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Futur*Hist*

Energy Retrofits in Historic and Traditional Buildings

Group 1



Futur*Hist*

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Location: 22 Kraszewskiego Street, Kraków, Poland.

Typology 4 - Willa miejska / Polish garden city/urban villa (1900 - 1945)

Kraszewskiego 22

Residential urban villa · 1923 · Group 1

Municipal register of monuments



1923

YEAR BUILT

8

INHABITANTS

5 · 4

RESID · COMM

3+A

FLOORS + ATTIC

● FLOOR AREAS (m²)

298.36

FOOTPRINT

359.34

TOTAL USABLE

~302

ROOF (HORIZ.)

Residential 294.46 m² (82%)

Garages & commercial 64.88 m² (18%)

● SYSTEMS & CONSTRUCTION

USAGE

Residential

HEATING

Central — municipal district-heating network

VENTILATION

Gravity

ROOF

Multi-pitched timber, profiled sheet metal

DOMESTIC HOT WATER

Individual — electric / gas

INSTALLATIONS

Water & sewage · electrical · gas

Simplified floor areas per municipal dossier - Kraszewskiego 22, Kraków — FuturHist retrofit assessment

Occupants generally happy in the house. Heating lacking in the back room.

Heritage Impact Assessment

Capabilities and limitations

An interwar urban villa in a NeoClassical style with Art Deco decorative elements.

The property is listed as a complex comprising the villa, with its original proportions preserved, together with the fence and garden.



Ornamental
frieze

decorative
columns

High plinth
mineral/lime
plaster

rectangular
windows
doors

pilasters
horizontal
divisions

representative
staircase



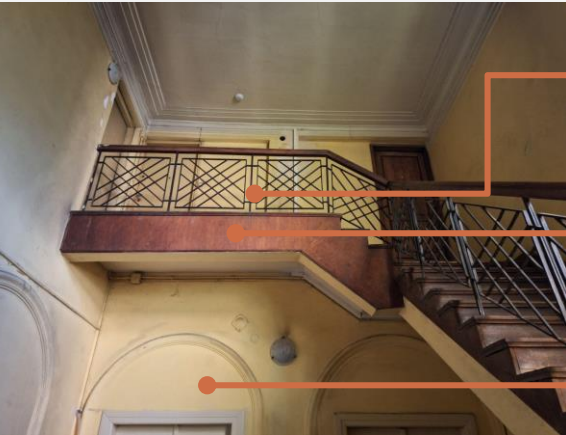
Front elevation



Garden elevation

Heritage Impact Assessment

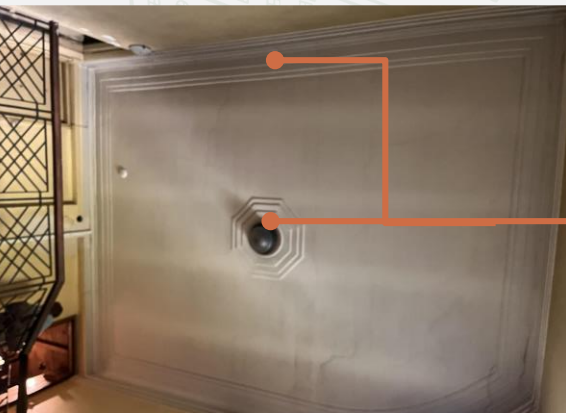
Staircase



Original
decorative
metalwork

Timber stair
cladding

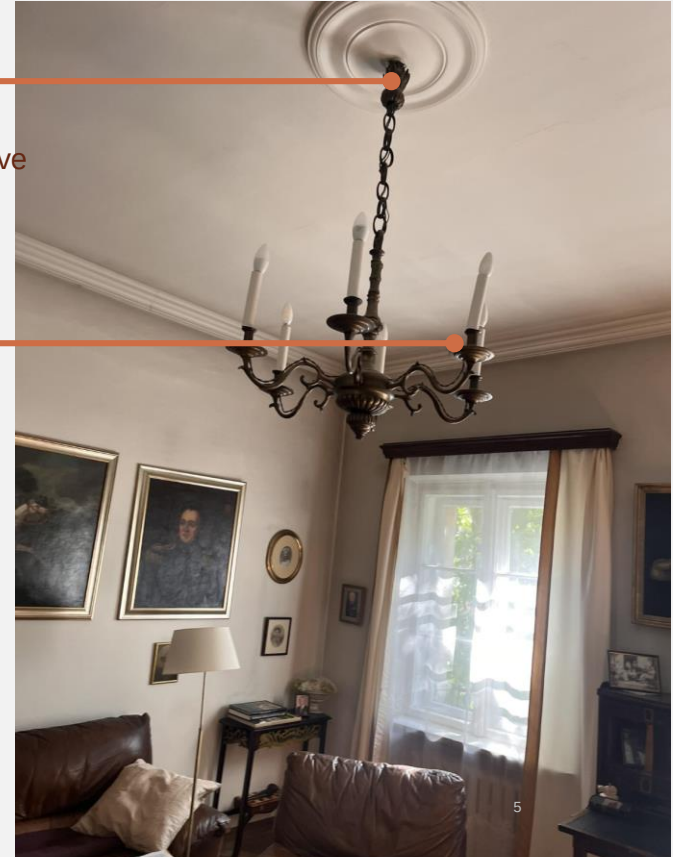
Wall plaster
decorative
finishes



ceiling
decorative
cornices

Interior of the apartment

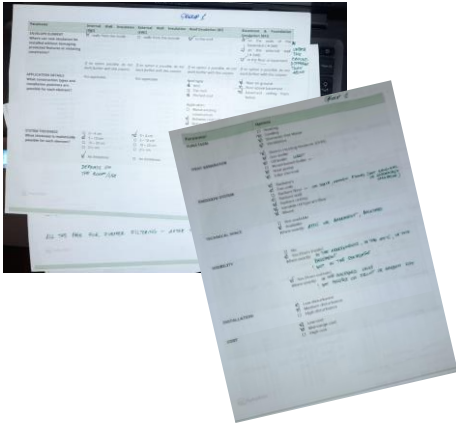
Later on decorative
additions
no historic
significance



Selecting the retrofit solutions

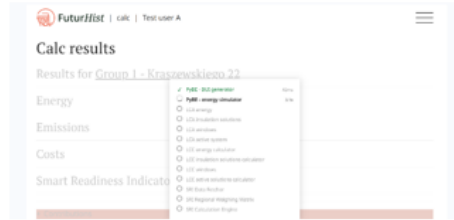
The decision process - from site analysis, through the FuturHist calc toolkit, to the chosen measures.

