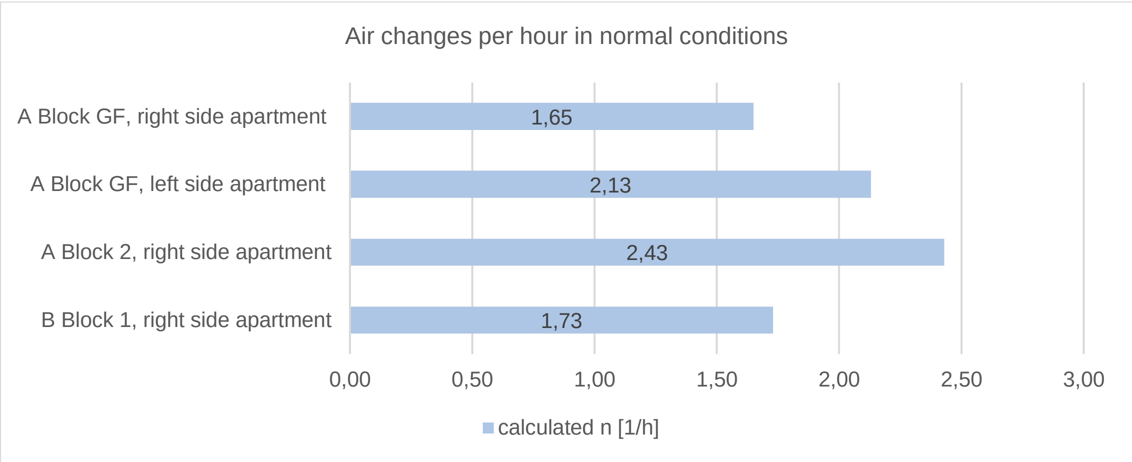


Figure 15 – Results of air tightness tests

Illuminance:

The interior illuminance in the living room and bedroom of three apartments were measured, using a luxmeter. Table 2 presents the calculated daylight factors for both the living room and the bedroom of each apartment.

Table 2 - Daylight factor for living room and bedroom of three apartments of the building.

Apartment	Room	Daylight Factor [%]
Ground floor	Living room	7,1
Ground floor	Bedroom	4,5
1st floor	Living room	1,8
1st floor	Bedroom	1,0
2nd floor	Living room	6,0
2nd floor	Bedroom	7,2

The 1st floor apartment presents a daylight factor less than 2 which means it is not adequately lit and therefore might need artificial lighting. By the other hand, both ground floor and the second floor have calculated values above 5, which is an indicator of rooms where artificial lighting is generally not needed, but where consequences of solar gains – such as increased temperatures – should be assessed. The recommended daylight factors for bedrooms and living rooms are presented in Table 3.

Table 3 –Recommended daylight factors (CIBSE, 1999)

Daylight factor	Observation
< 2	Not adequately lit, artificial lighting is required
2 < DF <5	Adequately lit but artificial lighting may be needed part of the time
> 5	Well lit, artificial lighting generally not required, except at dawn and dusk – but glare and solar gain may cause problems

Acoustic insulation:

An acoustic insulation index for the façade was calculated, following the procedure indicated by ISO 717-1:2013 and using measurements from a sonometer from two ground floor apartments. This test measures the level of acoustic insulation of the façade of the building to the exterior noise. Both apartments presented a result of 38 dB regarding the acoustic insulation index of the façade. The minimum allowed by regulation in Portugal is 33 dB, which means that the façade is performing well in what concerns acoustic insulation.

References

CIBSE (1999). Daylighting and window design. Lighting Guide LG10:1999. The Chartered Institution of Building Services Engineers. London, UK.

Attachments

Attachment to 5.1 Technical documentation for the Czech pilot approved by theCZ\MCdum_komplet.pdf building authority.

Appendix to 5.1 Photos from the construction of the mock-up

Attachment to 5.1 energy calculations Zoetermeer

Attachment to 5.1 deliverables Construction calculations Zoetermeer

Attachment to 5.1 and 5.2 deliverables Drawings including production Zoetermeer

Attachment to 5.1 and 5.2 deliverables Presikhaaf

Attachment 'Breda Kruiskamp.pdf'