Wood for Zero.

NERO – Cost reduction of new Nearly-Zero Energy Wooden buildings in Northern Climate Conditions

D1.2. Data collection templates and inspection procedures

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D1.1.	Data collection templates and inspection procedures		
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ABSTRACT:

This template is intended to be used in NERO project case buildings in order to collect energy, indoor climate, cost and design solutions data. The template is filled with example building data, which has to be replaced with actual data when used in NERO case buildings. It may be applied for one or couple of similar buildings in order to prepare a compact description of case study buildings.

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1 PU = Public; CO = Confidential, only for members of the Consortium (including the EC services).

2 R = Report; R+O = Report plus Other. Note: all “O” deliverables must be accompanied by a deliverable report.

3 eg DX.Y_name to the deliverable_v0xx. v1 corresponds to the final release submitted to the EC.

4 Person from the lead beneficiary that is responsible for the deliverable.

5 Person(s) from contributing partners for the deliverable.

6 Typically person(s) with appropriate expertise to assess the deliverable quality.

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Data collection templates for energy, indoor climate, cost, design solution – filled with example building data

1. General information

The building ‘X’ is located in the city of Helsinki. It is situated in a relatively open and suburban area. The distance from the ‘Y’ (city center, or coast or motorway) about ‘Z’ kilometers. All buildings in the immediate vicinity are low/medium/high-rise.

Figure 1. Front view of building.

Figure 2. Building location in climate region.

<u>Annual delivered energy summary:</u>

Total heating: 61 kWh/m^2a

Total electricity: 53 kWh/m^2a

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Table 1. Basic information of Building.

Building data		
Building type	School building	
Total net floor area	1500	m²
Total gross floor area	1700	m^2
Construction year	2015	
Construction cost	3800	€/m^2-gross
Operation hours	8:00-17:00	hour
days/week	5	day
hours/day	9	hour
hours/year	2400	hour
Mean occupant density	10	m²/person
Ventilation rate	2.0	l/s m^2
Illuminance level	500	lux
Climate data		
Design outdoor temperature for heating	12	°C
Design outdoor temperature for cooling	15	°C
Base temperature for heating	12	°C
Base temperature for cooling	15	°C
Heating degree days	2200	°C
Cooling degree days	199	°C
Building insulation		
Exterior wall U-value	0.17	W/(m² K)
Roof U-value	0.11	W/(m² K)
Base floor U-value	0.11	W/(m² K)
Window U-value	0.66	W/(m² K)
Window g-value	0.24	W/(m² K)
Basic system information		
Ventilation system type	Mechanical supply and exhaust	
Heating system	Yes	
Heating source	District heating	
Cooling system	No	
Cooling source	No	
Onsite production/Renewable sources	No	
Building certification level	BREEAM Outstanding	
EPC class	B	

2. Building description

The building is a small primary school and a day nursery, which completed in 2001. The school is designed for 270 children (aged 7 to 13) and the day nursery is designed for 42 children (aged under

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5). The building is owned by the city of Helsinki. The net heated floor area of the building is 3132 m², and volume is 17580 m^3. The building is usually fully occupied from Monday to Friday between 08.00 to 14.00 and partly occupied (the day nursery and some of the teachers) between 14.00 to 17.00. The school is closed during summer from June to August. Figure 3 shows a plan view.