1 FILTER



Screen candidate measures from the site analysis - which to choose?

2 ANALYSE



Energy · Emissions (LCA) · Costs (LCC) · SRI

Run each analysis per solution in the FuturHist calc toolkit.

3 SELECT

SELECTED SOLUTIONS

- 1 Façade - EWI insulating plaster
- 2 Interior wall - mineral-wool board
- 3 Windows - internal vacuum glazing
- 4 Roof - cold roof + loft insulation
- 5 Basement - ceiling insulation
- 6 Active - photovoltaic panels

Five elements addressed; the wall carries two candidate options.

"Roof Insulation - Cold Roof"

Attic area: 215.00 m²

Describe:

The solution is acceptable according to the Conservation Office's guidelines. Any alterations to the roof that would change its external appearance are not permitted, and the chosen solution would not raise the level of the roof and would not affect the roof drainage system and proportions of the roof facades, and the change wouldn't be actually visible from the street level. Insulation will be applied between rafters and above it with supporting elements and a plasterboard finish.

Another solution is considered – to place the insulation on top of the attic floor, closing off the heated space of the flats and communication areas from the unheated attic.

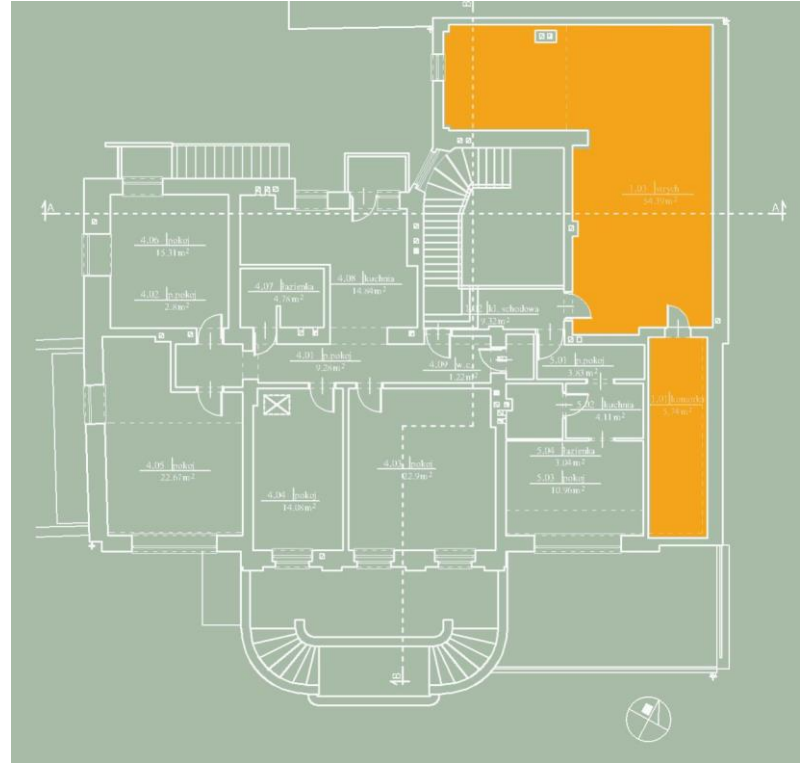
U-value before the intervention	U-value after the intervention
5.5 W/m ² K	0.14 W/m ² K



"Roof Insulation - Cold Roof"



Roof Plan – Shows Pitched Roof
Insulation



First Floor Plan – Shows Insulation in
Attic

"External Wall Insulation (EWI) - Insulating Plaster"

Passive solution: External insulation facade

Describe the solution:

Thermal insulating plaster (TIP). It can improve both thermal and acoustic properties of the building.

- **Breathable**
- **Traditionally looking**
- **Eliminate thermal bridging and thermal leaks** if applied in a continuous coat
- **Resistant to moisture** (depending on composition)
- **Much healthier** option than many other alternatives



"External Wall Insulation (EWI) - Insulating Plaster"

Impact on heritage vulnerabilities

Improving the appearance and performance of the wall, securing it from water ingress by removing existing damage.

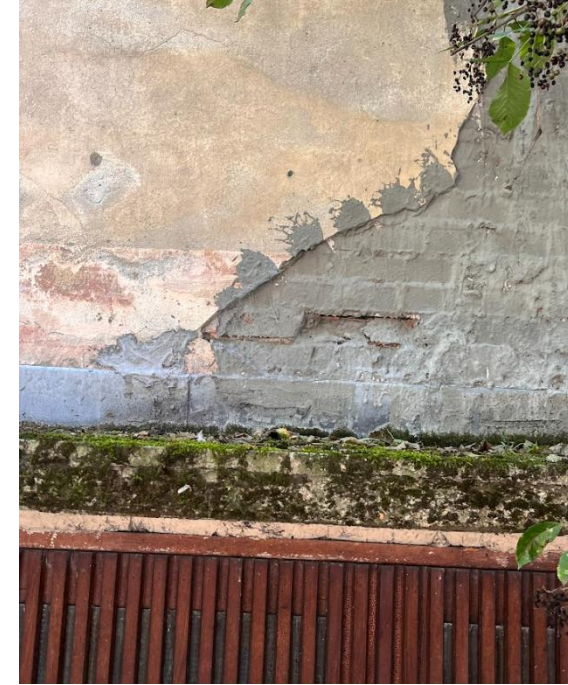
Replacing the existing layer with a new one (TIP) with better parameters but the same appearance will have no visual or spatial impact.

