REPORT
PUBLIC

CS22: (ATCS 01) ST03-BOZ11 in St. Johann, Tyrol

RENOVATION APPROACH DOCUMENT

outPHit
Deep retrofits made faster, cheaper and more reliable

Call: H2020-LC-SC3-2018-2019-2020 / H2020-LC-SC3-EE-2020-1

Deliverable D5.2

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OUTPHIT – DEEP RETROFITS MADE FASTER, CHEAPER AND MORE RELIABLE
outPHit pairs such approaches with the rigour of Passive House principles to make deep retrofits cost-effective, faster and more reliable. On the basis of case studies across Europe and in collaboration with a wide variety of stakeholders, outPHit is addressing barriers to the uptake of high quality deep retrofits while facilitating the development of high performance renovation systems, tools for decision making and quality assurance safeguards.
outphit.eu

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1. Executive Summary

- The residential building at Boznerstrasse 11a in St. Johann, Tyrol (Austria) is located in a town area called 'Südtiroler Siedlung' in the Southeast of St. Johann and is completely owned by **NEUE HEIMAT TIROL** (social housing association of Tyrol).
- The building was built in the early 60's, includes 8 flats on 3 stories. The total living area is about 559 m². The building is nearly in the original status, only the façade has been renovated in the 80's.
- For the **NEUE HEIMAT TIROL**, the EnerPHit standard is the only serious renovation standard to achieve the climate protection goals. As a non-profit developer, however, the necessary additional funding is still lacking to implement this standard on a broad basis.
- Folowing measures according to the the **EnerPHit standard** will be carried out:
    - Façade/Roof/Floor insulation (fully new thermal shell on highest level),
    - Insulated window frames with triple glazed windows within insulation level,
    - Central ventilation system with high heat recovery rate and low energy needs,
    - Central distribution of district heat based on renewable waste heat.
- A new method of subsequent integration of living space ventilation (developed for the first time in the FP7 SINFONIA project) is further perfected and can now be implemented with even less effort and costs.
- Instead of the existing mixture of single flat room heating and decentralized hot water systems, mostly based on fossil energy source, a central distribution of district heat based on renewable waste heat will be implemented.
- The biggest challenges are:
    - High cost pressure in terms of social housing,
    - Tenancy law challenges within the framework of the Austrian tenancy law,
    - Extreme weather, climate and inner-alpine conditions in Sankt Johann in Tirol in terms of technical challenges and EnerPHit Standard.

EnerPHit buildings of NHT building slot ST03; ©NHT/Malzer

Typical winter conditions in St. Johann in Tyrol; ©NHT

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2. Description of the existing building

The residential building at Boznerstrasse 11a in St. Johann, Tyrol (Austria) is located in a town area called 'Südtiroler Siedlung' in the Southeast of St. Johann and is completely owned by NHT (social housing association of Tyrol). The building was built in the early 60's, includes 8 flats on 3 stories. The total living area is about 559 m². The building is nearly in the original status, only the façade has been renovated in the 80's with 6 cm outside cork insulation. The roof and floor is not insulated and the windows are old style double glazed and not air tight. The technical status is also nearly original. It consists of a mixture of single flat room heating and decentralized hot water systems. There is also a connection to the natural gas pipeline and additionally there is a connection to the renewable district heating. The current heating demand of the building is about 153 kWh/m²y (calculated along the national energy certificate). An average 13 kWh/m²y energy demand for domestic hot water (DHW) preparation was estimated. The current final energy consumption of the building for heating and DHW is about 283 kWh/m²y. No cooling devices are actually installed and needed.

existing buildings of NHT building slot ST03 – BOZ11; ©NHT/Malzer

2.1. Building data

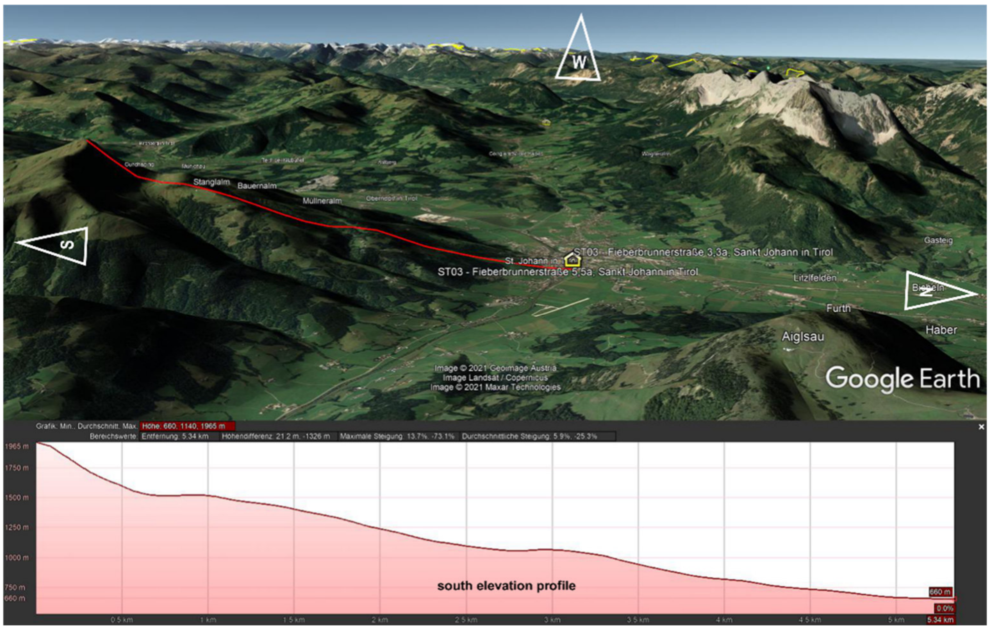
Year of construction:	1960 / apartment handover 1961
Treated Floor Area:	559
Number of floors:	3
Number of apartments:	8
Building typology (residential / other):	multifamily house
Main construction type:	massive

2.2. Owner data

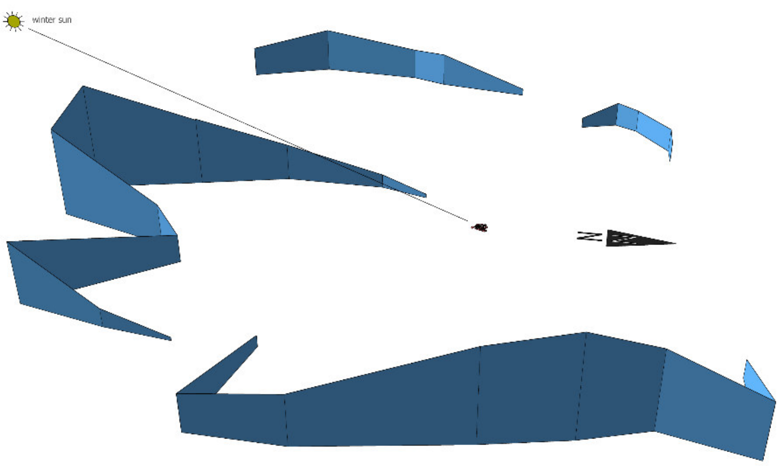
Name:	NEUE HEIMAT TIROL Gemeinnützige WohnungsGmbH
City:	Innsbruck
Type (private / housing association):	non-profit property developer

2.3. Location description

Extreme weather, climate and inner-alpine conditions in Sankt Johann in Tirol:



St. Johann in Tirol is located in the Tiroler Unterland in the center of the Leukental at about 700m altitude. The municipality is located as a regional traffic junction and as the intersection of four valleys in a wide valley basin. To the northwest of St. Johann, the mountain range of the Wilder Kaiser forms a natural weather divide between Kufstein and Bavaria, the Kitzbüheler Horn is to the south and the Kalksteinmassiv to the east. Due to the special basin location, St. Johann in Tirol is largely spared from the foehn storms feared in the Tyrolean Inn valley, but receives extremely heavy snowfalls in winter due to its location on the south side of the Wilder Kaiser Mountains.



Additional, the horizontal shading (above shown as part of the designPH 3D-model) shows the heavy shaded situation of the building site by the Kitzbüheler Horn from south.

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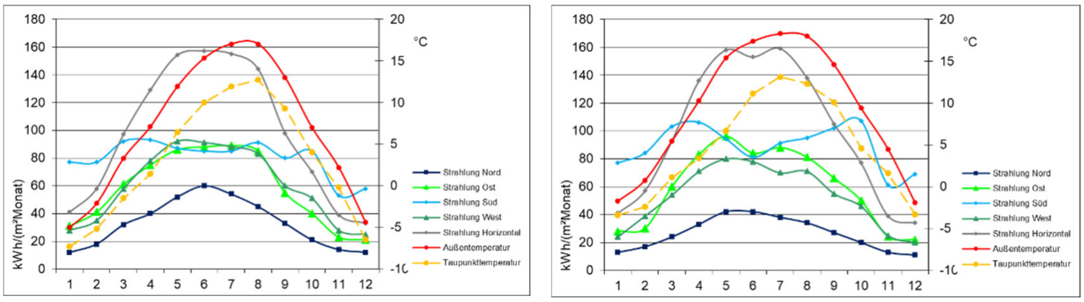
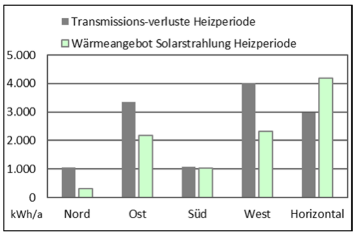
Less solar radiation combined with lower ambient temperatures and in fact larger amounts of precipitation in winter is a tricky combination for achieving EnerPHit-refurbishment standard.



