An LT-ready and economically feasible renovation façade design

Stamatia Kounaki | 4748751 | P5 presentation

1 FRAMEWORK

2 LITERATURE STUDY

3 CASE STUDY

4 8 MEASURES

5 SIMULATION GRASSHOPPER

6 DESIGN

7 CONCLUSION

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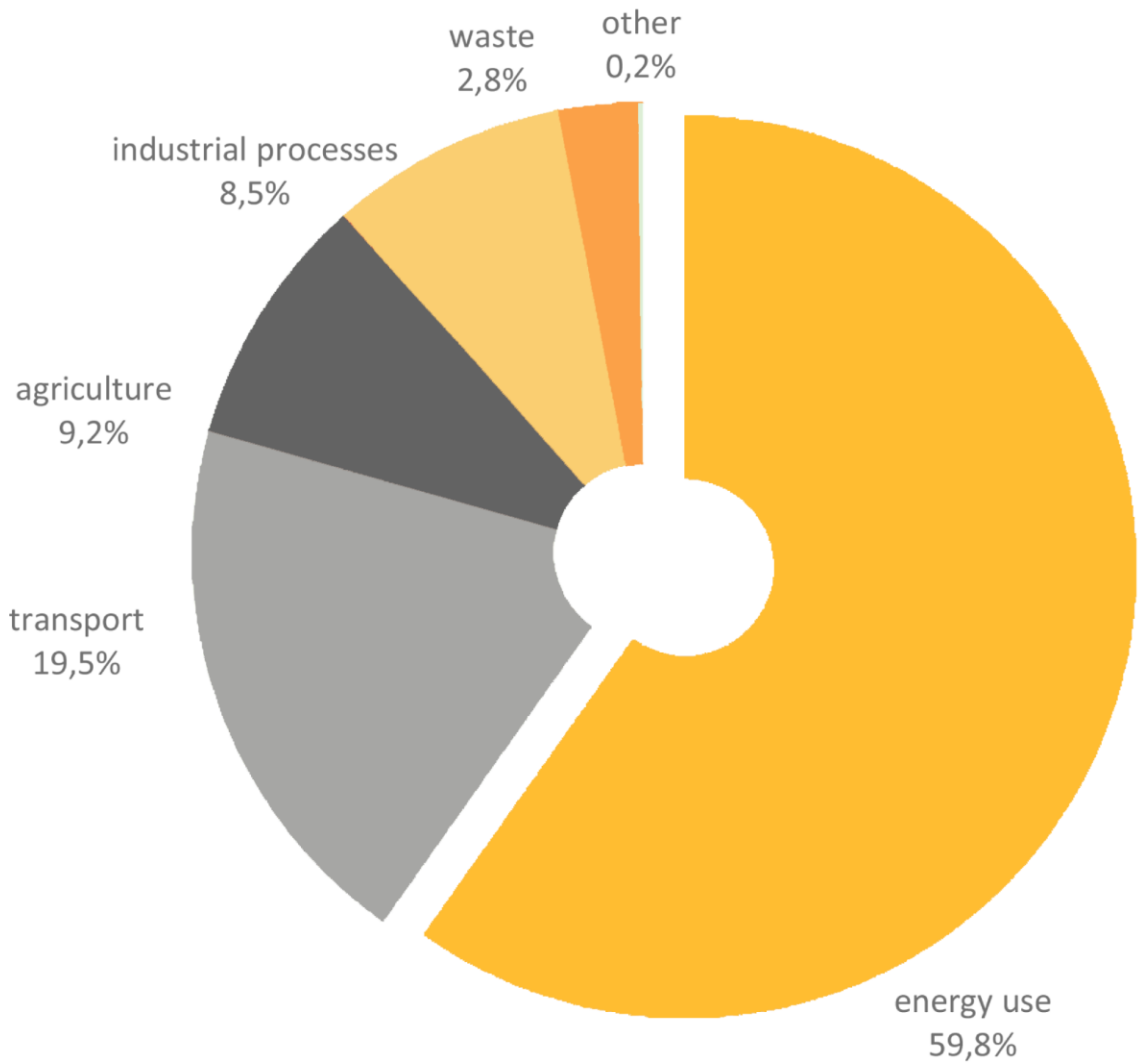
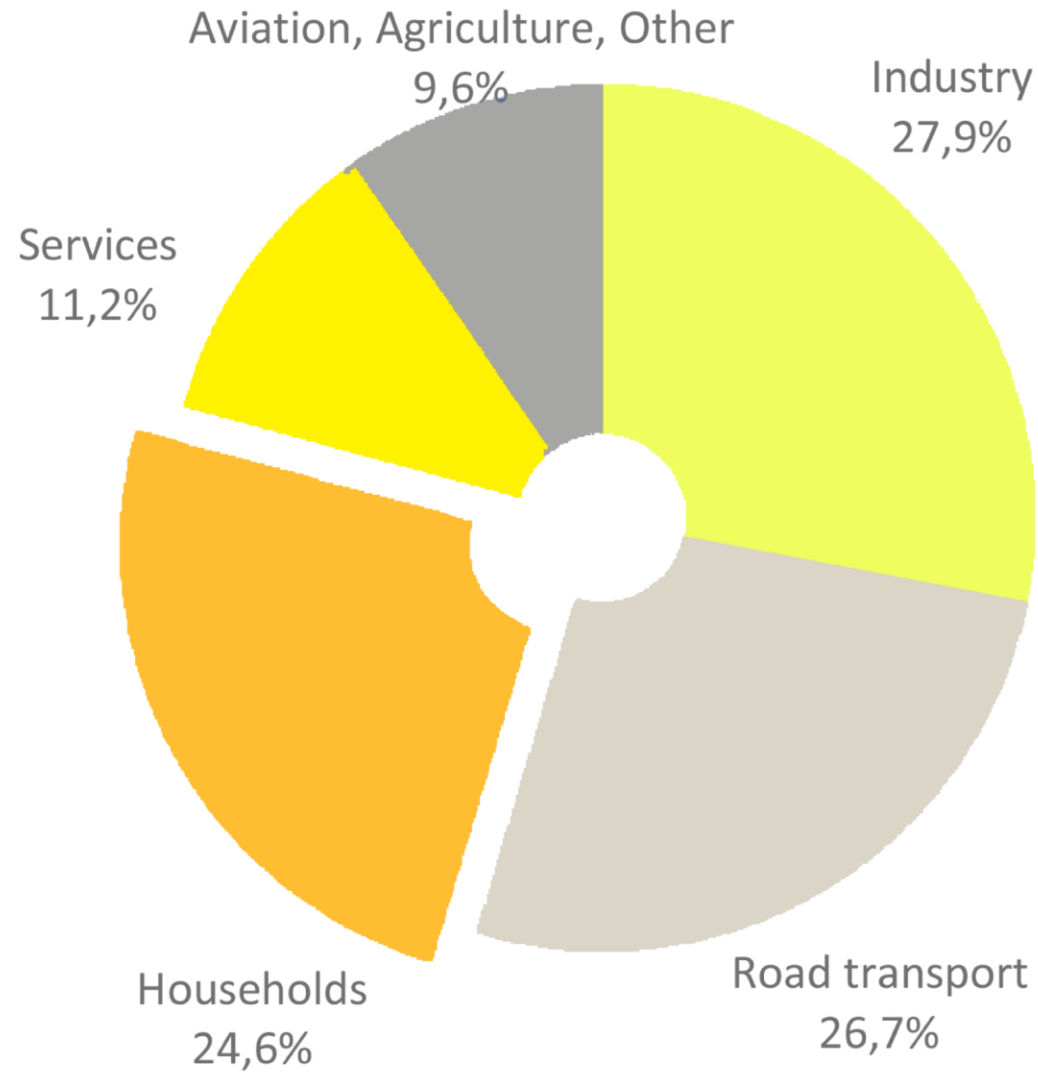
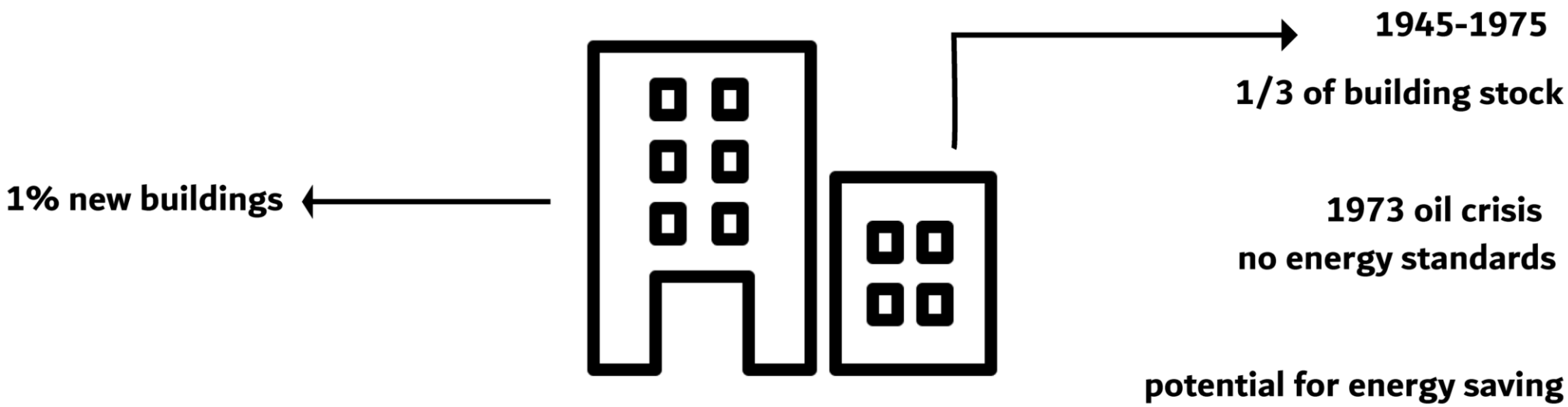
EU GREENHOUSE GAS EMISSIONS