If the change of the material is acceptable to the Conservation Office (keeping the original material, the original kind of render might be required), there will be no impact on the heritage value, as all the decoration and proportion will be intact.

Low visual impact, as the decorations and details are kept intact.



Lower part of front facade: Remove cement render, repair historic lime plaster, and restore missing decorative elements.



Existing condition of the external wall, backyard elevation

"External Wall Insulation (EWI) - Insulating Plaster"



SOUTH ELEVATION



EAST ELEVATION

"Internal Wall Insulation (IWI) - Mineral Wool Board"

Passive solution: Interior insulation

As a listed building, the external insulation is not possible.

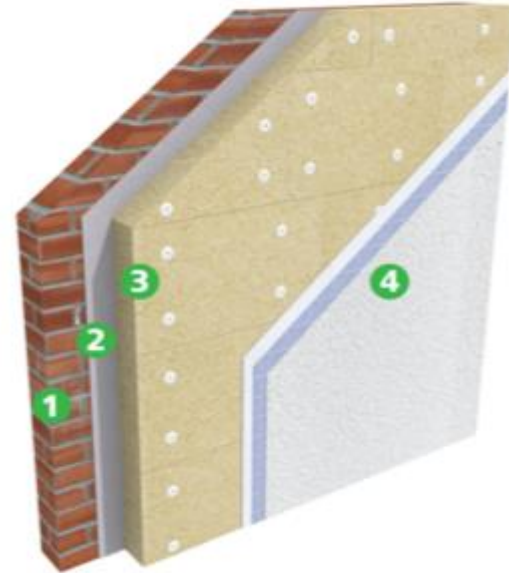
The solution raises the energy performance of the wall and the thermal comfort of the inhabitants but may cause moisture condensation risks.

The installation itself causes losing some floor space and disruption, as all the furniture, sockets and fixtures on the external walls need to be moved or reinstalled.

The height of the rooms is more than the minimum required.

The solution is 8 cm boards of mineral wool.

U-value before the intervention	U-value after the intervention
1.20 W/m ² K	0.32 W/m ² K



<https://www.steico.com/uk/solutions/wood-fibre-insulation/wall-insulation/internal-wall-insulation>

"Internal Wall Insulation (IWI) - Mineral Wool Board"

Conclusion

Is the solution acceptable or not? Under which circumstances? Do you need more information? What warnings would you give your client?

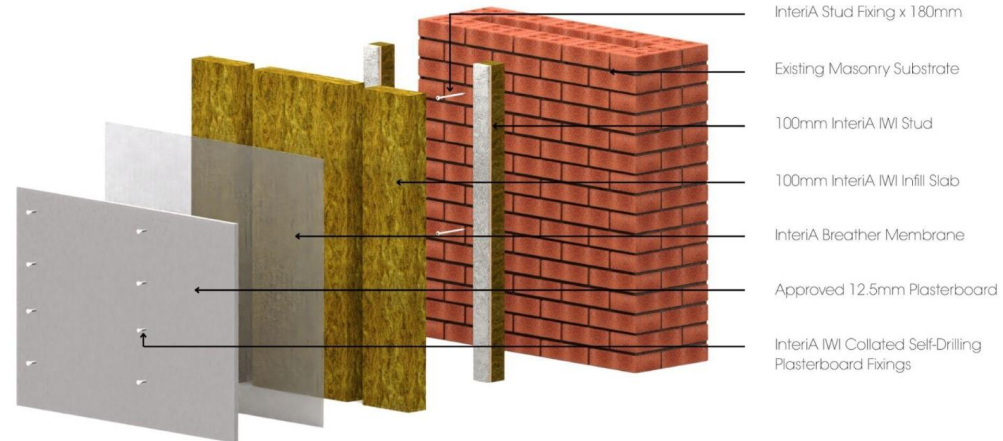
The solution needs to be accepted by the client and the tenants.

The solution needs to be carefully calculated and carried out to avoid moisture condensation in the barrier or between the layers. Moisture levels should be monitored after the installation.