The climatic data of St. Johann in Tirol (left) compared to that of Innsbruck (right) show the extreme climatic and inner-alpine conditions (Source PHPP, weather data by ZAMG).



Supply (solar radiation) versus transmission losses ATCS01

Pictures above show the heat supply (solar radiation) versus transmission losses of windows within the heating period (calculated with PHPP V9.7). The given east-west orientation of the large window areas and the associated low solar gains has to be mentioned here. Only “horizontal” glazing of staircase is positive, but without taking into account the extreme snow conditions (see photos below) of Sankt Johann.

Photo of snowfall and typical winter conditions in Sankt Johann in Tirol; ©NHT

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Photo of typical winter conditions in Sankt Johann in Tirol at the construction site of ST16-17; ©NHT

NHT construction sites have to be closed regularly in winter due to extreme weather conditions in Sankt Johann in Tirol. Photos above show approx. 90 cm of snow on the sloping roof and more than one meter at flat roofs.

2.4. Original situation

The building is nearly in the original status, only the façade has been renovated in the 80's with 6 cm outside cork insulation. The roof and floor is not insulated and the windows are old style double glazed and not air tight. The technical status is also nearly original. It consists of a mixture of single flat room heating and decentralized hot water systems.

designPH 3D **existing** district ST03 – outPHit - Boznerstrasse 11, Fieberbrunner Str. 3 & 5:

Existing buildings of NHT building slot ST03; ©NHT/Malzer

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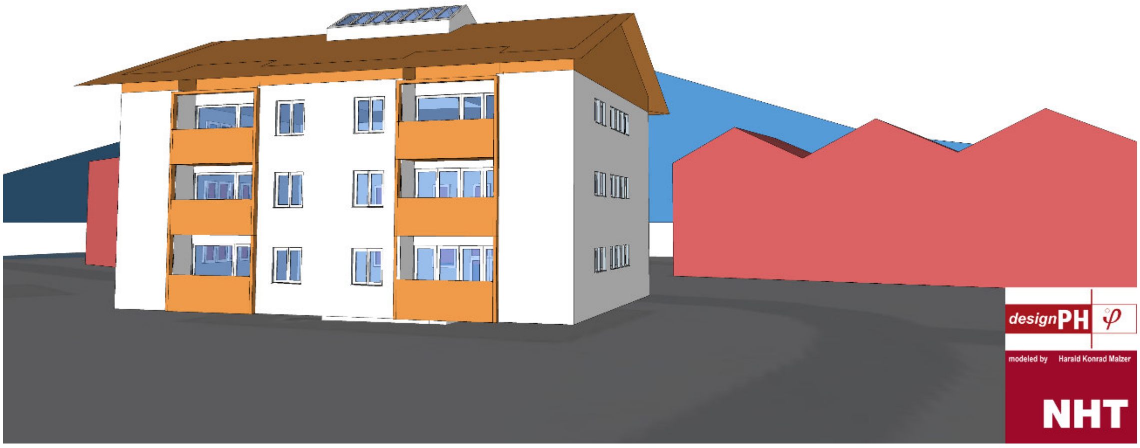
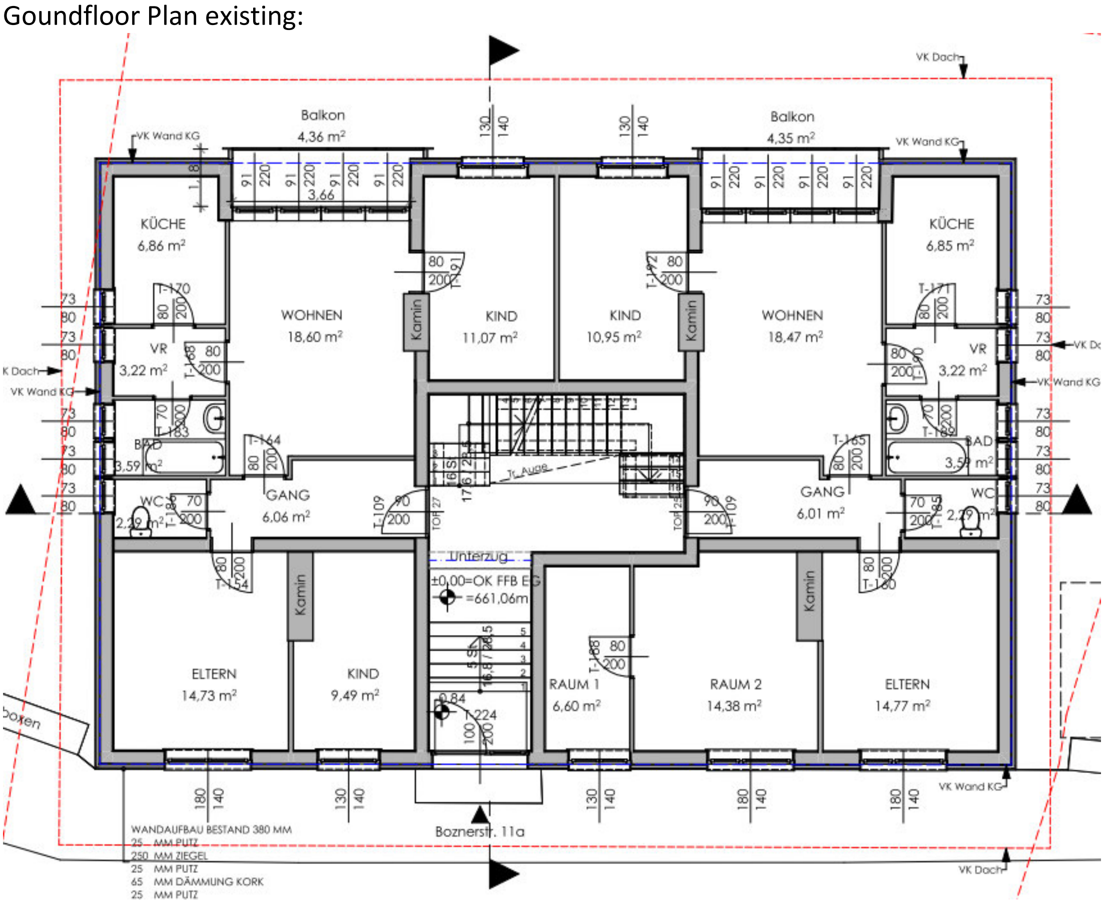
designPH 3D **existing** district ST03 – outPHit - Boznerstrasse 11:



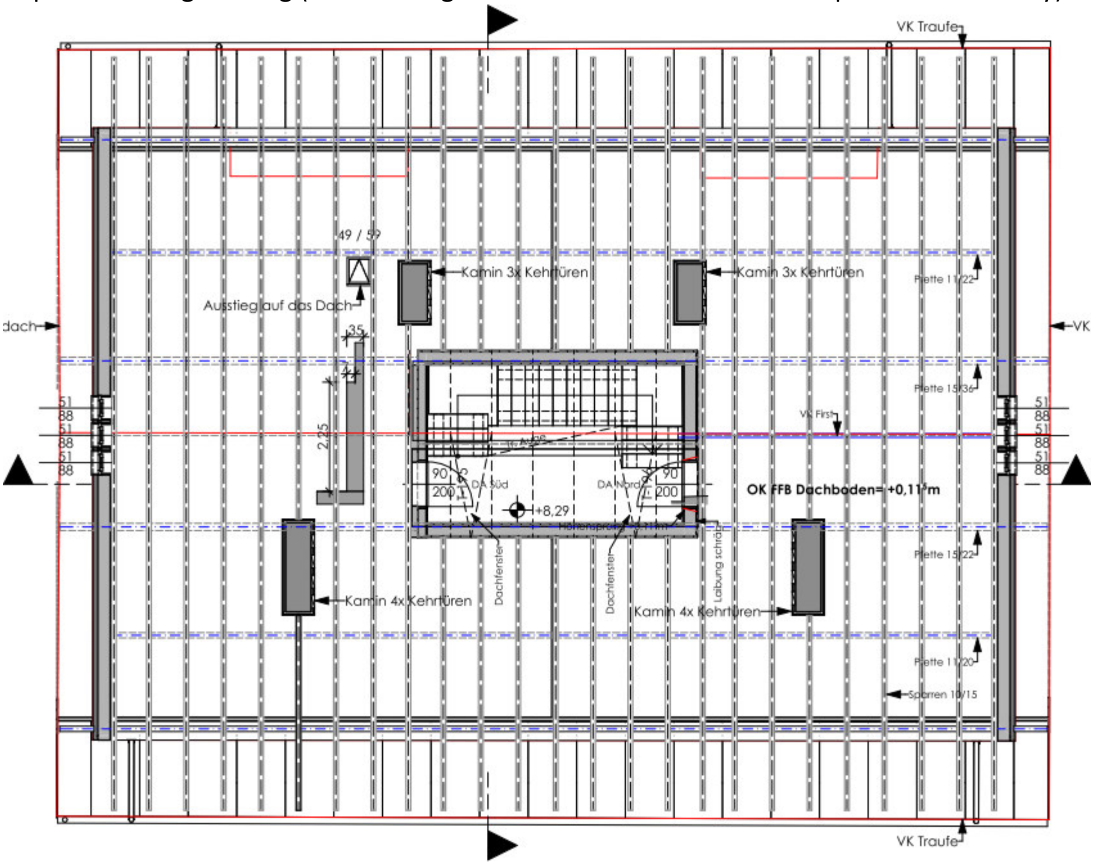
existing building in 3D simulation

2.5. Plans and pictures of the existing building

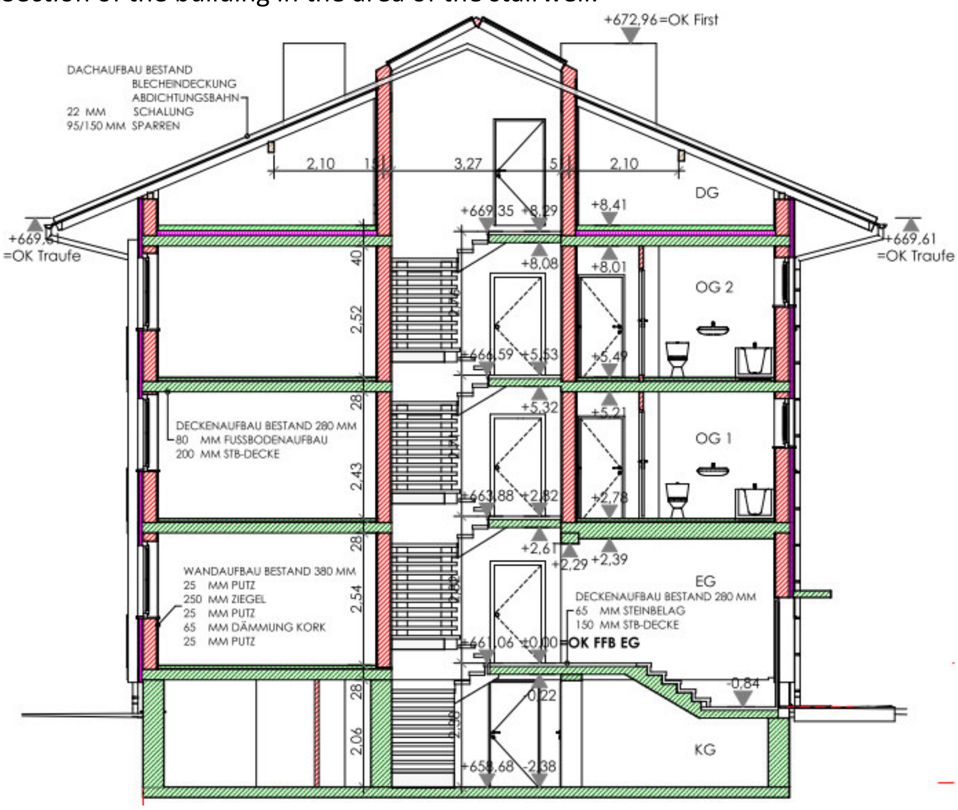
Goundfloor Plan existing:



Top floor ceiling existing (before integration of the central ventilation plus heat recovery):



Section of the building in the area of the stairwell:



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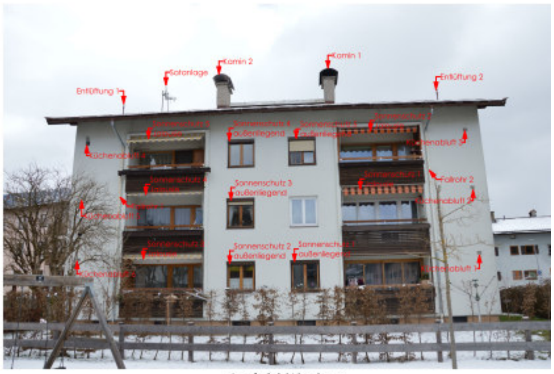
Architectural 3D-plan of existing building after detailed inventory:

Photos from the detailed inventory of the building:

Inventory of outside situation:

Ansicht Osten



Ansicht Westen

Ansicht Süden

Ansicht Norden

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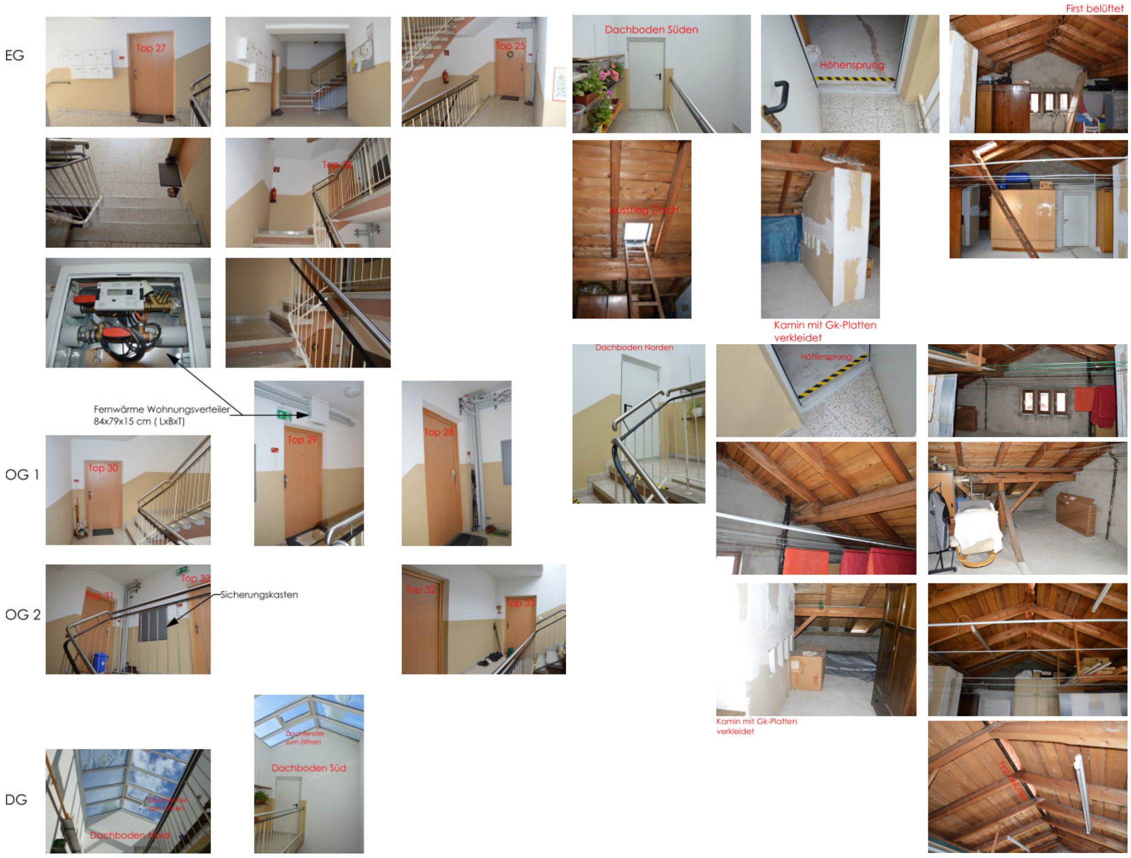
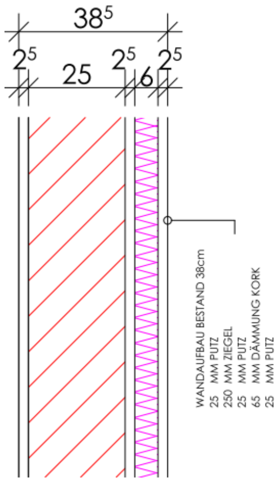
Inventory of inside situation:



Inventory of existing building service installations within the basement:

2.6. Envelope of the existing building



External walls

Material:	plaster perforated brick (60s) plaster + insulation adhesive cork insulation (80s) plaster	 25 [cm] 6 [cm]
Thickness:	38,5 [cm]	
Surface:	Plaster	
U-Value:	0,478 [W/(m²K)]	

Basement walls

Material:	in-situ concrete	40 [cm]
Thickness:	40 [cm]	
Surface:	exposed concrete	
U-Value:	3,030 [W/(m²K)]	

Floor slab / Basement ceiling

Material:	individual floor covering cement screed gravel fill in-situ concrete	 8 [cm] 5 [cm] 20 [cm]
Thickness:	35 [cm]	
Surface:	exposed concrete	
U-Value:	2,350 [W/(m²K)]	

Roof / Top floor ceiling

Material:	cement screed extruded polystyrol (80s) in-situ concrete (60s)	6 [cm] 10 [cm] 20 [cm]
Thickness:	38 [cm]	
Surface:	cement screed	
U-Value:	0,343 [W/(m²K)]	

Windows

Material:	Wood (original) / PVC (80s)

Thickness:	7 [cm]
U-Value (Uw, installed):	1,63 [W/(m²K)]

2.7. Technical equipment of the existing building

Ventilation

Ventilation concept: none

Bathrooms use static ventilation via vent chimneys (warm air rises)

Heating, Cooling and DHW

Heating:	individual (oil, gas, wood, district heat), decentralized apartments
Cooling:	none
Domestic hot water:	individual (gas, electricity, district heat), decentralized apartments

2.8. Energy efficiency of the existing building

Passive House Planning Package (PHPP)

PHPP calculation:	PHPP_9.7
Space heating demand:	205 [kWh/(m²a)]
Heating Load:	76 [W/m²]
Overheating frequency:	0 %
Cooling demand:	0 [kWh/(m²a)]
Cooling Load:	0 [W/m²]
Primary Energy Demand:	316 [kWh/(m²a)] equivalent to decentral natural gas
PER Demand:	456 [kWh/(m²a)] equivalent to decentral natural gas