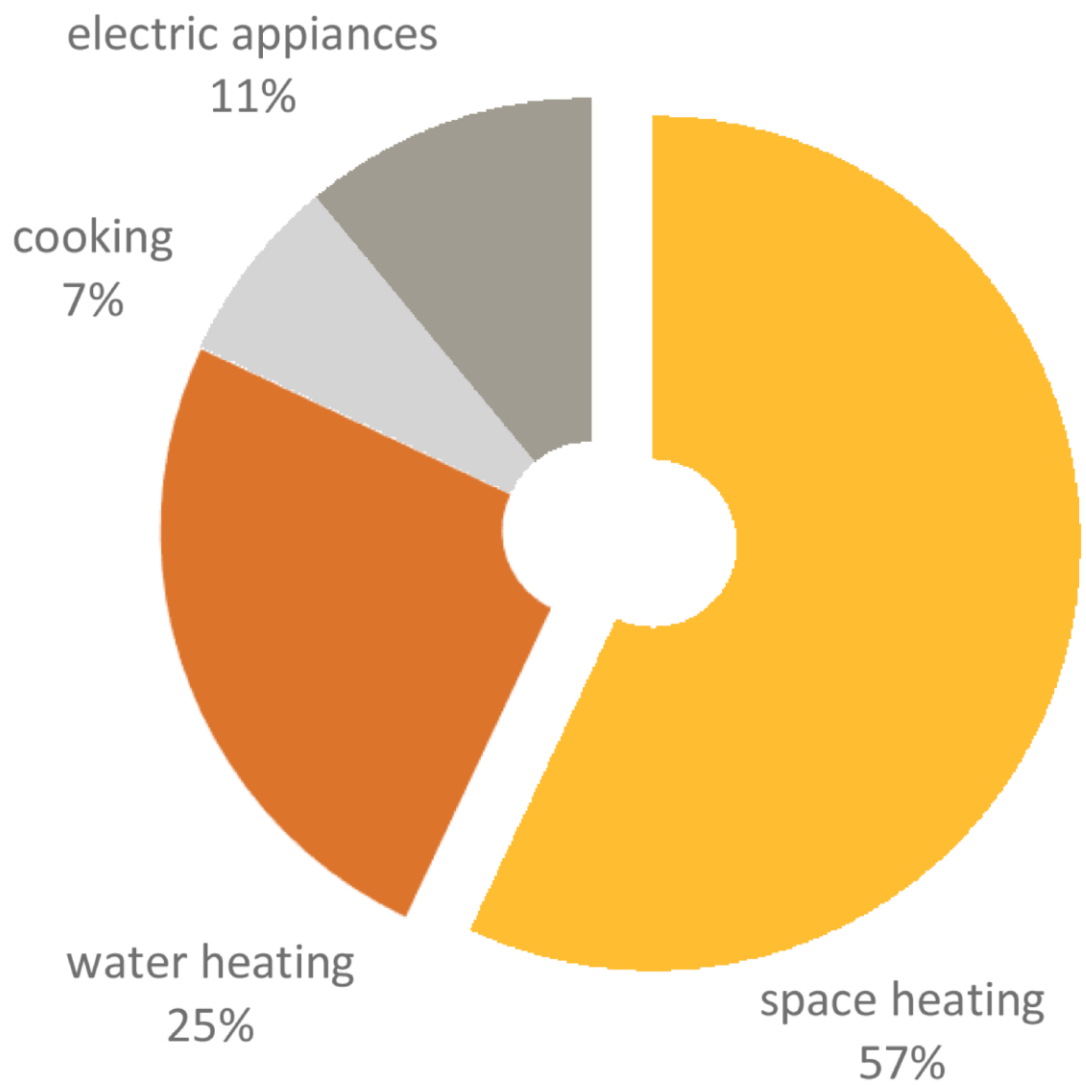
2050 EU - 80 to 95%

EU ENERGY USE

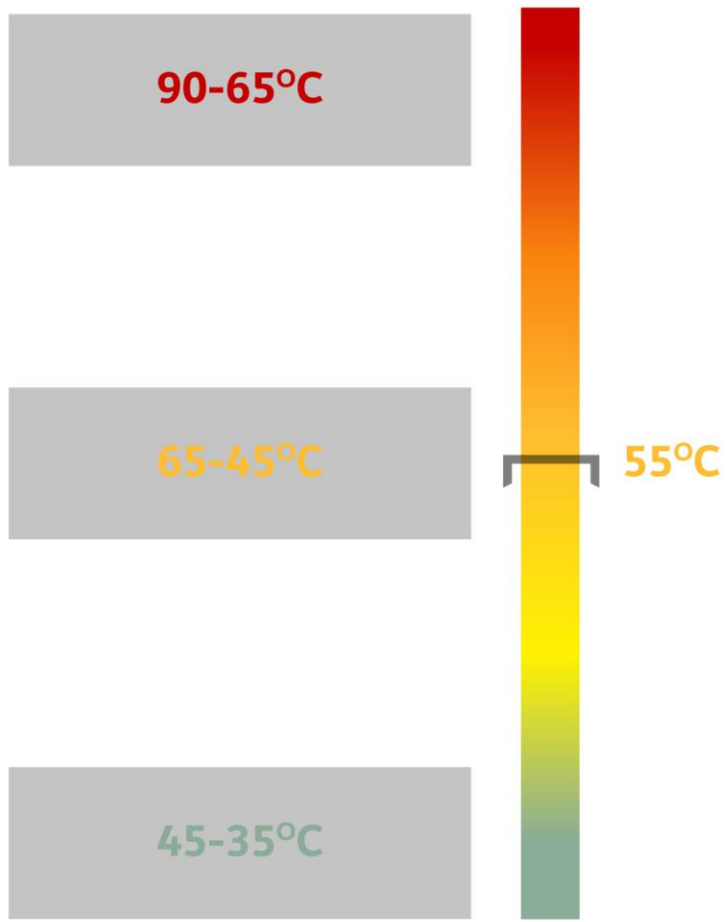


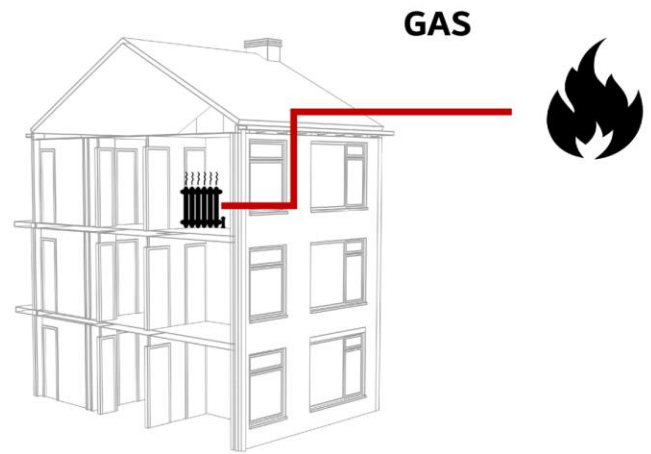

1945-1975
1/3 of building stock
1% new buildings
1973 oil crisis
no energy standards
potential for energy saving