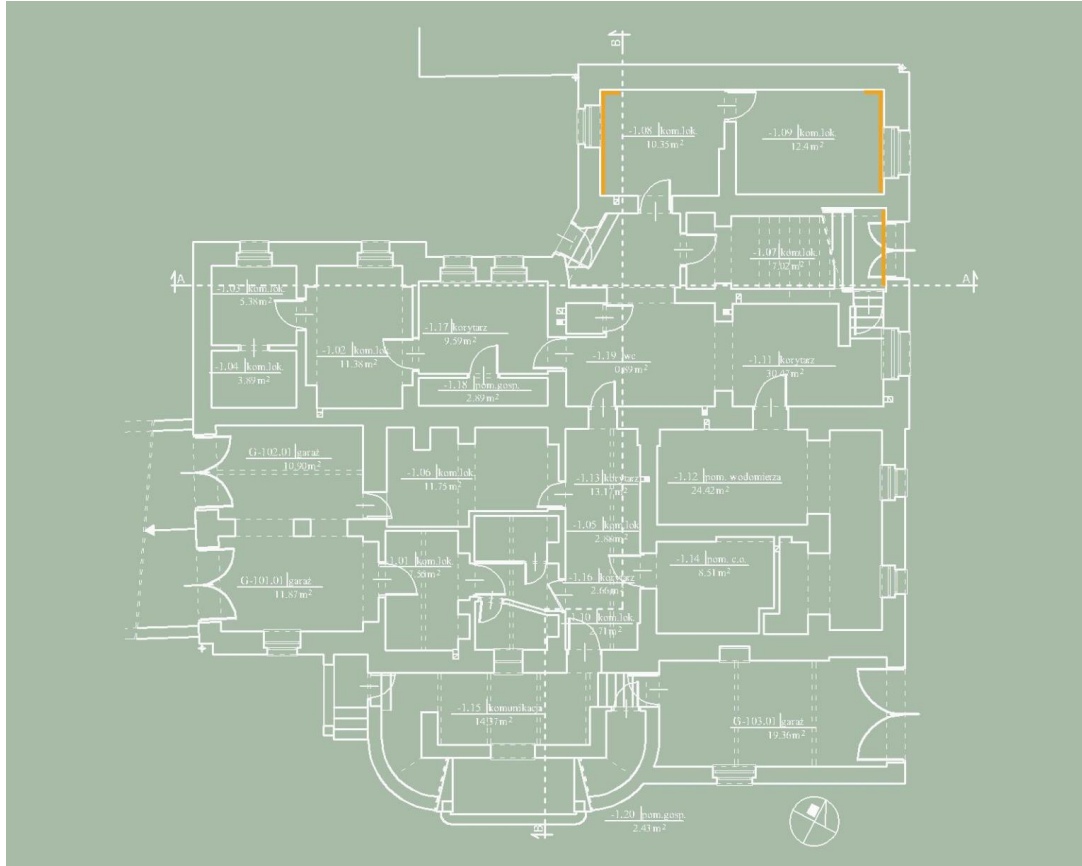
The change of the temperature on the external surface of the wall should be monitored as well to assess if the works influence the decorative details on the facades.



<https://www.insulation-info.co.uk/insulation-material/rock-wool>

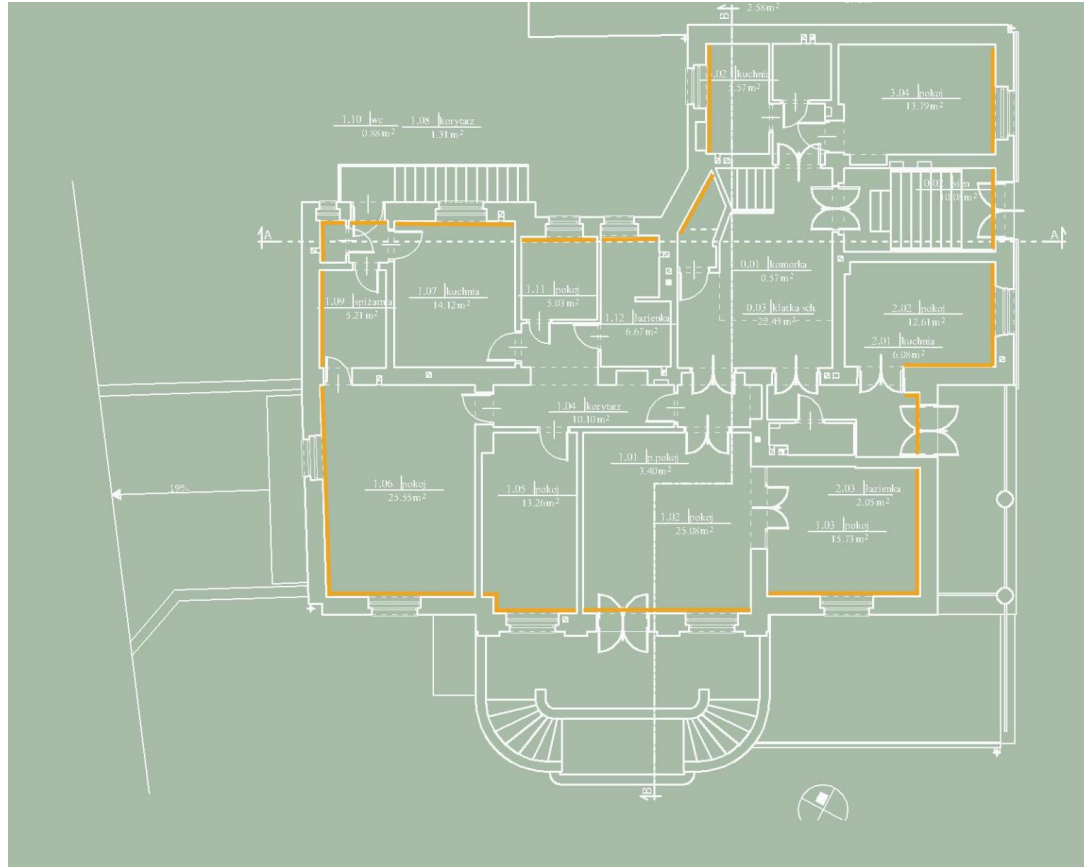


"Internal Wall Insulation (IWI) - Mineral Wool Board"