Final Energy demand for space heating

Final energy demand gas:	94,8 [kWh/(m²a)] – approx. 37,5% equivalent to natural gas
Final energy demand oil:	31,6 [kWh/(m²a)] – approx. 12,5% equivalent to natural gas
Final energy demand wood:	31,6 [kWh/(m²a)] – approx. 12,5% equivalent to natural gas
Final energy demand electricity:	19,7 [kWh/(m²a)]
Final energy demand district heating:	94,8 [kWh/(m²a)] – approx. 37,5% equivalent to natural gas

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Available consumption before renovation

Due to the decentralized space heating and hot water generation and distribution that varies from apartment to apartment, no clear statement is possible here. In the course of the stocktaking, a pre-monitoring by apartment was carried out with the University of Innsbruck. Following some sample results:

- Oil heating including hot water — 650 [l/a apartment]
- Oil stove + electric heating and DHW — 450 [l/a apartment] + electricity
- Gas heating including hot water — 550 - 708 [m³/a apartment]
- Gas heating including hot water + tiled stove — 477 [m³/a gas] + 0.70 [m³/a wood]
- Wood tiled stove + electric DHW — 2.50 [m³/a apartment] + electricity
- District heating including hot water — 3.500 - 8.900 [kWh/a apartment]

Energy costs before renovation for space heating

Annual energy costs gas:	Ø 2021: 0,068 [€/kWh] = approx. 1036 [€/a apartment] Ø 2022: 0,185 [€/kWh] = approx. 2820 [€/a apartment]
Annual energy costs oil:	Ø 2021: 0,083 [€/kWh] = approx. 1265 [€/a apartment] Ø 2022: 0,200 [€/kWh] = approx. 3049 [€/a apartment]
Annual energy costs electricity:	Ø 2021: 0,180 [€/kWh] = approx. 2744 [€/a apartment] Ø 2022: 0,220 [€/kWh] = approx. 3354 [€/a apartment]
Annual energy costs wood (pieces):	Ø 2021: 0,059 [€/kWh] = approx. 899 [€/a apartment] Ø 2022: 0,069 [€/kWh] = approx. 1052 [€/a apartment]

PHPP verification sheet before retrofit

Gebäudekennwerte mit Bezug auf Energiebezugsfläche und Jahr

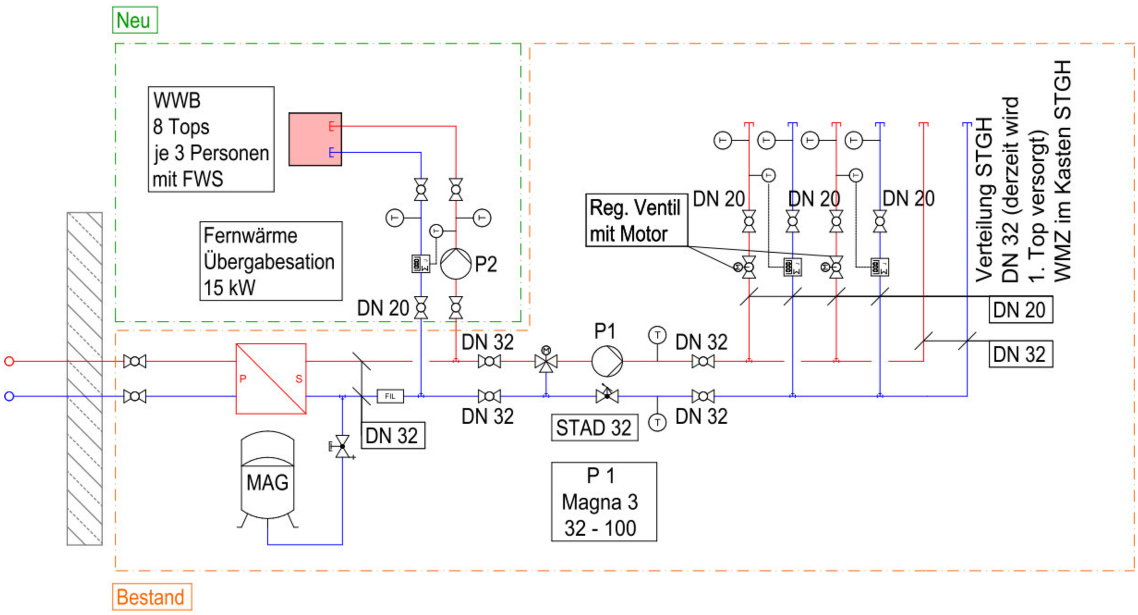
				Kriterien	alternative Kriterien	Erfüllt?[2]
	Energiebezugsfläche m²	547,2				
Heizen	Heizwärmebedarf kWh/(m²a)	205,51	≤	30	-	nein
	Heizlast W/m²	76,4	≤	-	-	
Kühlen	Kühl- + Entfeuchtungsbedarf kWh/(m²a)	-	≤	-	-	-
	Kühllast W/m²	-	≤	-	-	
	Übertemperaturhäufigkeit (> 25 °C) %	0	≤	10		ja
	Häufigkeit überhöhter Feuchte (> 12 g/kg) %	0	≤	20		ja
Luftdichtheit	Drucktest-Luftwechsel n_{50} 1/h	2,00	≤	1,0		nein
Nicht erneuerbare Primärenergie (PE)	PE-Bedarf kWh/(m²a)	316	≤	329		ja
Erneuerbare Primärenergie (PER)	PER-Bedarf kWh/(m²a)	456	≤	-	-	-
	Erzeugung erneuerb. Energie (Bezug auf überbaute Fläche) kWh/(m²a)	0	≥	-	-	

[2] leeres Feld: Daten fehlen; '-': keine Anforderung

3. Renovation approach description

The outPHit efficiency goal for this building is a comprehensive renovation according to the criteria of EnerPHit – the Passive house refurbishment standard (**https://passiv.de/downloads/03_building_criteria_en.pdf**).

This includes a full thermal refurbishment of the façade, top floor ceiling, basement ceiling and triple glazed windows. The thermal quality of the components corresponds to the passive house standard. Additionally, existing thermal bridges are largely minimized. The existing balconies will be demolished and new ones will be connected to the thermal envelope with as little thermal bridging as possible.
As part of the EnerPHit standard, the integration of a controlled ventilation of the living area with heat recovery is obvious (see point 3.4 for current top floor ceiling plan and 3D-planning of façade integrated central ventilation system).
In addition, the current decentralized and tenant-dependent heat supply should be transformed into a central and mostly renewable heat supply (see point 3.4 for current basement plan).



New heating and hot water scheme; ©NHT/alpSOLAR Klimadesign

One renovation approach, currently being investigated, is to "clean up" the existing very fissured facade littered with thermal bridges.

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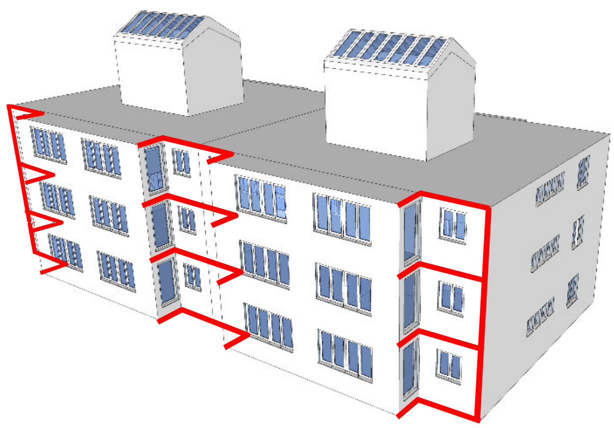
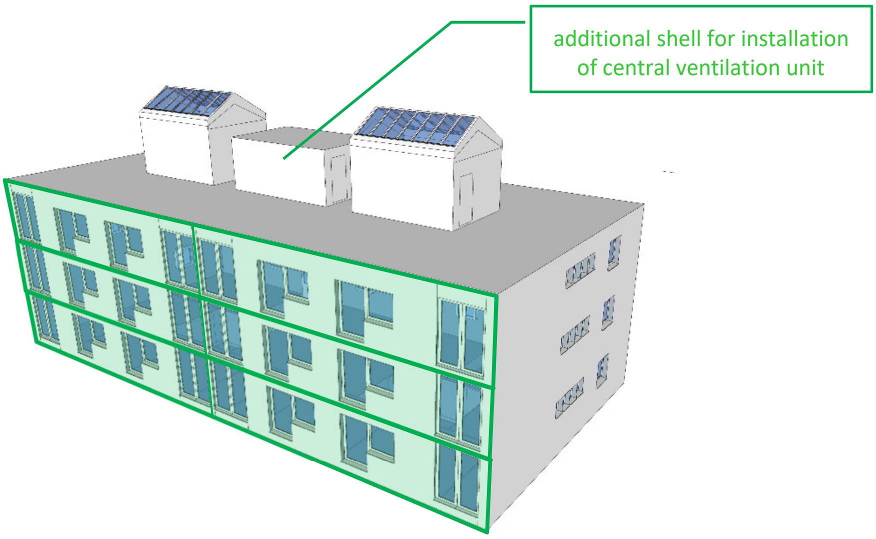


Thermal shell of existing facade of NHT building ST03; ©NHT/Malzer

A uniform surface allows the use of prefabricated facade elements. Prefabricated facade elements could offer the advantage of a high degree of prefabrication (including windows and air distribution), quality-assured production and quick assembly on the construction site. However, experience shows that a cost advantage that has also been promised can often not be kept.



