REPORT
PUBLIC

CS 36: Multifamily House

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

Last updated 07. October 2022 by
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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,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957175. The presented contents are the author's sole responsibility and do not necessarily reflect the views of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

CS36_MULTI FAMILY HOUSE, GERMANY

Renovation Approach Description

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Renovation Approach Description

1. Executive Summary

A housing association has set itself the goal of a climate-neutral housing stock by 2030. For this reason, all upcoming renovations will be carried out to the kfw40 or EnerPHit standard. The first construction phase comprises eight apartment blocks. The buildings each have 12, 16, 18 or 22 residential units and between two and four floors.

The buildings were built in the 1950s and were retrofitted in the 1990s with 8cm ETICS and insulation of the top floor ceiling. Currently, the facades and windows are being renovated with serially prefabricated highly insulating elements. In the area of the balconies, the insulation measures are traditionally carried out as a doubling on the existing ETICS. While the windows of the prefabricated facade are located in the insulation level, the balcony doors remain in their original position in the masonry. In addition, the basement ceiling will be fitted with 8cm of thermal insulation from below. In addition, the district's heat supply will be renewed. A central heating system supplies all eight buildings via a new local district heating network. Three energy piles serve as the heat source, providing heat for heating and domestic hot water with the help of heat pumps. Each residential unit receives a ventilation system with heat recovery and a new bathroom. The heat transfer station and the ventilation system are installed in a kind of backpack from the outside to the outer wall in the area of the bathroom. This backpack is thus attached from the outside as a prefabricated element like the facade elements, so that no space is required for it within the existing apartment.

2. Description of the existing building

The building is typical of the multi-story residential buildings of the 1950s and 1960s in Germany. Masonry walls and reinforced concrete floors form the supporting structure. The buildings have gable roofs with cold stores. The staircases are slightly set back. The original windows have been replaced in the meantime by plastic windows and partly by wooden windows with 2-pane thermal insulation glazing.



2.1. Building data

Year of construction:	1955
Treated Floor Area:	260-450m²
Number of floors:	2 … 4
Number of apartments:	12, 16, 18 or 22
Building typology (residential / other):	residential
Main construction type (e.g. massive)	massive

2.2. Owner data

Name:

City:

Type (private / housing association):

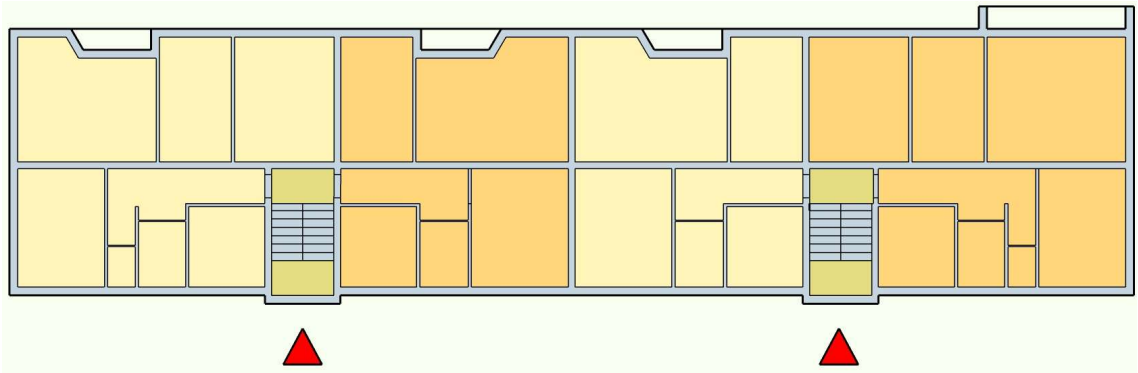
2.3. Location description

A city in the administrative district of Middle Franconia in the Free State of Bavaria. Due to its location in Central Europe, it is in the cool temperate climate zone. The town can neither be clearly assigned to the continental climate nor to the maritime climate. Typical of the continental influence is the low annual precipitation of 645 mm. Source: Wikipedia