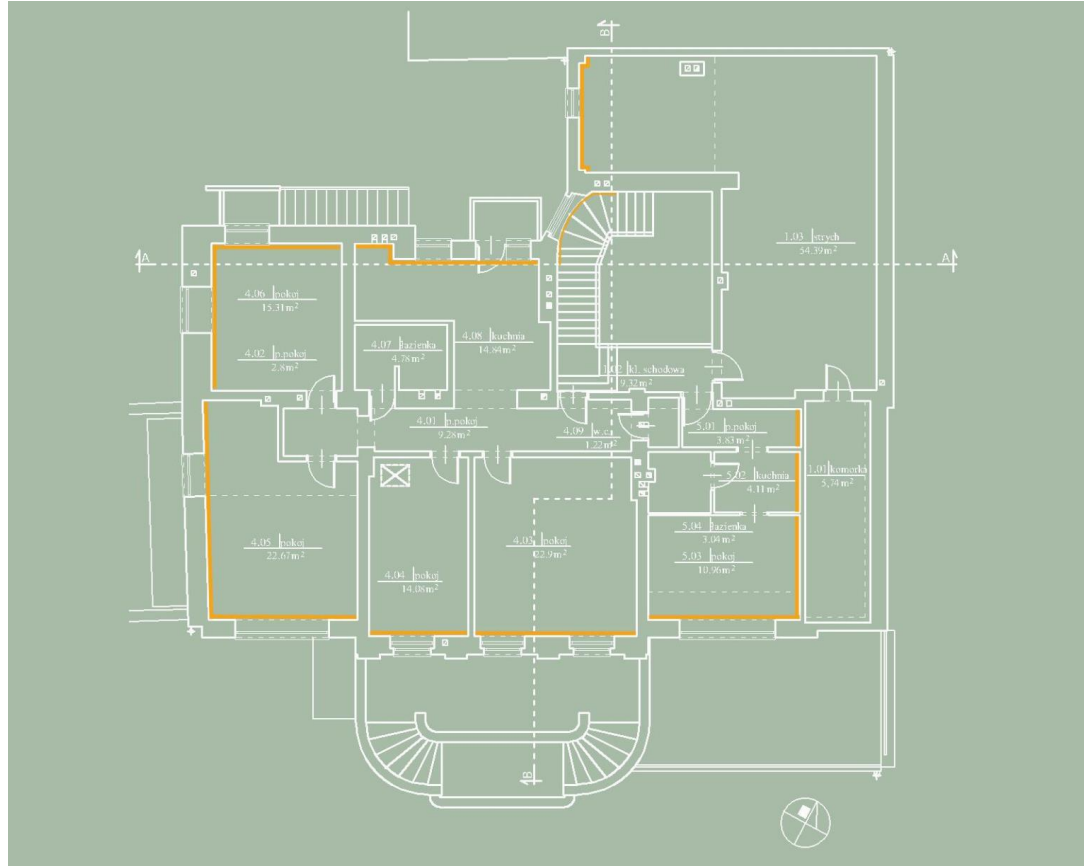
Basement Floor Plan

"Internal Wall Insulation (IWI) - Mineral Wool Board"



Ground Floor Plan

"Internal Wall Insulation (IWI) - Mineral Wool Board"



First Floor Plan

“Basement ceiling insulation”

Description of the solution

150 mm insulation boards fixed to the underside of the existing reinforced-concrete floor slab.

Material: mineral wool / wood fiber / calcium-silicate boards with the similar U-value parameter.

The surface can then be brush-painted using a highly vapour-permeable paint.

U-value before the intervention	U-value after the intervention
0.35 W/m ² K	0.14 W/m ² K



“Basement ceiling insulation”



AA SECTION

"Window repair and glazing replacement"

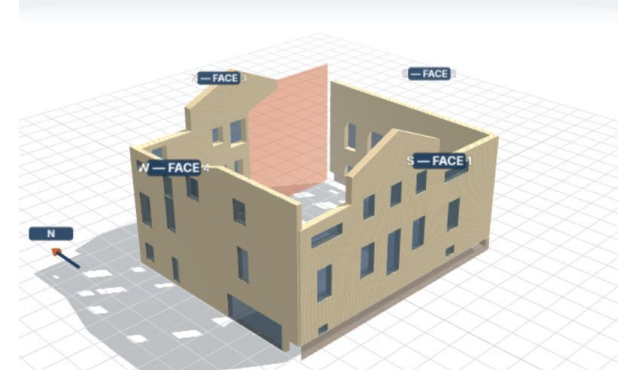
Existing situation and restraints

42 external openings were identified across the four facades and three-storey levels.

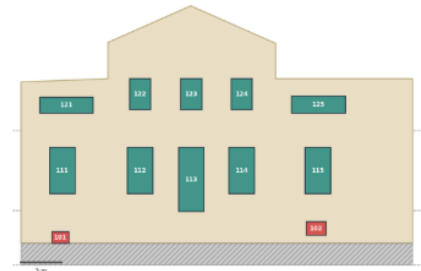
Three assembly types occur.

- **Single window – single** sash timber casement with historic single glazing. 4 cm thickness of the timber frame and 3 mm of single glazing.
- **Double box** (the majority) is two identical single-glazed timber sashes separated by a 6–8 cm air cavity. 4 cm thickness of the timber frame and 3 mm of single glazing.
- **Opaque openings** are in average solid 45 mm timber panels.
- **Some modern additions**

Restraints on the Windows. Original windows may only be replaced if they are in poor condition; if repairable, they must be conservatively restored and cannot be replaced (exterior **only**?).



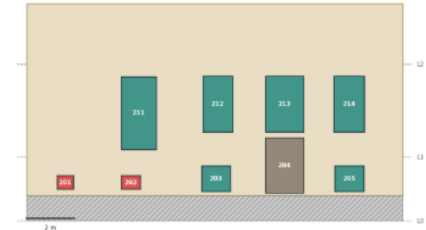
FACE 1 – SOUTH



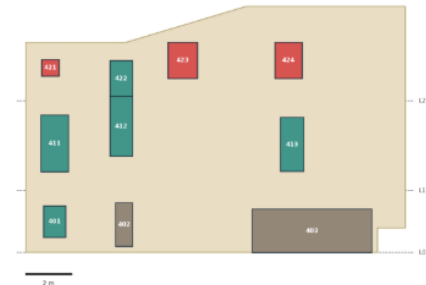
FACE 3 – NORTH



FACE 2 – EAST



FACE 4 – WEST



"Window repair and glazing replacement"

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"Window repair and glazing replacement"

Solution and impact

The **box-window** offers a retrofit lever a single sash cannot: the outer sash is the historic, street-facing element, while the inner sash is accessible and less visible.