Thermal shell of EnerPHit facade prepared for prefabricated facade elements, ST03; ©NHT/Malzer

3.1. EnerPHit standard approach

EnerPHit standard target (class):	2-EnerPHit Classic
Climate Zone	2-Cold
EnerPHit verification method:	1-PE (none renewable)

3.2. Design / Consultancy teams

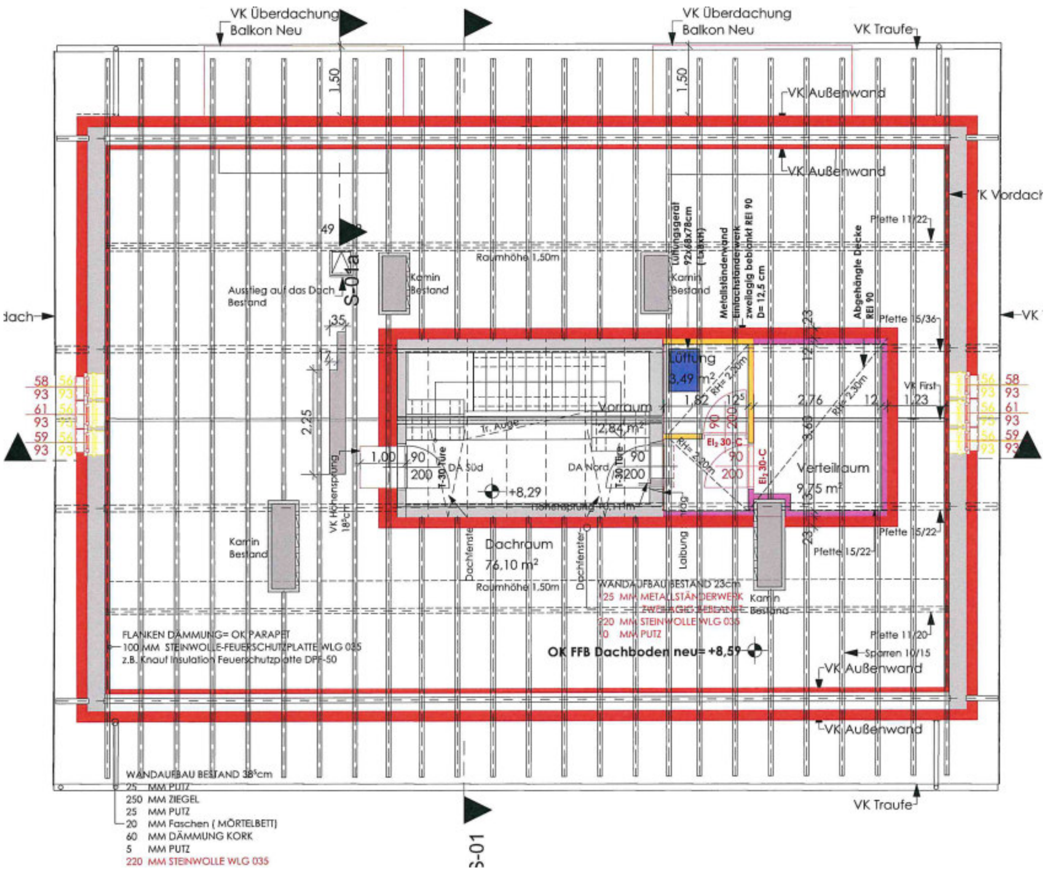
- **Project management**: NEUE HEIMAT TIROL Gemeinnützige WohnungsGmbH
- **Construction management**: NEUE HEIMAT TIROL Gemeinnützige WohnungsGmbH
- **Energy efficiency and sustainability**: NEUE HEIMAT TIROL Gemeinnützige WohnungsGmbH
  City: 6020 Innsbruck / Austria
  Type: non-profit property developer
- **Architectural planning**: Arch. DI Johannes Gomille MSc
  City: 6020 Innsbruck / Austria
  Type: private
- **Building service planning:** alpSOLAR Klimadesign
  City: 6020 Innsbruck / Austria
  Type: private

3.3. Design / Construction periods

Design period: Spring 2021 – Summer 2022

Construction period: Spring 2023 – earliest Spring 2024

3.4. Plans and pictures of the renovation



Thermal shell at top floor ceiling after refurbishment (compare to point 2.5); ©NHT/Arch. Gomille

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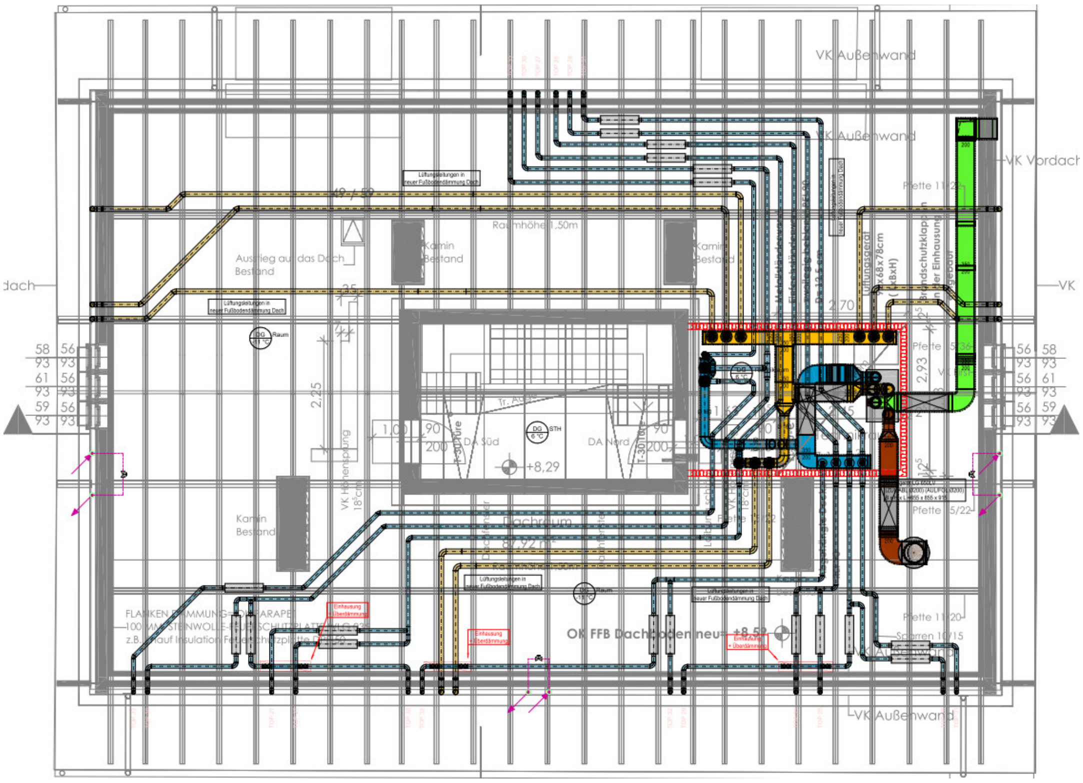
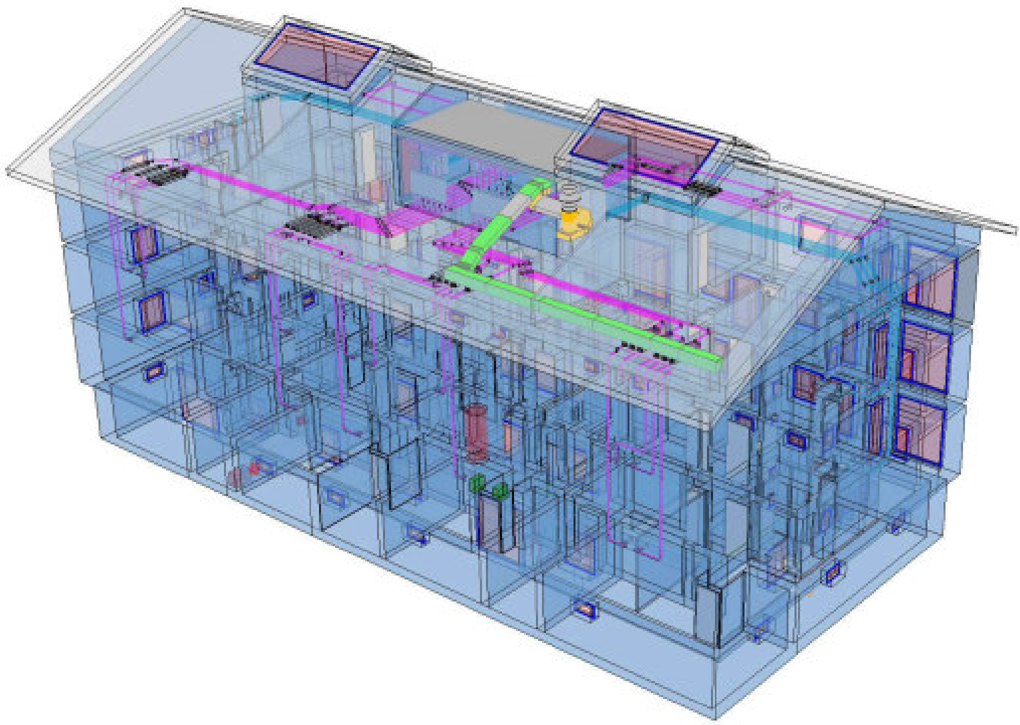