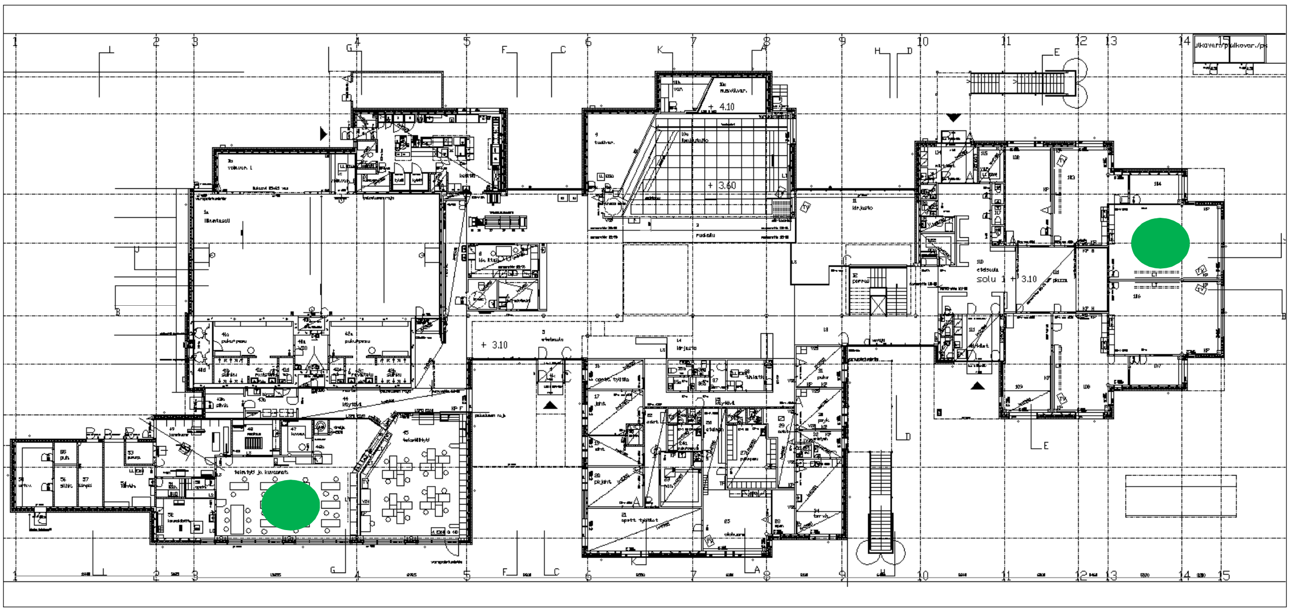

Figure 3. Ground floor of School.

3. Design solutions

The building is connected to the Helsinki area' district heating distribution system. Customers receive heat from the hot water circulating in the heating distribution network. The temperature of the district heating water varies usually between 65 °C and 115 °C for the supply and between 40 °C and 60 °C for the returning water, depending on the outdoor air temperature. In the summer, the heat is needed only for the DHW production. Heat extracted from the district heating network is used in the building for DHW and space heating through the hot water radiators and the central air-handling unit.

The School was a pilot project in which some elements typical for hybrid systems were combined with mechanical ventilation. The ventilation system is a fully mechanical low-pressure system, having central air-handling unit including filtering, heat recovery, fans, heating coil and silencers. The aim was to achieve low heating and electricity consumption by using demand controlled supply ventilation to individual rooms, with air transferred via internal rooms to a single central exhaust and heat recovery between main exhaust and supply ducts.

4. Building technical systems

Heating, cooling, ventilation, and lighting systems are to be described. The system information and efficiencies are reported in Table 2.

Table 2. System details with example value

Space heating system	Air heating/radiator/chilled beam…	
System efficiency	90	%

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Heating specific load	50	W/m^2
Cooling system	Ideal cooler/chilled beam…	
System efficiency, COP	3.0	
Cooling specific load	40	W/m^2
Ventilation system	Balance ventilation/CAV/VAV	
Ventilation rate	2.0	l/m^2 s
Ventilation heat recovery	70	%
Specific fan power	1.5	kW/(m^3/s)
Installed lighting power	8	W/m^2

5. Ventilation strategy in building (or what is specific in your building)

The building has mechanical supply and exhaust ventilation system with heat recovery. Only the computer classrooms are air-conditioned. An air handling unit mounted at roof level serves a large supply air duct on the roof (Figure 4a), from which two vertical ducts lead to each classroom and terminate in displacement diffusers (Figure 4b). There is a central extract duct from the main hall (Figure 4c). The building serves as the return airflow route avoiding the need for suspended ceilings or visible ducts (Figure 4d). The supply air is tempered and the principal source of heating of the rooms is by low temperature hot water radiators.