- **Re-glazing the inner sash alone with a 6 mm vacuum glazing unit** – leaving the outer historic sash untouched – preserves the external appearance entirely and respects the profile-thickness restriction that would otherwise rule out heavier glazing.
- **Repair timber frames**
- **Additionally, we propose to change the glazing in the staircase window to complete the coloured/tinted glass frame, as on the window above the main entrance.**

The solution needs to be accepted by the Conservation Office and carried out by experienced craftsmen.

- **Low to no MATERIAL, VISUAL AND SPATIAL change.**

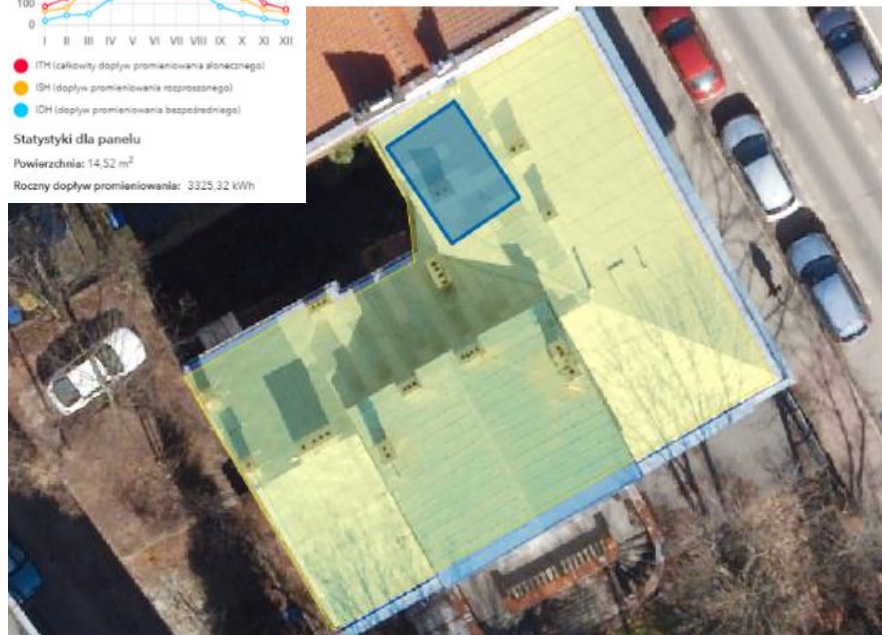
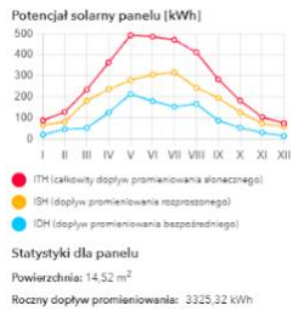


"Photovoltaic Panels - PV"

Active solution

In our case building, it is prohibited to change the external facades, roof shape or proportions of the volume, so no panels can be added at the east or south-east roofs, as they are the front and garden-facing sides and may be visible from the street level. The internal part (backyard side) of the south-west-facing roof can be proposed for PV panel location. The panels must match the colour of the roof. According to Kraków's Information System Solar Potential Map, some energy can be acquired – installation to be scaled according to the demand.

Wykonaj analizę dla panelu



"Photovoltaic Panels - PV"

Conclusion

Describe:

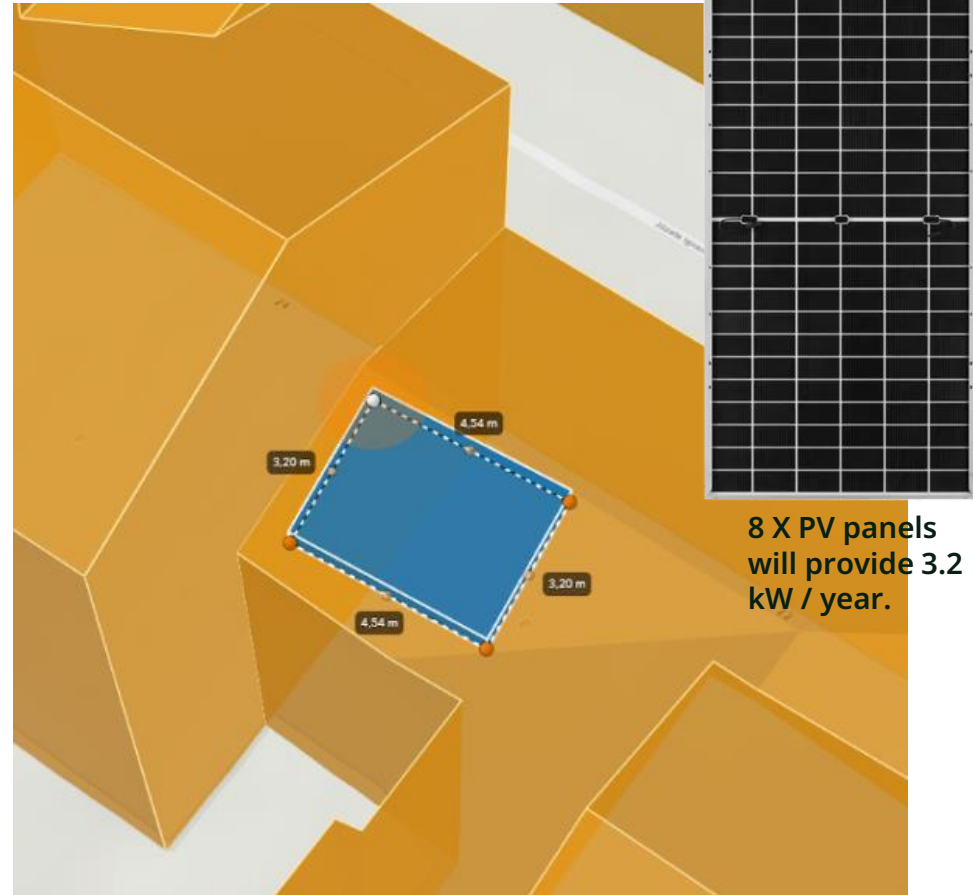
Is the solution acceptable or not? Under which circumstances? Do you need more information? What warnings would you give your client?