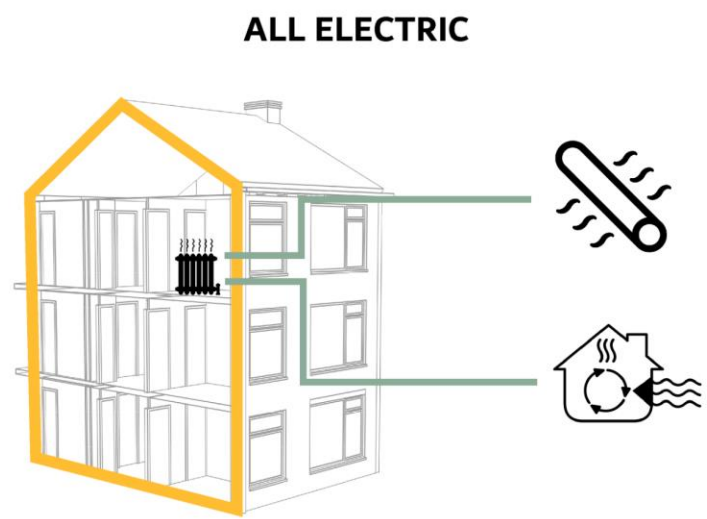
EU RESIDENTIAL ENERGY CONSUMPTION

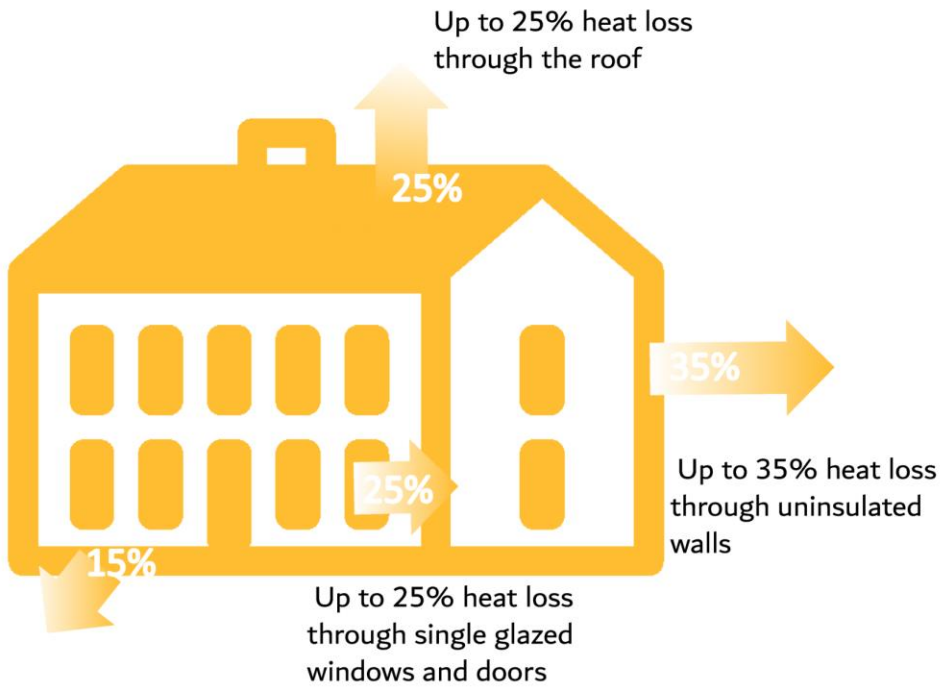


MVI-ENERGIE









1945-1975

1/3 of building stock

Portiekapartments

380000

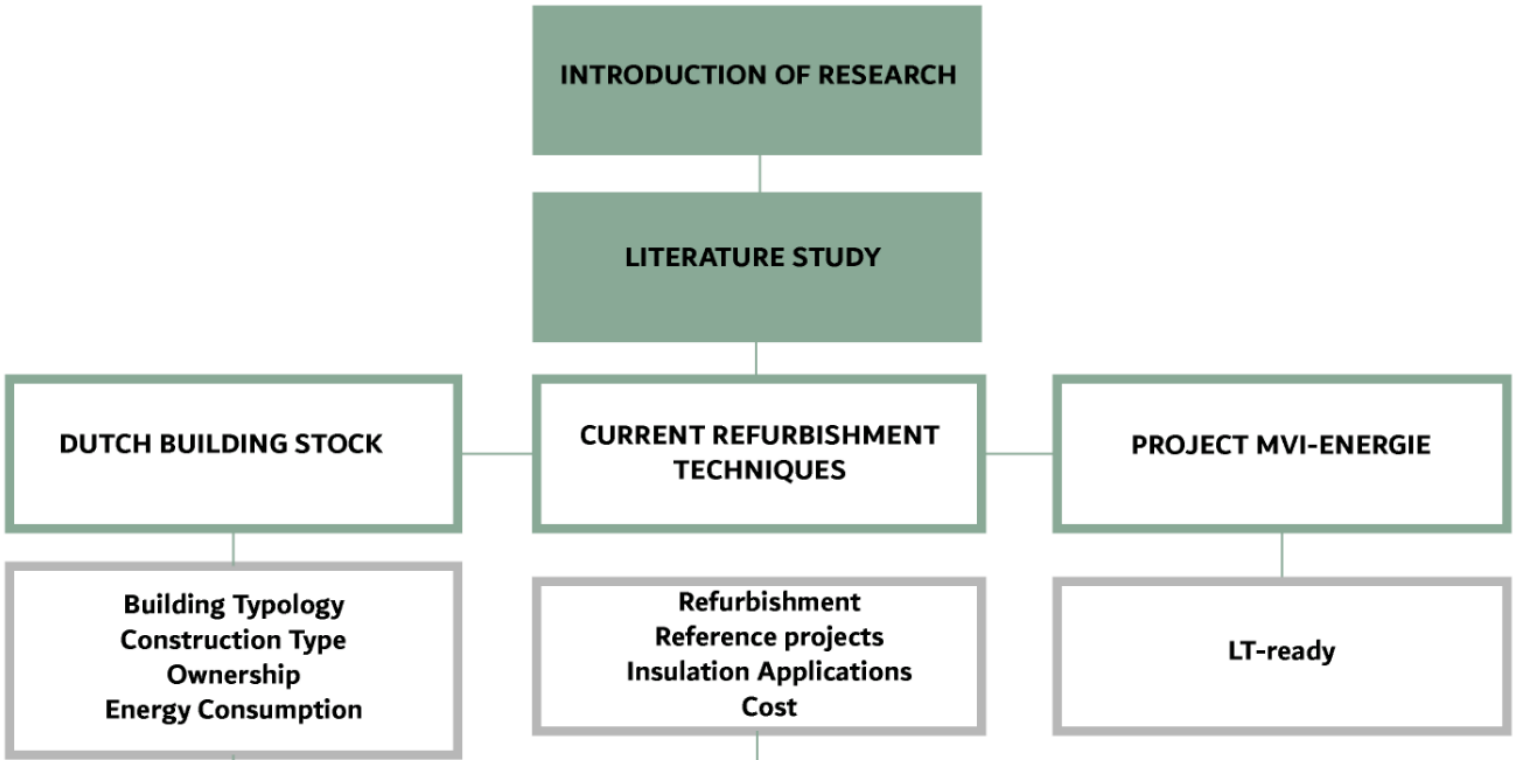
Facade

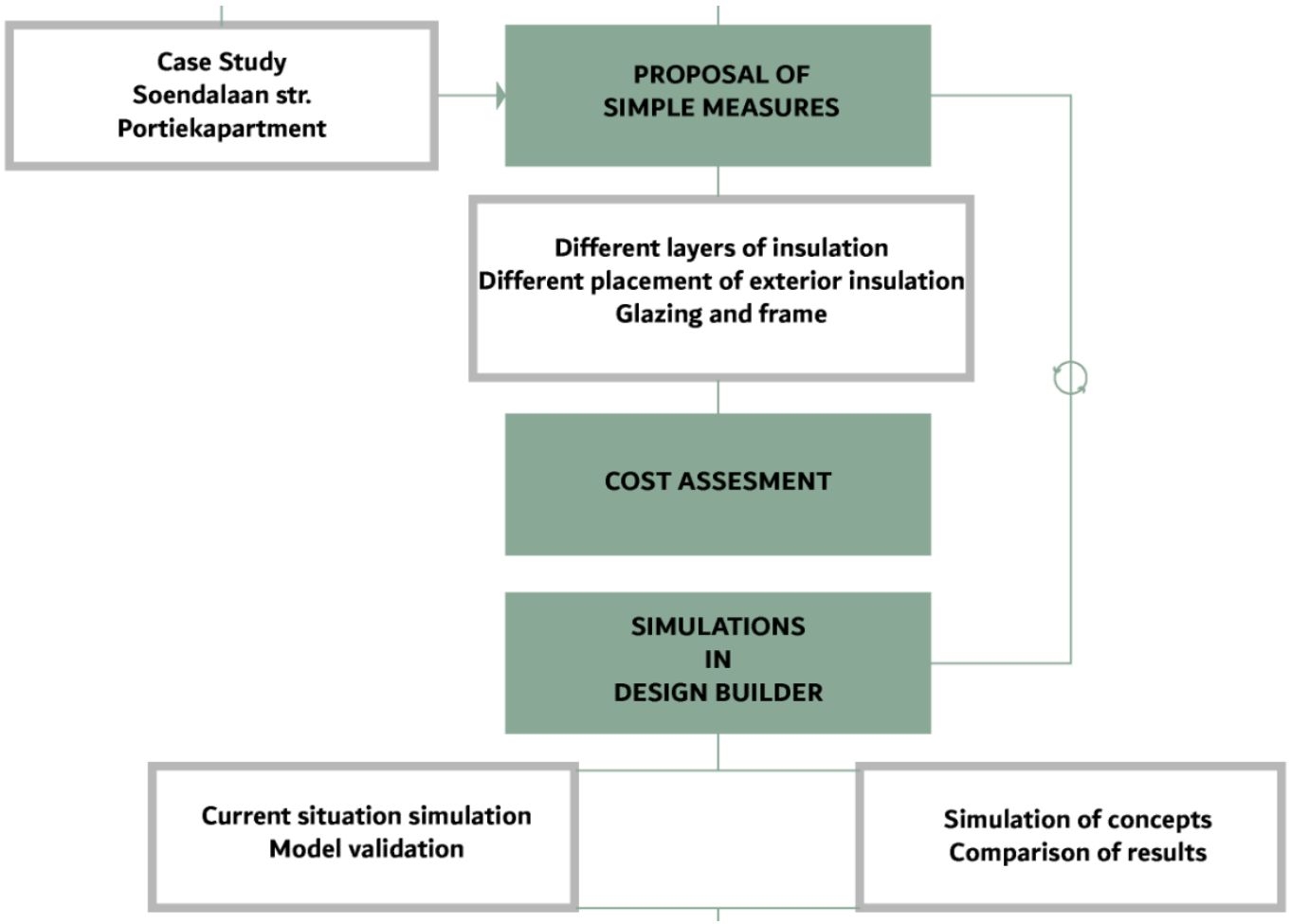
PROBLEM STATEMENT

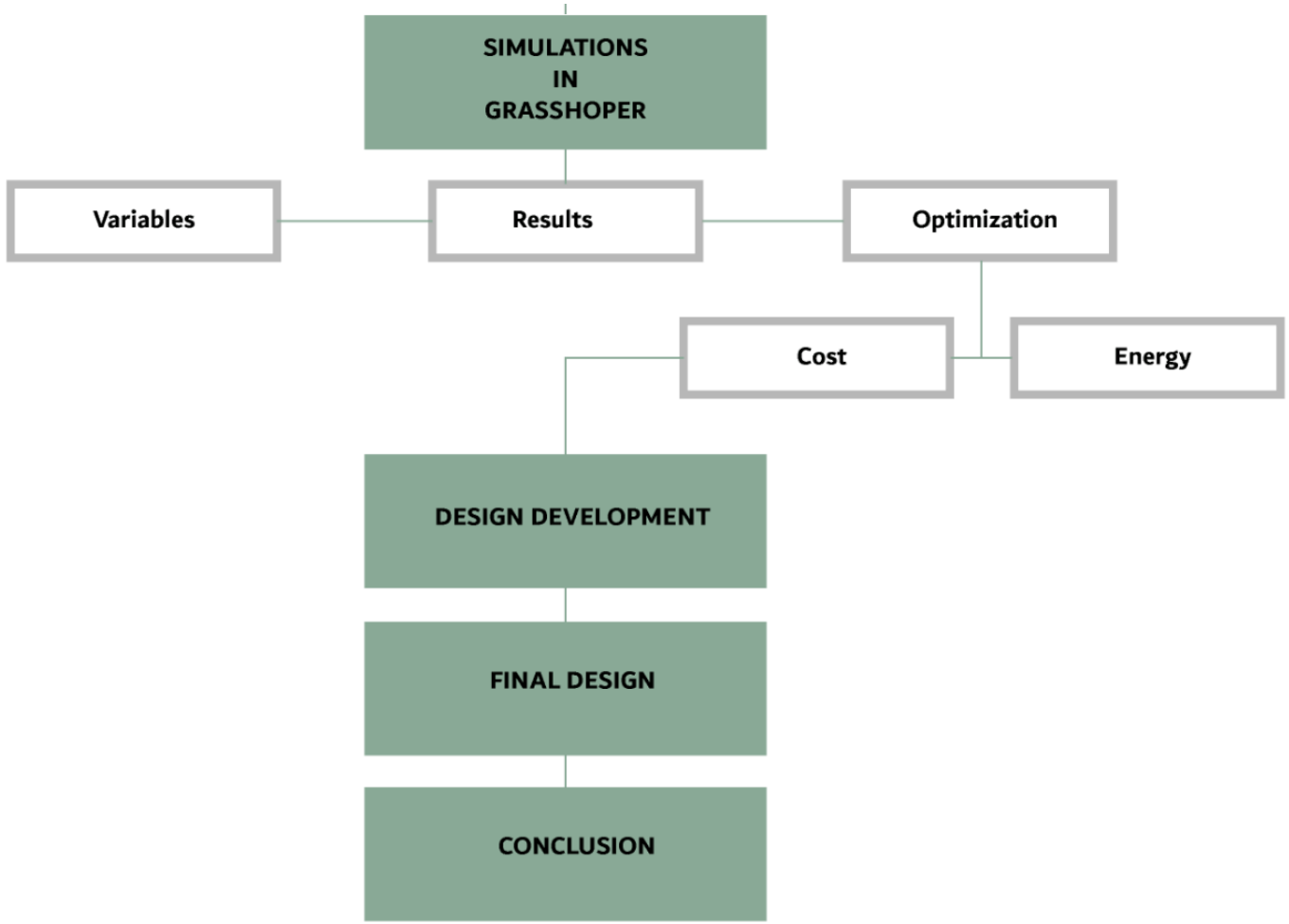
- **Not enough funds**
- **Not enough knowledge for changing to LT**
- **Time consuming and disturbing construction work.**
- **On site construction.**

RESEARCH QUESTION

Which design strategy is needed in order to achieve a faster, economically feasible and LT-ready refurbishment for post-war portiek apartments?


INTRODUCTION OF RESEARCH
LITERATURE STUDY
DUTCH BUILDING STOCK
CURRENT REFURBISHMENT TECHNIQUES
PROJECT MVI-ENERGIE
Building Typology
Construction Type
Ownership
Energy Consumption
Refurbishment
Reference projects
Insulation Applications
Cost
LT-ready


Case Study
Soendalaan str.
Portiekapartment
PROPOSAL OF
SIMPLE MEASURES
Different layers of insulation
Different placement of exterior insulation
Glazing and frame
COST ASSESMENT
SIMULATIONS
IN
DESIGN BUILDER
Current situation simulation
Model validation
Simulation of concepts
Comparison of results


SIMULATIONS
IN
GRASSHOPER
Variables
Results
Optimization
Cost
Energy
DESIGN DEVELOPMENT
FINAL DESIGN
CONCLUSION