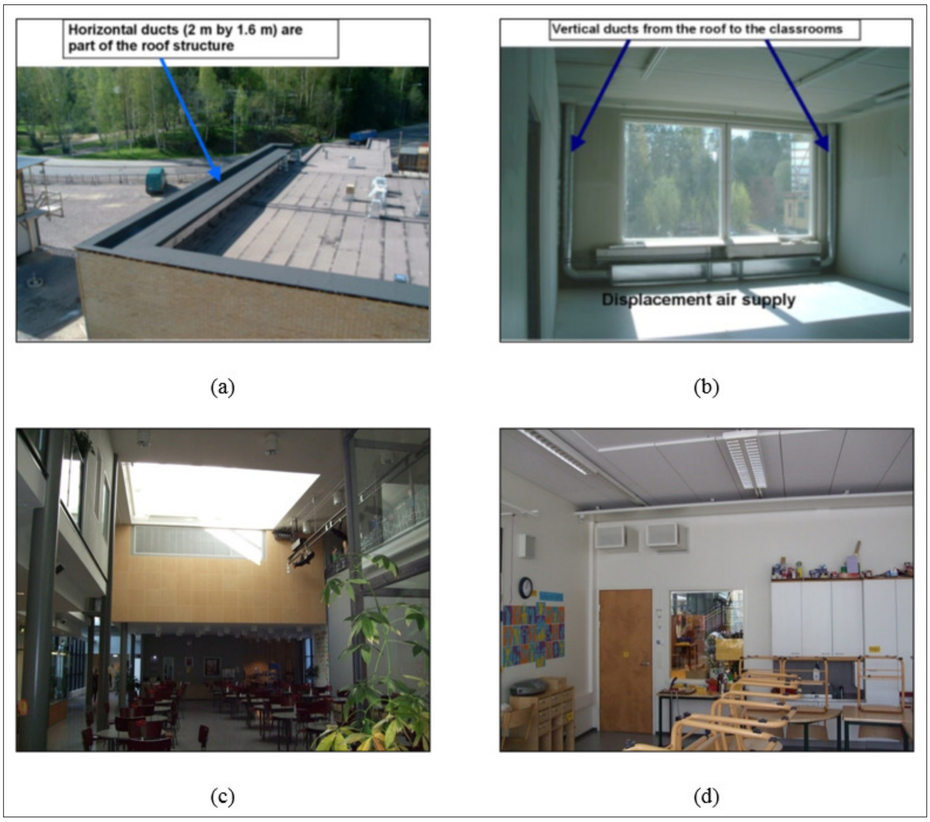

Figure 4. (a) Main air supply duct at roof level, shows the schematic layout of the heating and ventilation system. Air is heated and filtered in an air-handling unit before it is supplied to the rooms. The air handling unit is equipped a heat recovery heat exchanger, (b) Air supply ducts to classroom diffuser (during construction), shows the method of controlling the air supply. Control of the ventilation is based on temperature, CO_2, and occupancy sensors in the classrooms. There are supply airflow dampers for each classroom and a speed-controlled fan keeps constant 50 Pa pressure in the

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main supply duct on the roof. Design ventilation flow rates were 3 l/s per m² in classrooms, 5 l/s per m² in the dining room and 2 l/s per m² in offices, (c) Central extract in main hall, (d) Transfer air ducts from classrooms.