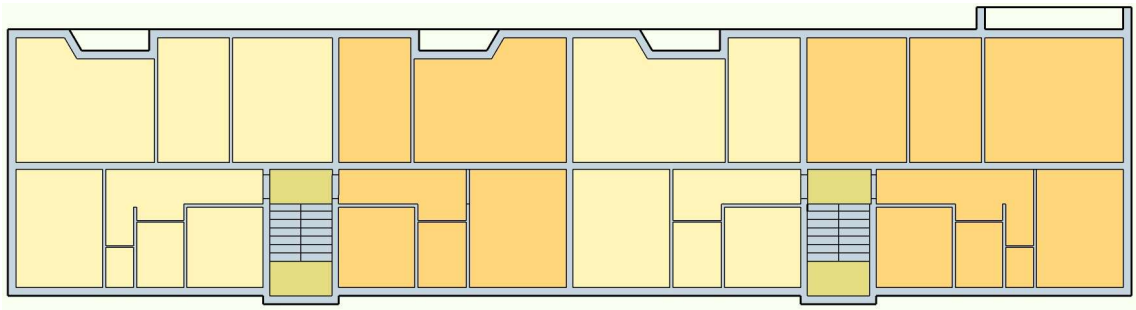
2.4. Original situation

The building fabric consists of masonry walls and reinforced concrete ceilings as well as a gable roof and a massive basement. The windows and façade have been renewed once so far.

2.5. Plans and pictures of the existing building



Ground Floor, Source PHI



1st and 2nd Floor, Source: PHI

2.6. Envelope of the existing building

External walls

Material:	Brick with 80mm ETICS
Thickness:	42 [cm]
Surface (Render / Brick / Cladding):	Rendering
U-Value:	0,35 [W/(m²K)]

Floor slab / Basement ceiling

Material:	Concrete
Thickness:	22 [cm]
Surface (Render / Brick / Cladding):	Concrete
U-Value:	3,0 [W/(m²K)]

Roof / Top floor ceiling

Material:	Concrete
Thickness:	33 [cm]
Surface (Render / Brick / Cladding):	OSB Board
U-Value:	0,15 [W/(m²K)]

Windows

Material:	PVC and some with Wood
Thickness:	8 [cm]
Material (Wood / Plastic / Aluminium):	Plastic
U-Value (Uw, installed):	1,8 [W/(m²K)]

2.7. Technical equipment of the existing building

Ventilation

Ventilation concept:	by opening windows

Add short description if required

Heating, Cooling and DHW

Heating:	central gas heating

Cooling:	Roller shutters at all windows, no active cooling
Domestic hot water:	central gas heating

2.8. Energy efficiency of the existing building

Passive House Planning Package (PHPP)

PHPP calculation:	PHPP_10.2
Space heating demand:	150 [kWh/(m²a)]
Heating Load:	63 [W/m²]
Overheating frequency:	0 %
Cooling demand:	0 [kWh/(m²a)]
Cooling Load:	0 [W/m²]
Primary Energy Demand:	226 [kWh/(m²a)]
PER Demand:	310 [kWh/(m²a)]

Final Energy demand

Final energy demand gas:	150[kWh/(m²a)]
Final energy demand electricity:	40 [kWh/(m²a)] typical average household electricity consumption in Germany, assumption: 3200 kWh/a per household on 80 m² living space
Final energy demand other:	0 [kWh/(m²a)]

Available consumption before renovation

Annual energy consumption gas:	? [kWh/(m²a)]
Annual energy consumption electricity:	? [kWh/(m²a)]
Annual energy consumption other:	? [kWh/(m²a)]

Available energy costs before renovation

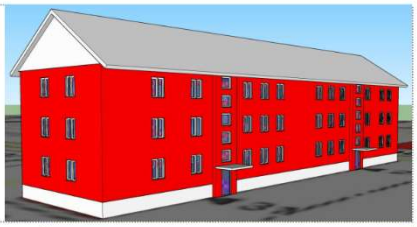
Annual energy costs gas:	? [€/(m²a)]
Annual energy costs electricity:	? [kWh/(m²a)]

CS36_MULTI FAMILY HOUSE, GERMANY

Renovation Approach Description

PHPP verification sheet before retrofit

EnerPHit-Nachweis 10.2 DE



Objekt:	MFH 102 -108		
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
Objekt-Typ:	5-Mehrfamilienhaus I Geschosswohnungsbau		
Klimadatensatz:	ud---01-Nürenberg PHI, höhenkorrigiert		
Klimazone:	3: Kühl-gemäßigt	Standorthöhe:	291 m
Bauherrschaft:			
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
Architektur:			
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
Haustechnik:			
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
Energieberatung:			
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
Zertifizierung:	Passivhaus Institut GmbH		
Straße:	Rheinstraße 44/46		
PLZ/Ort:	64283	Darmstadt	
Provinz/Land:		DE-Deutschland	

Baujahr:	1955	Innentemperatur Winter [°C]:	20.0	Innentemp. Sommer [°C]:	25.0
Anzahl WE:	16	Interne Wärmequellen (IWQ) Winter [W/m²]:	2.8	IWQ Sommer [W/m²]:	2.8
Personenzahl:	28.8	spez. Kapazität [Wh/K pro m² EBF]:	204	Mechanische Kühlung:	