1 FRAMEWORK

2 LITERATURE STUDY

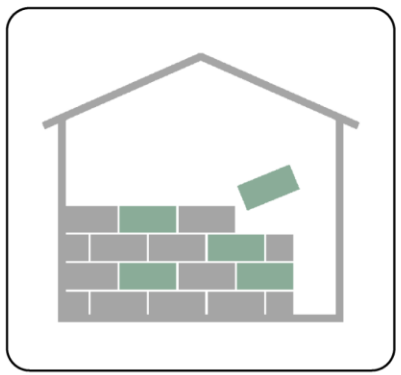
3 CASE STUDY

4 8 MEASURES

5 SIMULATION GRASSHOPPER

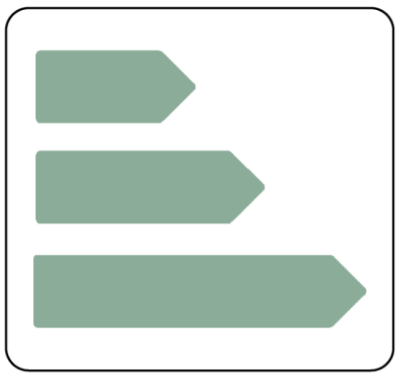
6 DESIGN

7 CONCLUSION



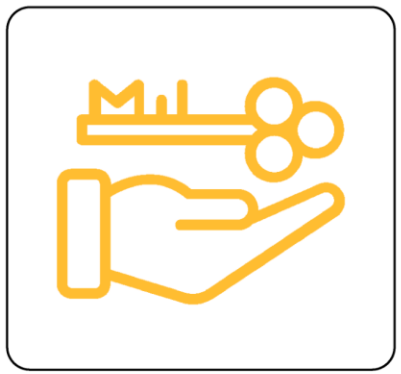
CONSTRUCTION

- TRADITIONAL
- SYSTEEM
  - EXPIRED ENVELOPE
  - GOOD STRUCTURE



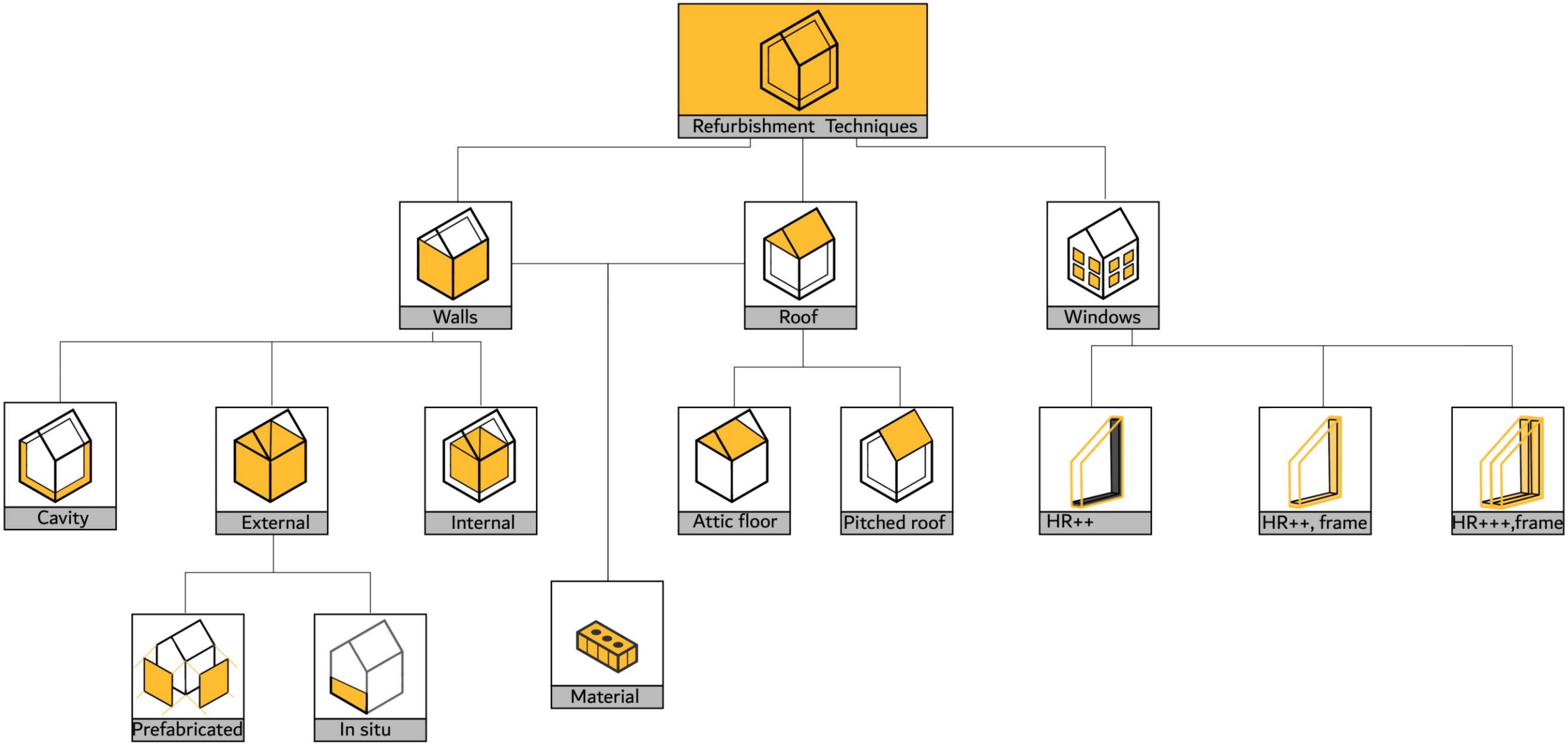
ENERGY PERFORMANCE

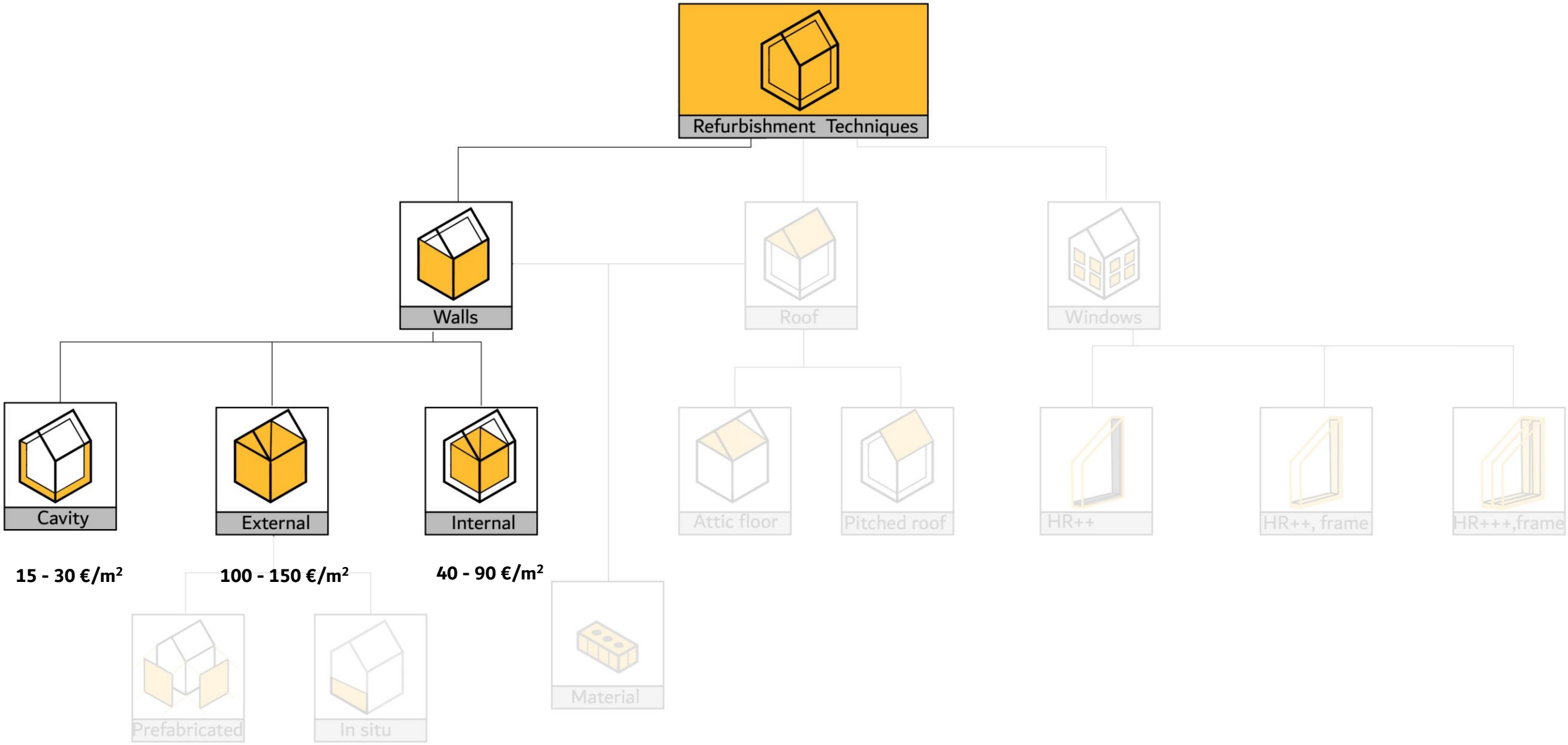
20.000 kWh/dwelling/year
Between D and F