Installation of the solar panels is possible, but it needs to be accepted by the Conservation Office.

First of all, it needs to be consulted with the client (municipal building management) and other parts of the design to determine whether there is a demand for energy justifying the investment.

If additional energy-consuming systems are installed, an additional energy source could be the right choice.

If not, the roof space could be used to install solar panels for a water heating system or to unify existing individual gas or electric water heaters.



"Hot Water"

Describe:

Add heat pump system to uniformize the existing different not efficient solutions

"Climatization"

Describe:

Improve and repair district heating system



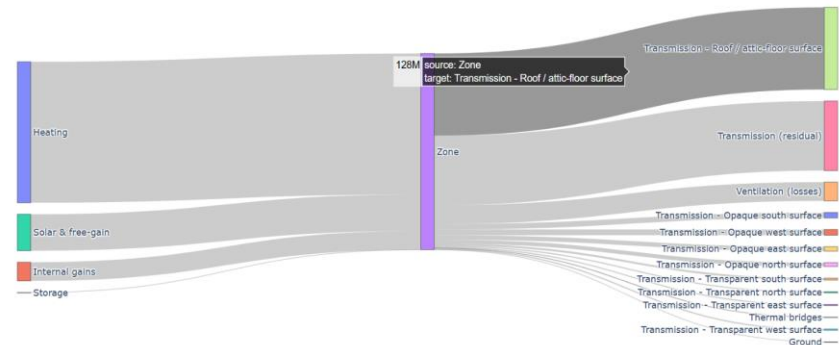
Evaluation of building's energy consumption and efficiency

- *Assessment of the different solution individually*

- *Solution 1 - Walls*
- *Solution 2 - Windows*
- *Solution 3 - Roof/attic*
- *Solution 4 - Basement Ceiling*

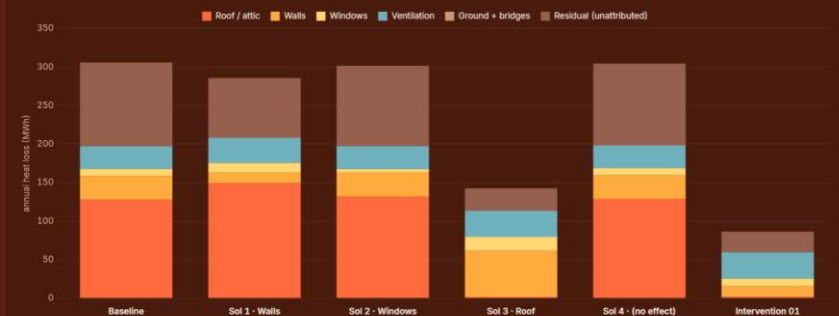
- *Assessment of the global intervention*

Annual energy balance — Sankey



HOW THE ENERGY ESCAPES — SANKEY LOSS PATHS COMPARED

Each bar is one scenario's annual loss balance (MWh) split by pathway. Click a legend key to isolate a path. The **roof/attic** block collapsing is the whole story of Sol3 and the intervention; the recessive **residual** is transmission pybul could not attribute to a named surface (~a third of the baseline — treat surface shares as indicative, not exact).



Baseline

516 kWh/m²
reference

free - floats

Sol 1 - Walls

458 kWh/m²
-11.3%

free - floats

Sol 2 - Windows

507 kWh/m²
-1.6%

free - floats

Sol 3 - Roof

220 kWh/m²
-57.5%

holds 20 °C

Sol 4 - (no effect)

514 kWh/m²
-0.4%

free - floats

Intervention 01

86 kWh/m²
-83.3%

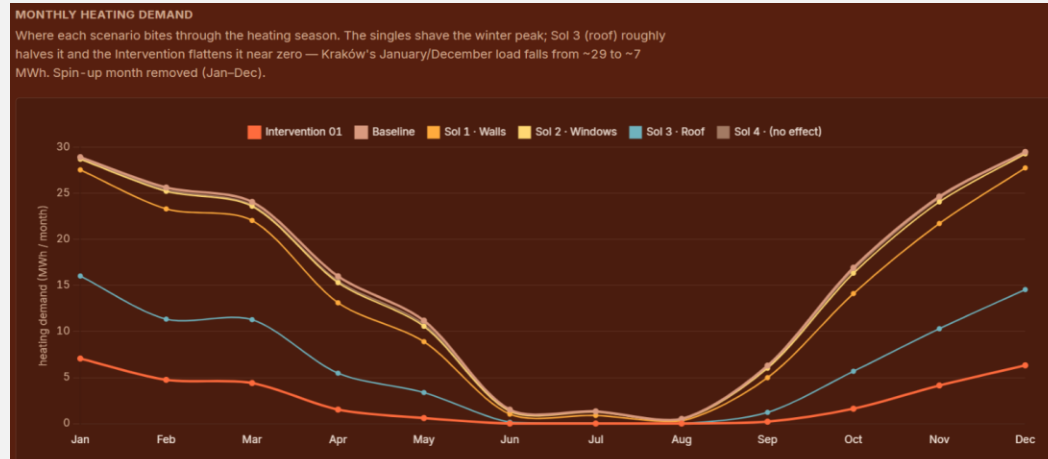
holds 20 °C

Evaluation of building's energy consumption and efficiency

- *Assessment of the different solution individually*

- *Solution 1 - Walls*
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- *Assessment of the global intervention*



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LCA and LCC

- *Assessment of the different solutions individually*

- *Solution 1 - Walls*
- *Solution 2 - Windows*
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- *Solution 4 - Basement Ceiling*

Embodied Carbon

of the retrofit package

Kraszewskiego 22

Group 1

SCOPE

A1-A3 + C3 + C4

Biogenic carbon released at end-of-life (C3) is fully counted — timber is not reported as "carbon-negative".