Top floor ceiling after refurbishment incl. integration of the central ventilation plus heat recovery (compare to point 2.5); ©NHT/alpSOLAR Klimadesign



3D-planning of façade integrated central ventilation system; ©NHT/alpSOLAR Klimadesign

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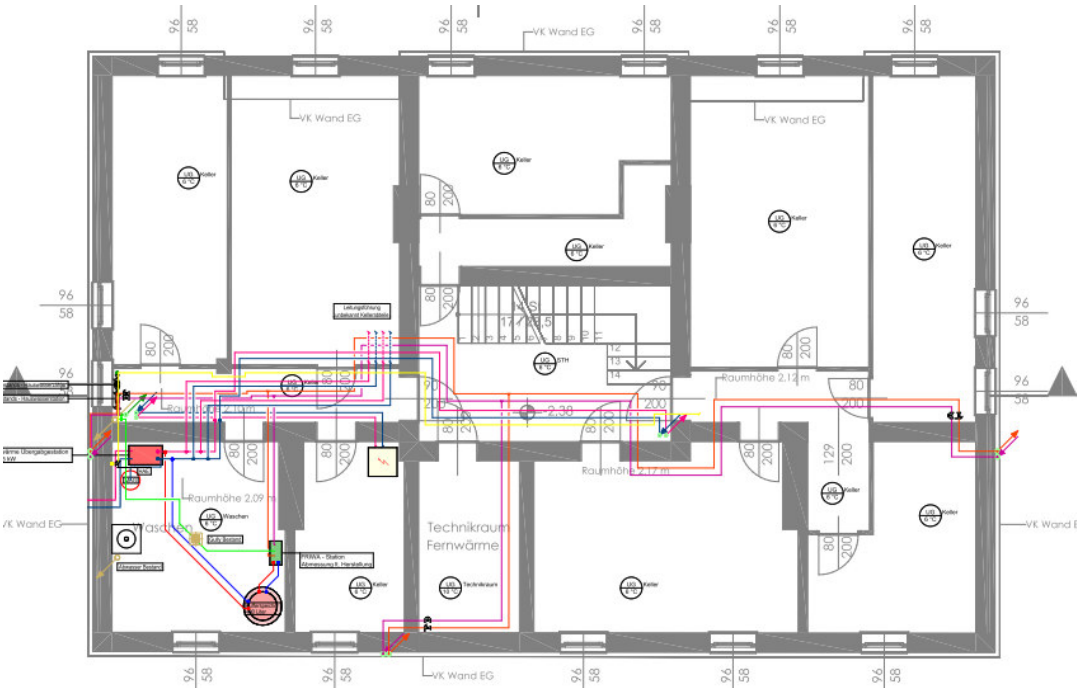
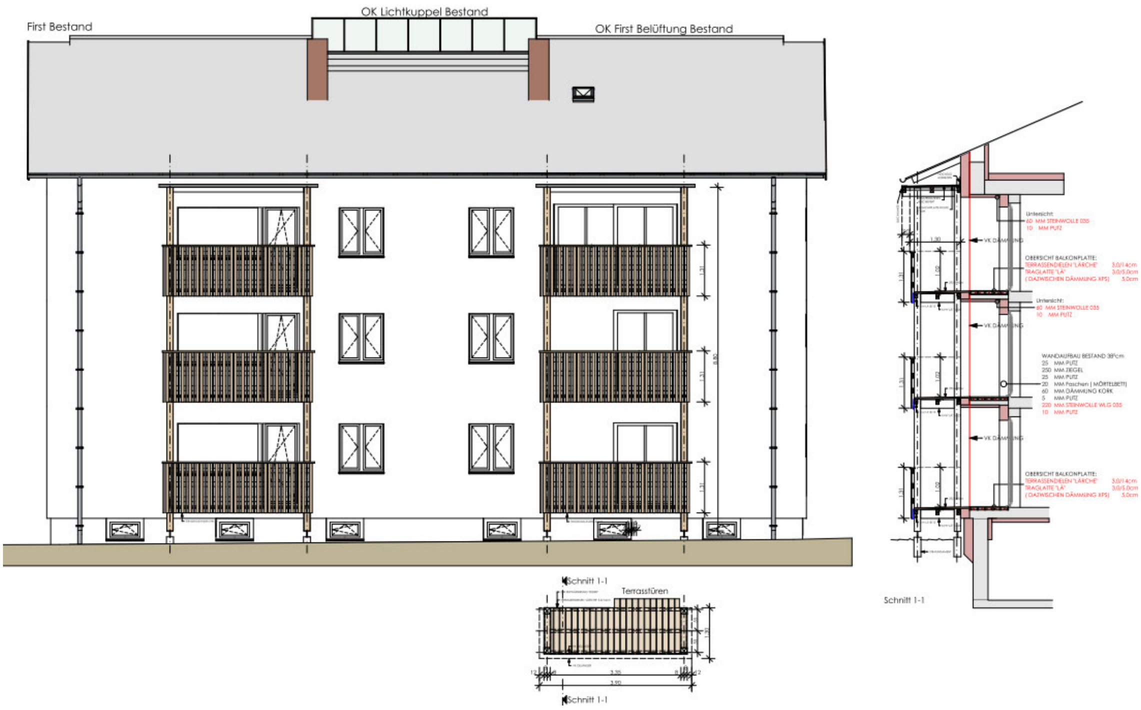
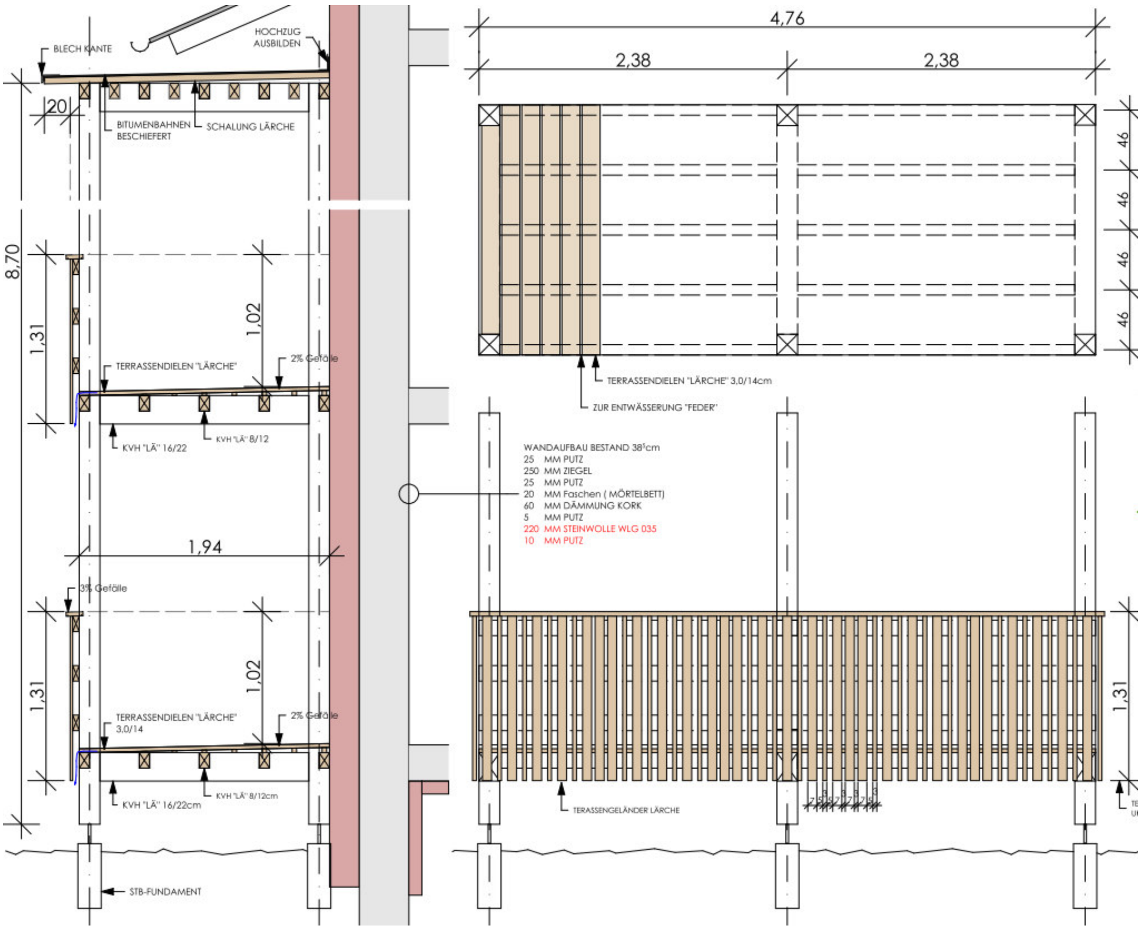


Planning of the central and renewable heat supply and distribution within the basement; ©NHT/alpSOLAR Klimadesign