Gebäudekennwerte mit Bezug auf Energiebezugsfläche und Jahr

					Kriterien	alternative Kriterien	Erfüllt?[2]
	Energiebezugsfläche	m²	1090.9				
Heizen	Heizwärmebedarf	kWh/(m²a)	**142.6**	≤	25	-	**nein**
	Heizlast	W/m²	**63**	≤	-	-	
Kühlen	Kühl- + Entfeuchtungsbedarf	kWh/(m²a)	**-**	≤	-		**-**
	Übertemperaturhäufigkeit (> 25 °C)	%	**0**	≤	10		**ja**
	Häufigkeit überhöhter Feuchte (> 12 g/kg)	%	**0**	≤	20		**ja**
Luftdichtheit	Drucktest-Luftwechsel n_{50}	1/h	**3.0**	≤	1.0		**nein**
Feuchteschutz							
	kleinster Temperaturfaktor $f_{Rsi=0.25\ m²K/W}$	-	**-**	≥	0.46	0.33	**-**
Behaglichkeit	Alle Anforderungen erfüllt?	-					**nein**
	U-Wert	W/(m²K)		≤	0.84		
	U-Wert	W/(m²K)		≤	1.01		
	U-Wert	W/(m²K)		≤	1.10		
	U-Wert	W/(m²K)		≤	0.46		
Nicht erneuerbare Primärenergie (PE)	PE-Bedarf	kWh/(m²a)	**226**	≤	248		**ja**
Erneuerbare Primärenergie (PER)	PER-Bedarf	kWh/(m²a)	**311**	≤	-	-	**-**
	Erzeugung erneuerb. Energie (Bezug auf überbaute Fläche)	kWh/(m²a)	**0**	≥	-	-	

Ich bestätige, dass die angegebenen Werte nach dem Verfahren PHPP auf Basis der Kennwerte des Gebäudes ermittelt wurden. Die Berechnungen mit dem PHPP liegen diesem Nachweis bei.

EnerPHit (Energiebedarfsverfahren) Classic? **nein**

Funktion	Vorname	Nachname	Unterschrift
	darnautu		

Zertifikats-ID	Ausgestellt am	Ort

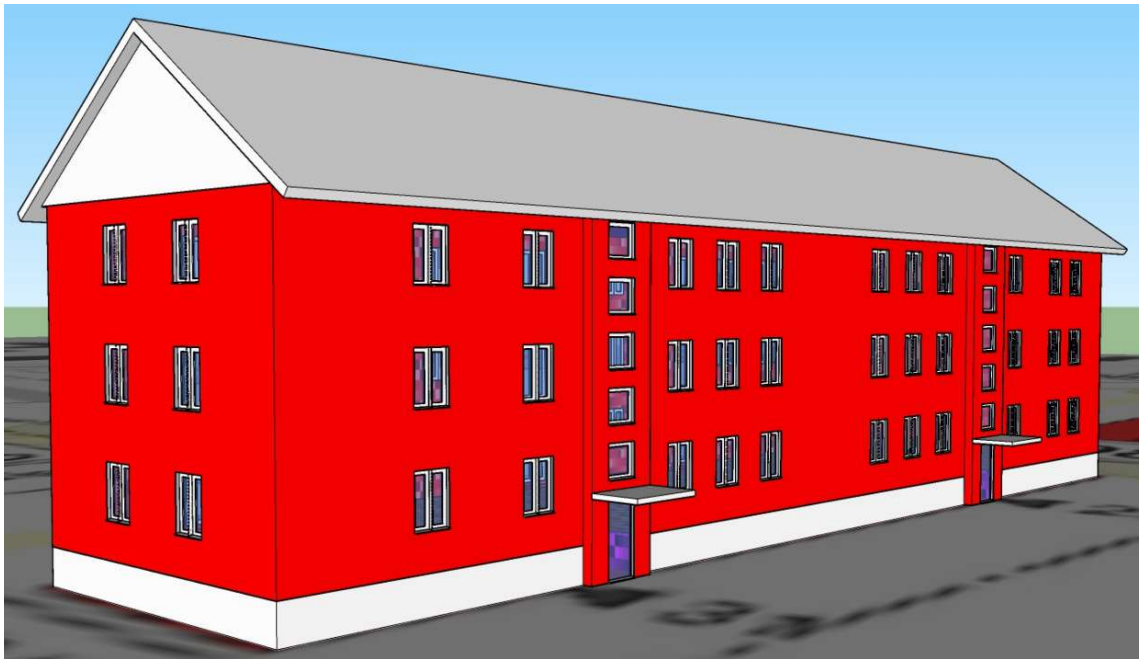
3. Renovation approach description

The building will be equipped with a prefabricated facade of wood with cellulose fibre insulation. The windows are already installed to the elements in the factory. Some work will be carried out by a craftsman's company on site. This includes the connection of new windows to the existing reveal, the doubling of the existing ETICS in the area of the balconies as well as the replacement of the balcony doors, the insulation in the area of the basement as well as the insulation of the basement ceiling from below.