● ENVELOPE — EMBODIED CARBON

values in kg CO₂e / m²

7.9

Solution 1 - Interior wall insulation

80 mm mineral wool + plasterboard + skim + paint. Finishing layers ≈ 30% of the total.

19

Solution 2 - Windows 6 mm vacuum glazing

FINEO Low-Carbon, per m² of glass. Ug 0.7 vs 5.8 — strongest carbon-per-performance.

41

Solution 3 - Attic-floor insulation

250 mm mineral wool + 19 mm OSB + timber joists. Mineral wool ≈ 69% of the total.

20

Solution 4 - Basement-ceiling insulation

150 mm mineral wool, continuous. Simplest — no thermal bridge, no heritage impact.

Life-Cycle Cost

of the retrofit package

Kraszewskiego 22

Group 1

COST COMPONENTS

Installed = material + labour · €/m²

Maintenance · €/m²·year

Disposal · €/m² (end-of-life)

Undiscounted, per m² of element. Disposal taken as a one-off end-of-life cost (source labelled if €/m²·yr). Windows are the costliest measure — the opposite of their strong carbon-per-performance.

● ENVELOPE - INSTALLED COST

chip = €/m² installed · bar scaled to cost

21

Solution 1 - Interior wall insulation

Material 14.00 · labour 7.45 €/m² · maint. 0.11 €/m²·yr · disposal 5.36 €/m². 50-yr LCC = 32 €/m².

260

Solution 2 - Windows 6 mm vacuum glazing

Material 200 · labour 60 €/m² · maint. 1.30 €/m²·yr · disposal 65 €/m². 50-yr LCC = 390 €/m².

84

Solution 3 - Attic-floor insulation

Material 70.75 · labour 13 €/m² · maint. 0.42 €/m²·yr · disposal 20.94 €/m². 50-yr LCC ≈ 126 €/m².

109

Solution 4 - Basement-ceiling insulation

Material 92.50 · labour 16 €/m² · maint. 0.54 €/m²·yr · disposal 27.13 €/m². 50-yr LCC = 163 €/m².

FuturHist ToolKit - Comparative Analyses

 FuturHist | calc | Test user A

Calc results

Results for Group 1 - Kraszewskiego 22

Energy

--- 1A. ENERGY NEED (Building Envelope) ---
Net Floor Area **630.7** sqm
Baseline Need **133.9** kWh/sqm

Improved Need **69.3** kWh/sqm

Envelope Reduction **48.2** %

--- 1B. ENERGY DEMAND (Active Systems) ---
System CoP **Base: 0.85 | Imp: 0.85**
Baseline Demand **157.6** kWh/sqm

Improved Demand **81.5** kWh/sqm

System Reduction **48.2** %

--- Improved Monthly Heating Demand ---

Jan	(12726) kWh
Feb	(7288) kWh
Mar	(6789) kWh
Apr	(2421) kWh
May	(1550) kWh
Jun	(0) kWh
Jul	(0) kWh
Aug	(0) kWh
Sep	(340) kWh
Oct	(2567) kWh
Nov	(6916) kWh
Dec	(10809) kWh

Emissions

--- 2. LCA RESULTS ---
Baseline Emissions (Energy) **358.8** tons CO2eq

Improved Emissions (Materials+Energy) **2149.0** tons CO2eq

Achieved Reduction **-499.0** %

⚠ Increased Emissions **+1790.2** tons CO2eq

 FuturHist | calc | Test user A

Emissions

--- 2. LCA RESULTS ---

Baseline Emissions (Energy) **358.8** tons CO2eq

Improved Emissions (Materials+Energy) **2149.0** tons CO2eq

Achieved Reduction **-499.0** %

⚠ Increased Emissions **+1790.2** tons CO2eq

Costs

--- 3. LCC RESULTS ---

Baseline Cost (Energy) **236 739** EUR

Improved Cost (Materials+Energy) **181 510** EUR

Achieved Reduction **23.3** %

--- FINANCIAL PAYBACK ---

Total Investment **58 982** EUR

Annual Energy Savings **2 284** EUR/year

Breakeven Time **25.8** years

Smart Readiness Indicator

--- 4. SRI RESULTS ---

SRI Class **G** (Score: 0.0%)

Scale Reference

[A] 90-100%

[B] 80-89%

[C] 65-79%

[D] 50-64%

[E] 35-49%

[F] 20-34%

[G] 0-19% <<<

Replicability

of the retrofit package

Kraszewskiego 22 → Tyniecka 46

3 replicate directly

1 partial / conditional

4 do not transfer

Same typology - yet building-specific facts break most of the envelope measures.

● ENVELOPE

DOESN'T

Roof / attic-floor insulation

Attic already converted to a flat and probably already insulated — no cold unheated attic.

DOESN'T

Basement ceiling insulation

Basement is shallow (<2.20 m) and sits under only part of the footprint.

DOESN'T

Exterior wall — insulating render

Façade is exposed detailed brick; brick must stay visible — no render to replace.

PARTIAL

Interior wall insulation (mineral wool)

Space loss & altered proportions may push rooms below minimum dimensions.

● WINDOWS

REPLICATES

Box windows + 6 mm vacuum glazing

Vacuum glazing named acceptable in the Tyniecka guidelines; same box-window type.

● ACTIVE SYSTEMS

DOESN'T

Rooftop PV / solar

No panels permitted on any roof slope → ground-mounted array instead.

REPLICATES

Heat pump for DHW (per flat)

Supports the existing individual gas system where hot-water demand justifies it.

REPLICATES

Heating upgrade (but for different system - efficient boiler + radiators)

Transfers directly (but for different system) to the gas-heated baseline.



FuturHist

Thank you!



PROJECT
COORDINATOR

eurac
research



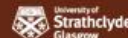
ERIKarkitekter



ICOMOS



natürlich bauen



whiiz



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