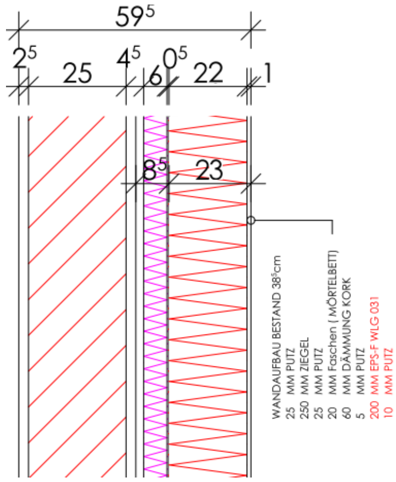


Tender plan of the new wooden balconies at ST03_BOZ11 – CS22; ©NHT/Arch. Gomille



Detailed planning of the new wooden balconies, which are connected without thermal bridges; ©NHT/Arch. Gomille

3.5. Envelope of the renovated building



External walls

Material:	plaster	
	perforated brick (60s)	25 [cm]
	plaster + insulation adhesive	
	cork insulation (80s)	6 [cm]
	insulation adhesive	
	mineral wool insulation (new)	22 [cm]
	plaster	
Thickness:	59,5 [cm]	
Surface:	Plaster	
U-Value:	0,111 [W/(m²K)]	

Basement walls

Material:	in-situ concrete	40 [cm]
	insulation adhesive	
	flank insulation inside (new)	
	(mineral wool	
	+ wood fiber board)	10 [cm]
Thickness:	at flank insulation 50 [cm]	
Surface:	exposed concrete + wood fiber board	
U-Value:	0,322 [W/(m²K)]	

Floor slab / Basement ceiling

Material:	individual floor covering	
	cement screed	8 [cm]
	gravel fill	5 [cm]
	in-situ concrete	20 [cm]
	insulation adhesive	
	ceiling insulation (new)	
	(mineral wool	
	+ wood fiber board)	12,5 [cm]
Thickness:	45 [cm]	
Surface:	wood fiber board	
U-Value:	0,257 [W/(m²K)]	

Roof / Top floor ceiling

Material:	OSB wood board (new)	2,5[cm]
	cellulose filling + vent tubes (new)	22 [cm]
	cement screed (80s)	6 [cm]

	extruded polystyrol (80s)	10 [cm]
	in-situ concrete (60s)	20 [cm]
Thickness:	60 [cm]	
Surface:	OSB wood board	
U-Value:	0,113 [W/(m²K)]	

Windows

Material:	PVC + triple glazed glazing (new)
Thickness:	Frame 9 [cm]; Glazing (4:/18/4/18/:4 Ar 90%) 4,8 [cm]
U-Value (Uw, installed):	0,85 [W/(m²K)]

3.6. Technical equipment of the renovated building

Ventilation

Ventilation concept	central + distribution within top floor ceiling and insulated façade
Ventilation heat recovery efficiency	81,1 %
Ventilation specific efficiency	0,33 [Wh/m³]
Ventilation standard air flow rate	554 [m³/h]

In the cold attic, an additional small room is built for the ventilation unit (separate fire compartment) and an adjoining one for the central distribution, unit silencer and the constant volumetric flow controller for each residential unit (for supply air and exhaust air). From there, the distribution to the residential units takes place via the newly erected double floor (= additional insulation of the top floor ceiling, blown out with 22cm cellulose) to the outer walls. The distribution in the outer walls takes place either in the existing cork insulation (80s) up to core holes or within prefabricated facade elements up to the window reveals. The fresh air is brought in from there (bedrooms) and flows via the corridor and living rooms to the exhaust air rooms (kitchen, bathroom, toilets) where it is finally extracted.

Heating, Cooling and DHW

The current decentralized and tenant-dependent heat supply (see point 2.7 and 2.8) will be transformed into a central and renewable heat supply based on available district heat network of St. Johann (> 50% renewable waste heat from a big wood processing plant). See point 3 and 3.4 for current building service plan of the subsequently integrated district heating connection in the basement and the distribution system in the building.

Heating:	central, district heating (mostly renewable waste heat from wood processing plant)
Cooling:	none, not necessary due to local climate conditions
Domestic hot water:	central, district heating (mostly renewable waste heat from wood processing plant)

3.7. Summer comfort

Efforts to improve summer comfort:

- Central ventilation unit use the summer bypass mode
- Temporary summer shading as required by tenants
- Optimized fixed shading by new and deeper balconies at southwest orientated façade
- No active cooling needed due to cool local climate conditions also in summer

By this, PHPP shows no warnings in term of bad summer comfort:

Ergebnisse passive Kühlung			Ergebnisse aktive Kühlung		
Übertemperaturhäufigkeit:	4,3%	Übertemperaturgrenze ϑ_{max} = 25 °C	Nutzkältebedarf:	1,2	kWh/(m²a)
maximale Feuchte:	12,0	g/kg	Entfeuchtungsbedarf:	0,0	kWh/(m²a)
Häufigkeit überhöhter Feuchte:	0,1%		Häufigkeit überhöhter Feuchte:	0,2%	

3.8. Energy efficiency of the renovated building

Passive House Planning Package (PHPP)

PHPP calculation:	PHPP_9.7
Space heating demand:	36,4 [kWh/(m²a)]
Heating Load:	20,5 [W/m²]
Overheating frequency:	4,3 %
Cooling demand:	--- [kWh/(m²a)]
Cooling Load:	--- [W/m²]
Primary Energy Demand:	50,2 [kWh/(m²a)]
PER Demand:	151 [kWh/(m²a)]
Airtightness n50 target:	0,8 1/h

Final Energy demand

Final energy demand gas:	--- [kWh/(m²a)]
Final energy demand oil:	--- [kWh/(m²a)]
Final energy demand wood:	--- [kWh/(m²a)]
Final energy demand electricity:	21,6 [kWh/(m²a)]
Final energy demand district heat:	68,9 [kWh/(m²a)]

PHPP verification sheet after retrofit

Gebäudekennwerte mit Bezug auf Energiebezugsfläche und Jahr

				Kriterien	alternative Kriterien	Erfüllt?[2]
	Energiebezugsfläche m²	547,2				
Heizen	Heizwärmebedarf kWh/(m²a)	36,36	≤	30	-	nein
	Heizlast W/m²	20,5	≤	-	-	
Kühlen	Kühl- + Entfeuchtungsbedarf kWh/(m²a)	-	≤	-	-	-
	Kühllast W/m²	-	≤	-	-	
	Übertemperaturhäufigkeit (> 25 °C) %	4	≤	10		ja
	Häufigkeit überhöhter Feuchte (> 12 g/kg) %	0	≤	20		ja
Luftdichtheit	Drucktest-Luftwechsel n_{50} 1/h	0,8	≤	1,0		ja
Nicht erneuerbare Primärenergie (PE)	PE-Bedarf kWh/(m²a)	50,2	≤	126		ja
Erneuerbare Primärenergie (PER)	PER-Bedarf kWh/(m²a)	137	≤	-	-	-
	Erzeugung erneuerb. Energie (Bezug auf überbaute Fläche) kWh/(m²a)	0	≥	-	-	

[2] leeres Feld: Daten fehlen; '-': keine Anforderung

3.9. Predicted energy savings

Space heating demand:	36,4 - 205,5	= **- 169,1** [kWh/(m²a)]
Primary Energy Demand:	50 - 316	= **- 266** [kWh/(m²a)]
PER Demand:	137 - 456	= **- 319** [kWh/(m²a)]
Final energy demand gas:		**- 94,8** [kWh/(m²a)]
Final energy demand oil:		**- 31,6** [kWh/(m²a)]
Final energy demand wood:		**- 31,6** [kWh/(m²a)]
Final energy demand electricity:	21,6 - 19,7	= **+ 2,6** [kWh/(m²a)]
Final energy demand district heating:	68,9 - 94,8	= **- 25,9** [kWh/(m²a)]

3.10. RES strategy

The existing, decentralized space heating and hot water requirement from a fossil mix of gas and oil is replaced by centrally provided district heating with a high proportion of renewable industrial waste heat.

The systems set up at the *FRITZ EGGER GmbH & Co. OG Holzwerkstoffe* wood processing plant are designed for maximum availability. In addition to a biomass boiler and the heat pump, the network can be operated with natural gas in an emergency. In addition, a total of three district heating network pumps, which are switched alternately, are installed. To ensure security of supply, peak load boilers were installed in the town center in 2009 and 2018. Through the use of biomass, there is extensive independence from fossil fuel imports. There is only hot water in the district heating network.

FRITZ EGGER GmbH & Co. OG Holzwerkstoffe wood processing plant in St. Johann in Tyrol; https://www.egger.com/shop/de_AT/ueber-uns/oesterreich; © FRITZ EGGER GmbH

Ortswärme St. Johann in Tirol - district heating supply area; https://www.ortswaerme.info/fernwaerme/versorgungsgebiet/; © Ortswärme St. Johann in Tirol GmbH

4. Project challenges and opportunities

Challenges

High cost pressure in terms of social housing

The present requirements of the renovation project, which include a highly energy efficient thermal renovation, the installation of a living space ventilation and a central, renewable heat distribution system create high cost pressure.