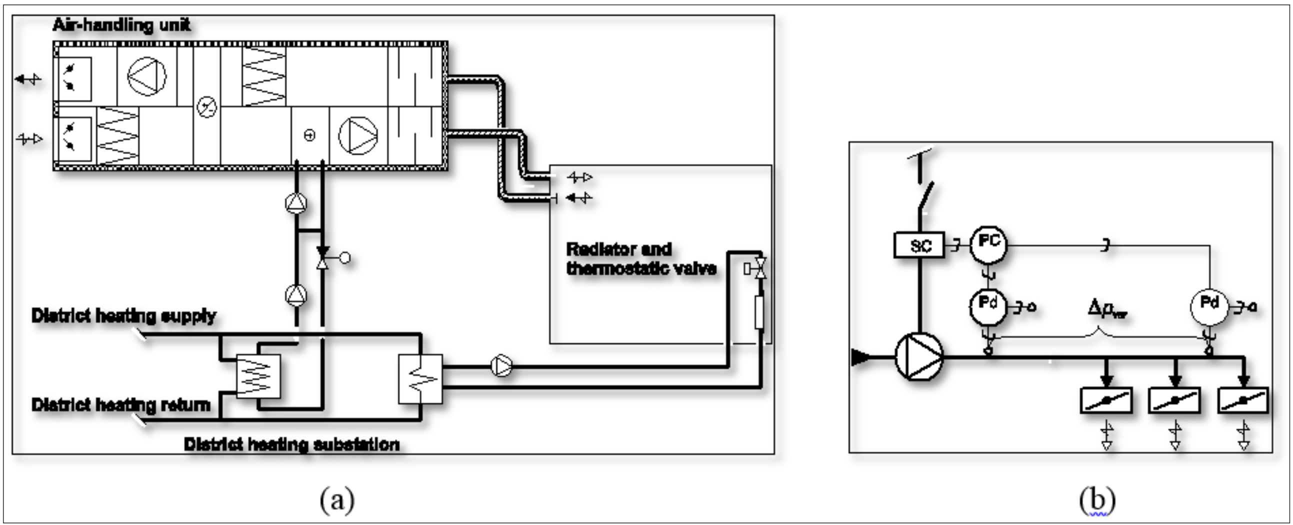

Figure 5. General arrangement of the heating and ventilation system, (a) Schematic of heating and ventilation system, b) Schematic of control system

6. Indoor climate condition

Indoor climate is a broad field, which accounts indoor air quality, indoor temperature, thermal comfort, CO_2 level, illumination level, sound environment, etc. A small variation of indoor temperature range will have significant impact on thermal comfort and energy use in building. Higher ventilation rate can improve the indoor air quality, although it increases the chance of draught rate and energy use. The indoor climate condition needs to be assessed according to the prEN15251.

According to the standard [1], indoor environment has four different categories, i.e. Category I, II, III, and IV. Category I represents the high level of expectation, whereas Category II stands for normal level of expectation. Also, accepted level of expectation is offered by Category III. The values outside for above III categories are included in Category IV and only be accepted in limited part of the year. Furthermore, the design ventilation rate is estimated from two components. The design ventilation is summed up of ventilation required to remove the pollution from occupants (bio effluents) and pollution from the buildings, i.e. system, materials, etc.[1]. The actual state of CO_2 concentration in indoor air will be used to determine the ventilation rate.

Table 3. Indoor condition classification according to EN15251 [1].

Indoor Air quality	Category I, II, III, IV	%
Thermal Environment, heating season	Category I, II, III, IV	%
Thermal Environment, cooling season	Category I, II, III, IV	%

Based on BMS system or measured data, it is possible to present the indoor condition classification of room temperature, ventilation rate, or CO_2 level. The data will present for both heating and cooling seasons. An example of footprint is shown in Figure 6.