The buildings are scheduled to be added an extra floor with living space on top within the next two years. Therefore, the attic is not currently being upgraded.

The prefabricated facade elements are attached to the building within two days of delivery. Between the facade elements are located so-called backpackers. These are attached to the outside of the facade in the area of the bathrooms and contain a heat transfer station and a ventilation system with heat recovery for each residential unit.

Heating and hot water are supplied by a central heating system that serves eight residential buildings in the quarter. The heat is generated by heat pumps, which in turn draw heat from the ground via energy piles. The heat is transported to the residential units via a newly installed local district heating network.



3D Modell, Source: PHI

Source: Passive House Instituite. Facade elements with ventilated facade made of wood lath. The black strips are the backpackers with the building services components: The heat transfer station from district heating grid and the ventilation system

CS36_MULTI FAMILY HOUSE, GERMANY

Renovation Approach Description

3.1. EnerPHit standard approach

EnerPHit standard target (class):	classic
Climate Zone	
EnerPHit verification method:	energy demand process

3.2. Design / Consultancy teams

Name:	PHI
City:	Darmstadt
Type (private / housing association)	private

3.3. Design / Construction periods

Design period:	01.2022 – 01.2023
Construction period:	05.2022 – 01.2023

3.4. Plans and pictures of the renovation

Not available yet

3.5. Envelope of the renovated building

External walls

Material:	Wood
Thickness:	70 [cm]
Surface (Render / Brick / Cladding):	Wood
U-Value:	0,125 [W/(m²K)]

Floor slab / Basement ceiling

Material:	EPS
Thickness:	8 [cm]
Surface (Render / Brick / Cladding):	EPS
U-Value:	0,18 [W/(m²K)]

Windows

Material:	PVC
Thickness:	8 [cm]
Material (Wood / Plastic / Aluminium):	Plastic
U-Value (Uw, installed):	0,85 [W/(m²K)]

3.6. Technical equipment of the renovated building

Ventilation

Ventilation concept (central / decentral)	decentral
Ventilation heat recovery efficiency	80 %
Ventilation specific efficiency	0,45 [Wh/m³]
Ventilation standard air flow rate	120 [m³/h]

Heating, Cooling and DHW

Heating:	District heating with central Heat Pumps and ground probes
Cooling:	Roller shutters at all windows, no active cooling
Domestic hot water:	District heating with central Heat Pumps and ground probes

3.7. Summer comfort

The climate is moderate in summer, therefore active cooling is not required. The windows of living rooms in the prefabricated facade receive a roller shutter. The balcony doors are set back in the facade and are shaded by the balconies above them in each case. Thats's why, a roller shutter was omitted here.

3.8. Energy efficiency of the renovated building

Passive House Planning Package (PHPP)

PHPP calculation:	PHPP_10.2
Space heating demand:	25 [kWh/(m²a)]
Heating Load:	16 [W/m²]
Overheating frequency:	0 %
Cooling demand:	0 [kWh/(m²a)]
Cooling Load:	0 [W/m²]
Primary Energy Demand:	58 [kWh/(m²a)]
PER Demand:	67 [kWh/(m²a)]
Airtightness n_{50} target:	1,0 1/h

Final Energy demand

Final energy demand gas:	30,5 [kWh/(m²a)]
Final energy demand electricity:	28 [kWh/(m²a)] (household electricity)

CS36_MULTI FAMILY HOUSE, GERMANY

Renovation Approach Description

PHPP verification sheet after retrofit

EnerPHit-Nachweis

10.2 DE



Objekt:	MFH 102 -108		
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PLZ/Ort:			
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Klimadatensatz:	ud---01-Nürenberg PHI, höhenkorrigiert		
Klimazone:	3: Kühl-gemäßigt	Standorthöhe:	291 m
Bauherrschaft:			
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
Architektur:			
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
Haustechnik:			
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
Energieberatung:			
Straße:			
PLZ/Ort:			
Provinz/Land:		DE-Deutschland	
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Baujahr:	1955	Innentemperatur Winter [°C]:	20.0	Innentemp. Sommer [°C]:	25.0
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Personenzahl:	28.8	spez. Kapazität [Wh/K pro m² EBF]:	204	Mechanische Kühlung:	