Tenancy law challenges

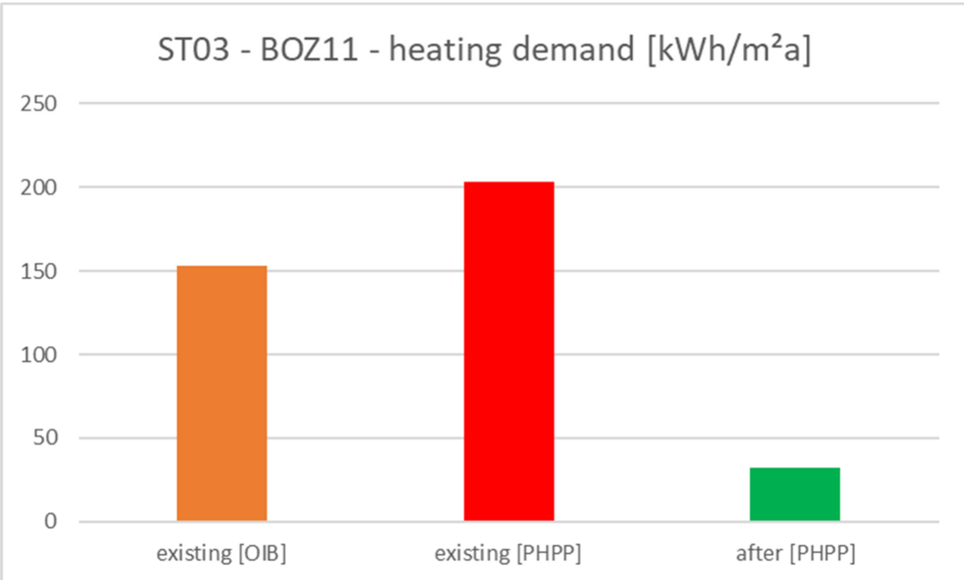
In fact, apart from technical challenges, also tenancy law challenges are created within the framework of the Austrian tenancy law.

These must also be clarified in advance, as for example a changed area code or a transformation from decentralized heating to a central heat distribution would result in new rental agreements, which in turn would first have to be agreed with the residents.

Opportunities

Efficiency improvement

The expected improvement in efficiency, measured by the heating requirement and the measures planned to date, can amount to up to 84%.



Through to thermal refurbishment district heating network can reach more households

Within the district energy balance carried out by the UIBK, it was possible to show how important it is to have a low energy requirement even for renovations, since this allows the number of households supplied with renewable district heating to be maximized. Although in future the quota of district heating at St. Johann cannot be further increased.

5. Current project status

Currently the design phase is finished. Since several renovation options and variants had to be worked out, both in the area of the thermal envelope (prefabricated facades) and in the building technology concept (air distribution, heat distribution) this took quite a long time.

The tendering process is currently underway. The results are then summarized in a price comparison table. The final costs can then be determined, which will form the basis of the presentation at the tenants' meeting in November 2022. After a positive majority vote, the major refurbishment can then begin in spring 2023.

6. Lessons learnt and guidelines for replication

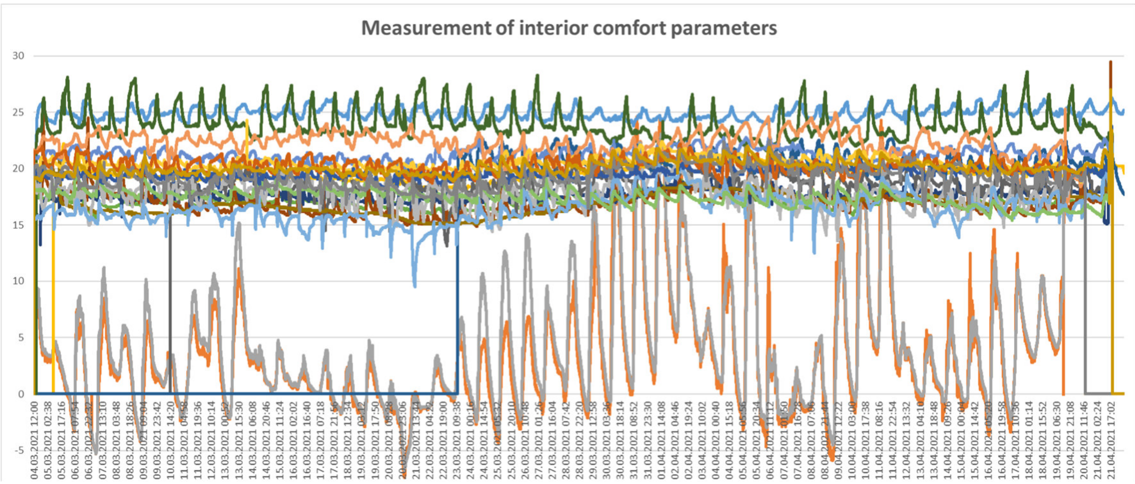
To be added after practical implementation.

7. Pre-Monitoring description (if applicable)

In order to be able to determine the improvements in indoor air, comfort and energy savings through the planned refurbishment a premonitoring before renovation was executed.

Measurement of interior comfort parameters

A small measuring device for the purpose of measurement (room temperature, humidity, CO_2) was set up on a cupboard or shelf in the bedrooms. An employee of the University of Innsbruck picked up this measuring device again after approx. 6 weeks. A second appointment with the tenants has been made for that.

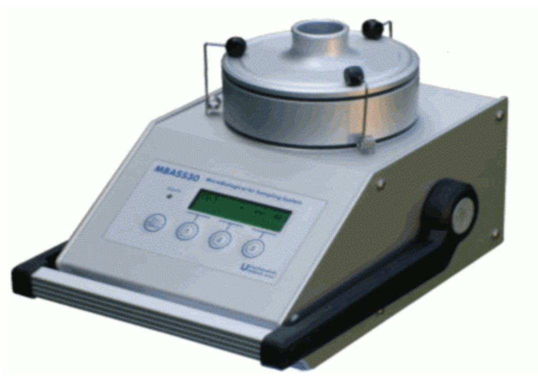


Results of measurement of interior comfort parameters of 19 apartments; © UIBK

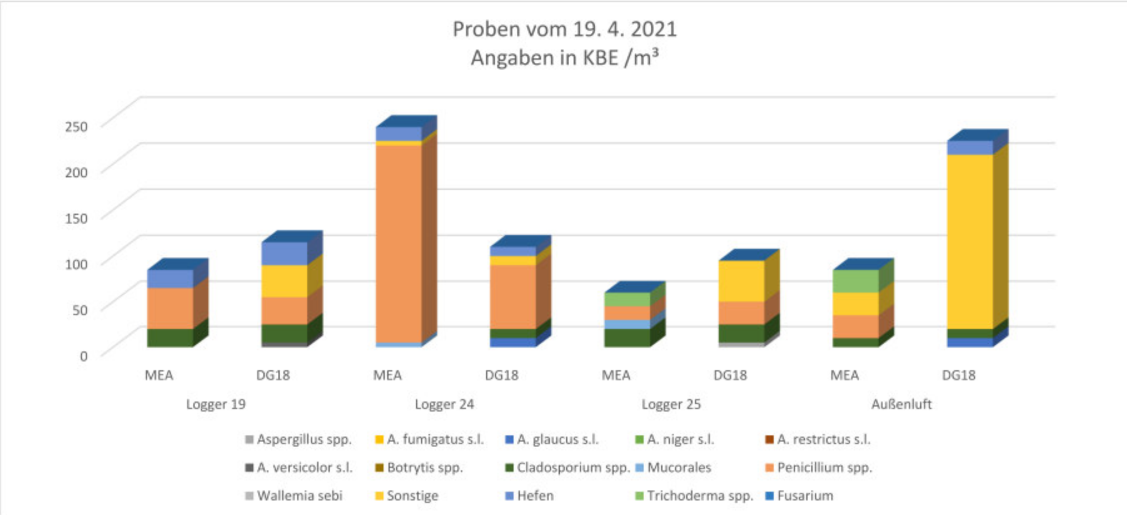
Measurement of fungal spore load indoors

Within this appointment, the indoor air quality was additionally measured with special mold detectors in the flat for approx. 20 minutes. For this purpose air samples were taken, between 19 04. 2021 and 22. 04. 2021 from indoor rooms and on all measurement days as a reference also from the outside air. The sampling was taken by the University of Innsbruck.

The air samples (indoor, reference: outdoor air) were taken using an **MBASS30 air sampler** on malt extract agar (MEA) and DG18 agar according to ÖNORM DIN ISO 16000-18 (indoor air pollution - Part 18: Detection and counting of molds - sampling by impaction). Collection volume for fungi 100L; collection height in the room about 1.5 m above ground level. The plates for the mesophilic fungi (MEA, DG18) were incubated for 7 days at 25 ° C. The growing colonies can thus be observed. The colonies were counted as CFU = colony forming units.



At 4 sampling points, a clearly increased spore load, especially of Penicillium spp. to be determined. If one compares the spore load from Penicillium with data from surveys in recent years, there is a medium but clear load from fungal spores. At 3 sampling points there was a slightly increased contamination by spores from Penicillium spp. verifiable. Affected tenants were informed immediately and informed about possible measures to improve the situation.



Excerpt from the results of airborne germ collection and determination; © UIBK/Mag. Dr. Martin Kirchmair – **www.mykon.at**

Thermal indoor imaging

A thermal imaging camera was used to record indoor surface temperatures on the walls of the apartments.

Collection of existing energy costs and quantities

In order to be able to determine the heating energy savings as best as possible through the refurbishment, a monthly meter reading or the gas bill (for gas floor heating) had to be handed over by the tenants. Other heating bills (district heat) or quantities (oil, wood) were also requested.

In order to be able to best determine possible electricity savings after the refurbishment, a monthly meter reading before the refurbishment, was done by the NHT staff (building supervisor).

Number of apartments:	**19**
Period of pre-monitoring:	**04.03.2021 – 22.04.2021**