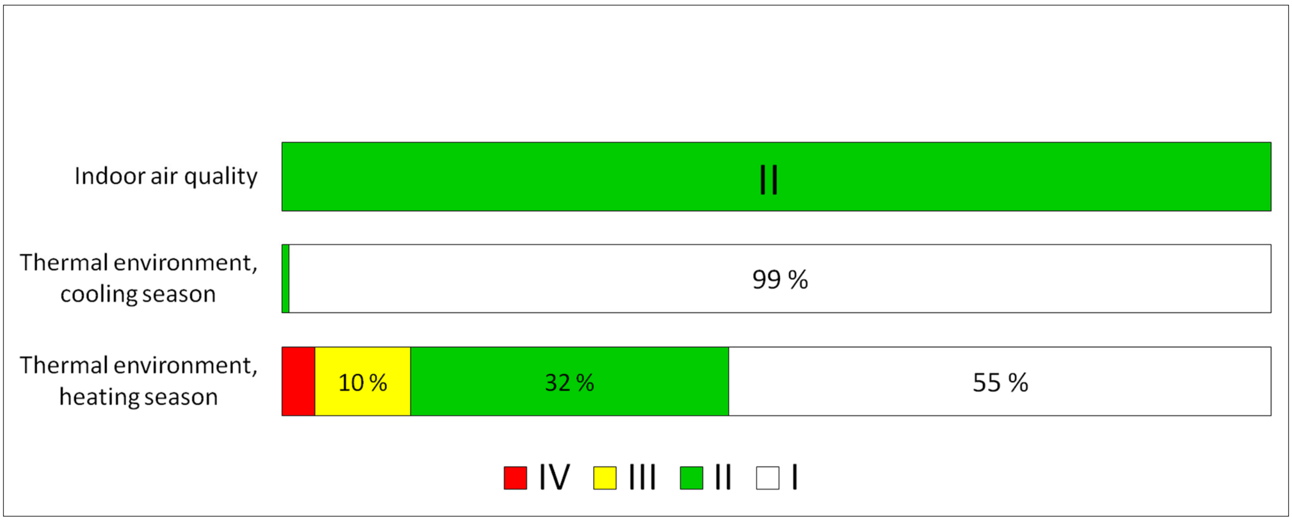

Figure 6. Example of indoor condition classification by footprint diagram [1].

Onsite measurements of indoor temperature, CO_2 level, ventilation rate, air velocity, noise level will be taken during heating and cooling season. The reference rooms will be selected in such a manner that they can represent for main functions of an entire building. Typically 3-5 reference rooms are enough to provide the relevant picture about indoor climate quality. For office building, measurements will be taken in open office space, meeting room, single office room, rooms that oriented to north and south direction (i.e. account the solar heat. For day care center, measurements will be taken in playroom, sleeping room, assembly hall, etc. The reference room location needs to be shown on the floor plan. Findings will present according to EN15251 classification and footprints. Additionally, onsite measurement results from rooms will be reported in Table 4.

Table 4. Ventilation rate, air velocity, noise level parameters measurements in reference rooms.

Measured parameters	R1	R2	R3	R4	Avg.	Max	Min.
Ventilation air flow, $l/s.m^2$	4.1	3.9	4.2	3.8	4.0	4.2	3.8
Air velocity, m/s	0.16	0.13	0.18	0.17	0.16	0.18	0.13
Noise level, dB	31	29	28	30	30	31	28

For evaluation of indoor air quality, it may possible to measure the ventilation airflow rate for those buildings, which have constant air volume (CAV) system (preferred method). In the buildings equipped with demand controlled (DCV) or variable air volume (VAV) system, CO_2 needs to be monitored or collect the CO_2 data from building management system (BMS).

7. Occupant Assessment of Performance

A questionnaire survey of 16 adult full-time occupants (80% response rate) was undertaken in 2017. A very high proportion was satisfied with the internal environment, although a smaller number were satisfied with the specific aspects of indoor air quality and thermal comfort. There was no clear cause for dissatisfaction about thermal comfort, but concerns with indoor climate, where draught was found in winter and a lack of air movement was noticed during summer. Some complaints of draught may be explained by occasional low temperatures measured in the heating season in some of the classrooms (category III and IV in Figure 6).

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Table 5. Summary of occupant satisfaction with the internal environment.

	Summer %	Winter %
People finding the **overall indoor environment** acceptable	93	87
People finding the **thermal environment** acceptable	71	62
People finding the **indoor air quality** acceptable	64	60
People finding the **illuminance level** acceptable	92	85
People finding the **acoustic level** acceptable	77	78

8. Energy use

The energy data can be collected from the energy bills. More detailed breakdown of services is appreciated. Energy use in delivered energy can divide into couple of parts according to energy carrier, i.e. district heating, district cooling, electricity, onsite production, as shown in Table 6.

Table 6. Energy use of different services.

Services	System	Unit energy per year, kWh/m^2 a
Heating (space and ventilation air)	District heating/gas boiler/GSHP	
DHW use	District heating/gas boiler/GSHP	
Cooling	District cooling/electricity	
Lighting, , fan, pump	Electricity	
Appliance	Electricity	
Facility (fan, pump)	Electricity	
Onsite production solar energy	Solar panel (if any)	
Onsite production solar thermal	Solar thermal panel (if any)	

Reference

[1] "Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics," 2007.

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