Gebäudekennwerte mit Bezug auf Energiebezugsfläche und Jahr

					Kriterien	alternative Kriterien	Erfüllt?²
	Energiebezugsfläche	m²	1090.9				
Heizen	Heizwärmebedarf	kWh/(m²a)	25	≤	25	-	ja
	Heizlast	W/m²	16	≤	-	-	
Kühlen	Kühl- + Entfeuchtungsbedarf	kWh/(m²a)	-	≤	-		-
	Übertemperaturhäufigkeit (> 25 °C)	%	0	≤	10		ja
	Häufigkeit überhöhter Feuchte (> 12 g/kg)	%	0	≤	20		ja
Luftdichtheit	Drucktest-Luftwechsel n_{50}	1/h	1.0	≤	1.0		ja
Feuchteschutz							
	kleinster Temperaturfaktor $f_{Rsi=0.25\ m^2K/W}$	-	-	≥	0.46	0.33	-
Behaglichkeit	Alle Anforderungen erfüllt?	-					nein
	U-Wert	W/(m²K)		≤	0.84		
	U-Wert	W/(m²K)		≤	1.01		
	U-Wert	W/(m²K)		≤	1.10		
	U-Wert	W/(m²K)		≤	0.46		
Nicht erneuerbare Primärenergie (PE)	PE-Bedarf	kWh/(m²a)	58	≤	107		ja
Erneuerbare Primärenergie (PER)	PER-Bedarf	kWh/(m²a)	67	≤	-	-	-
	Erzeugung erneuerb. Energie (Bezug auf überbaute Fläche)	kWh/(m²a)	0	≥	-	-	

Ich bestätige, dass die angegebenen Werte nach dem Verfahren PHPP auf Basis der Kennwerte des Gebäudes ermittelt wurden. Die Berechnungen mit dem PHPP liegen diesem Nachweis bei.

EnerPHit (Energiebedarfsverfahren) Classic? ja

Funktion	Vorname	Nachname	Unterschrift
	darnautu		

Zertifikats-ID	Ausgestellt am	Ort

3.9. Predicted energy savings

Savings In space heating demand:	125 [kWh/(m²a)]
Savings Primary Energy Demand:	168 [kWh/(m²a)]
Savings PER Demand:	243 [kWh/(m²a)]
Savings of Final energy demand gas:	120 [kWh/(m²a)]
Savings of Final energy demand electricity:	10 [kWh/(m²a)] if household appliances will be updated

3.10. RES strategy

The buildings will receive solar PV elements on the rooftop after finalization. The detailed energy delivery is not yet clear as the form and the useful roof-area are not yet designed.

4. Project challenges and opportunities

An important goal is to ensure the least possible impact on tenants during the construction period. Intervention in the residential units should therefore be kept to a minimum. The construction processes must settle in with the first property. A challenge is therefore the high time pressure for the implementation and the work in the individual apartments: Removal of the old windows and sealing of the new windows to the existing reveal including reveal cladding is a crucial task. As far as the building services are concerned, the new prefabricated bathrooms have to be installed and the ducts of the ventilation system have to be laid and connected.

The digital geometric measurement of the building and the precisely fitting prefabrication of the elements worked very well. There were only very few touch-ups on site.

The air-tightness concept still has to be proved. Testing the element joints and the interfaces between the curtain wall and the ETICS is a major challenge, as it will not be possible to find leaks in the curtain wall elements.

5. Current project status

Currently, the curtain wall is in place on two of the eight buildings. The old windows are currently (October 2022) being removed and the new windows in the façade elements are being airtightly connected to the old reveal with suitable foils and bonding. A preliminary airtightness test has been performed and the result is good after minor touch-ups. Basement wall insulation and basement ceiling insulation have been carried out.

6. Lessons learnt and guidelines for replication

Very important for the successful process is the planning phase before the elements are produced in the factory. High time pressure leads to adjustments of details in the ongoing refurbishment process and increases the susceptibility to errors. By repeating the same steps several times and always using comparable details, the construction team can quickly practice and learn good implementations. Quality assurance during the design process (optimization of thermal bridge effects and air tightness concept) is very helpful. During the construction of the first buildings, appropriate supervision is absolutely necessary so that routine can be practiced by the team during execution.

7. Pre-Monitoring description (if applicable)

Pre-Monitoring in some buildings before renovation will be organized during the next winter 2022/2023