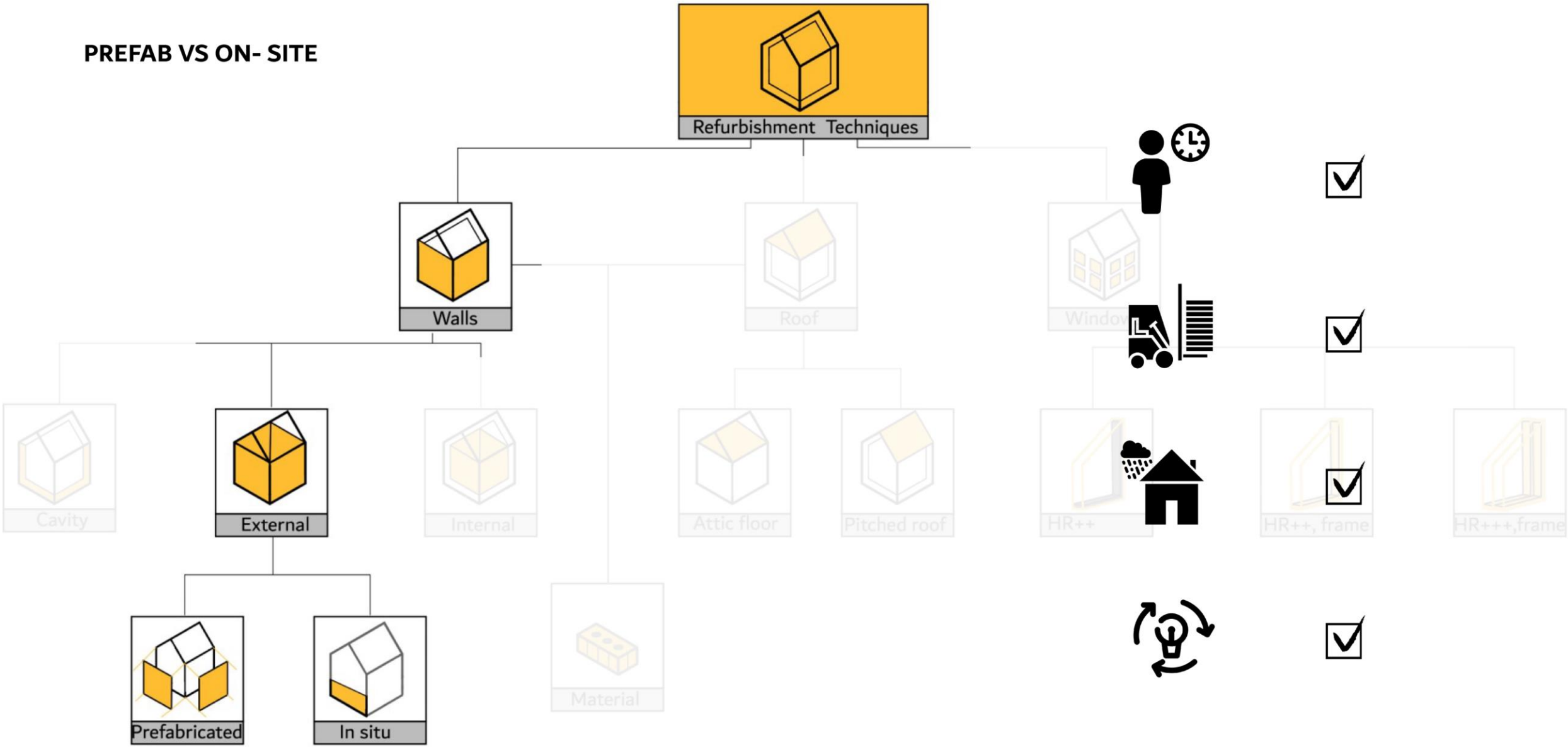
OWNERSHIP

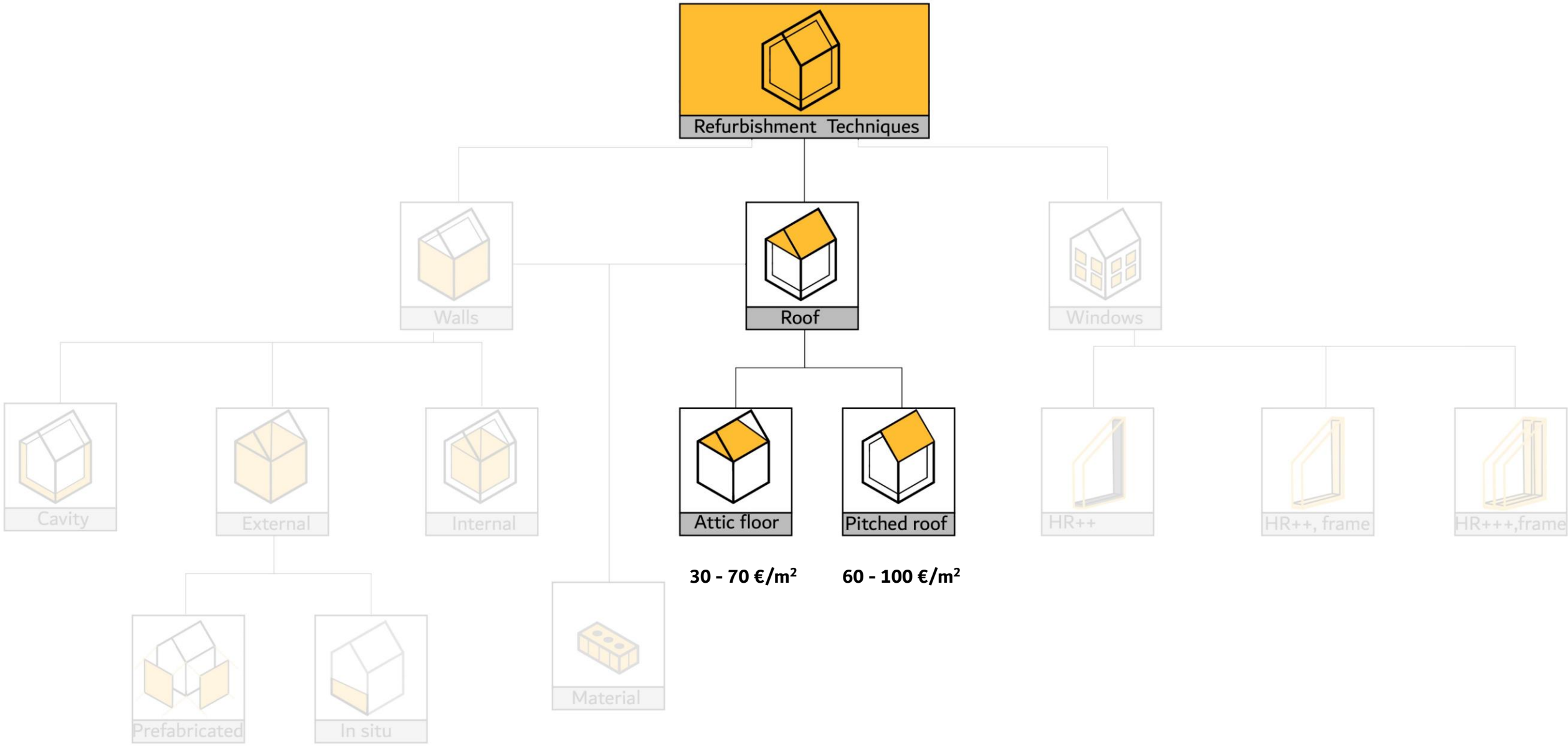
- 60% PRIVATE
- 31% SOCIAL
- 11% PRIVATELY RENTED

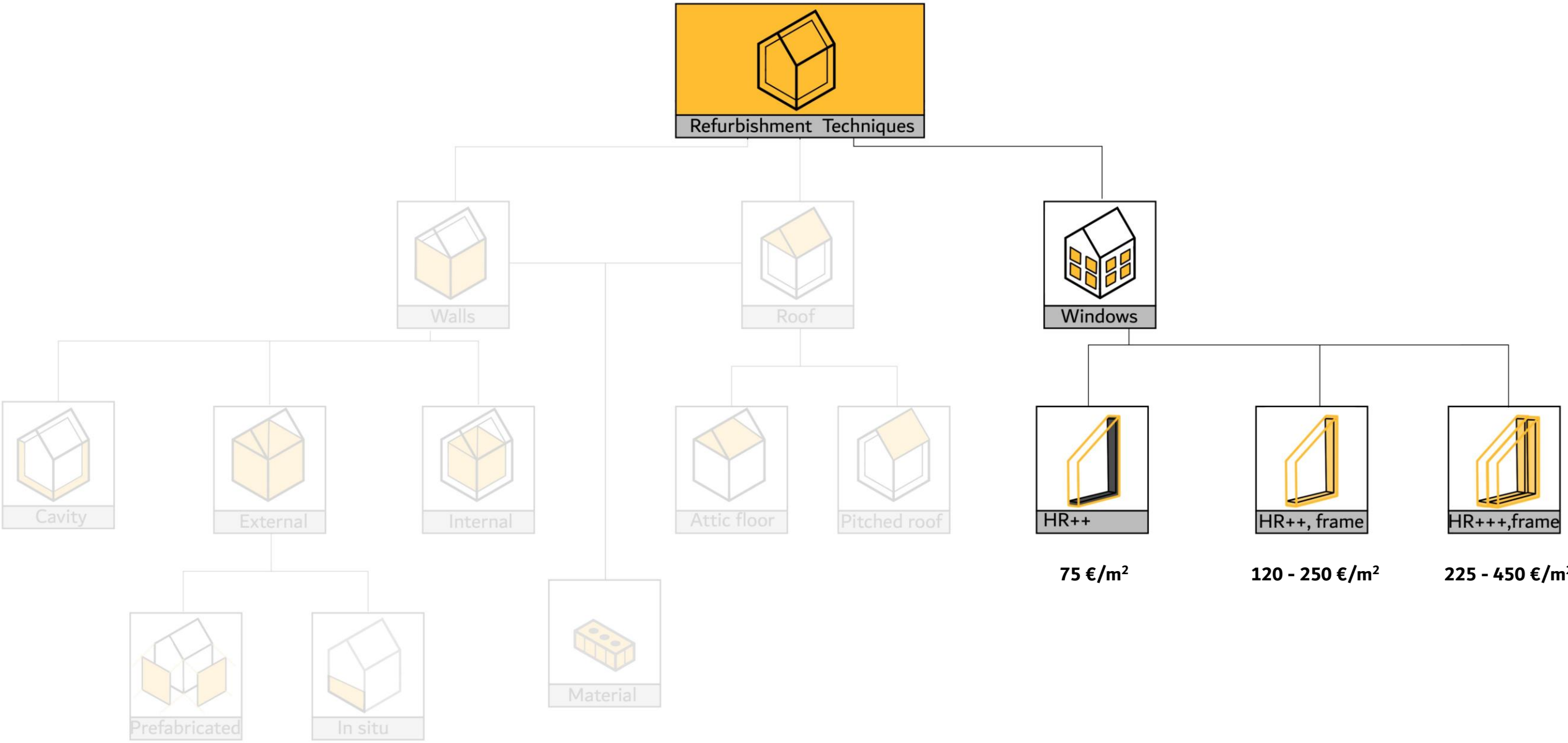

Refurbishment Techniques
Walls
Roof
Windows
Cavity
External
Internal
Attic floor
Pitched roof
HR++
HR++, frame
HR+++,frame
Prefabricated
In situ
Material


Refurbishment Techniques
Walls
Roof
Windows
Cavity
External
Internal
Attic floor
Pitched roof
HR++
HR++, frame
HR+++,frame
15 - 30 €/m²
100 - 150 €/m²
40 - 90 €/m²
Material
Prefabricated
In situ

PREFAB VS ON- SITE




Refurbishment Techniques
Walls
Roof
Windows
Cavity
External
Internal
Attic floor
Pitched roof
HR++
HR++, frame
HR+++,frame
Prefabricated
In situ
Material
30 - 70 €/m²
60 - 100 €/m²


Refurbishment Techniques
Walls
Roof
Windows
Cavity
External
Internal
Attic floor
Pitched roof
HR++
HR++, frame
HR+++,frame
75 €/m²
120 - 250 €/m²
225 - 450 €/m²
Prefabricated
In situ
Material

1 FRAMEWORK

2 LITERATURE STUDY

3 CASE STUDY

4 8 MEASURES

5 SIMULATION GRASSHOPPER

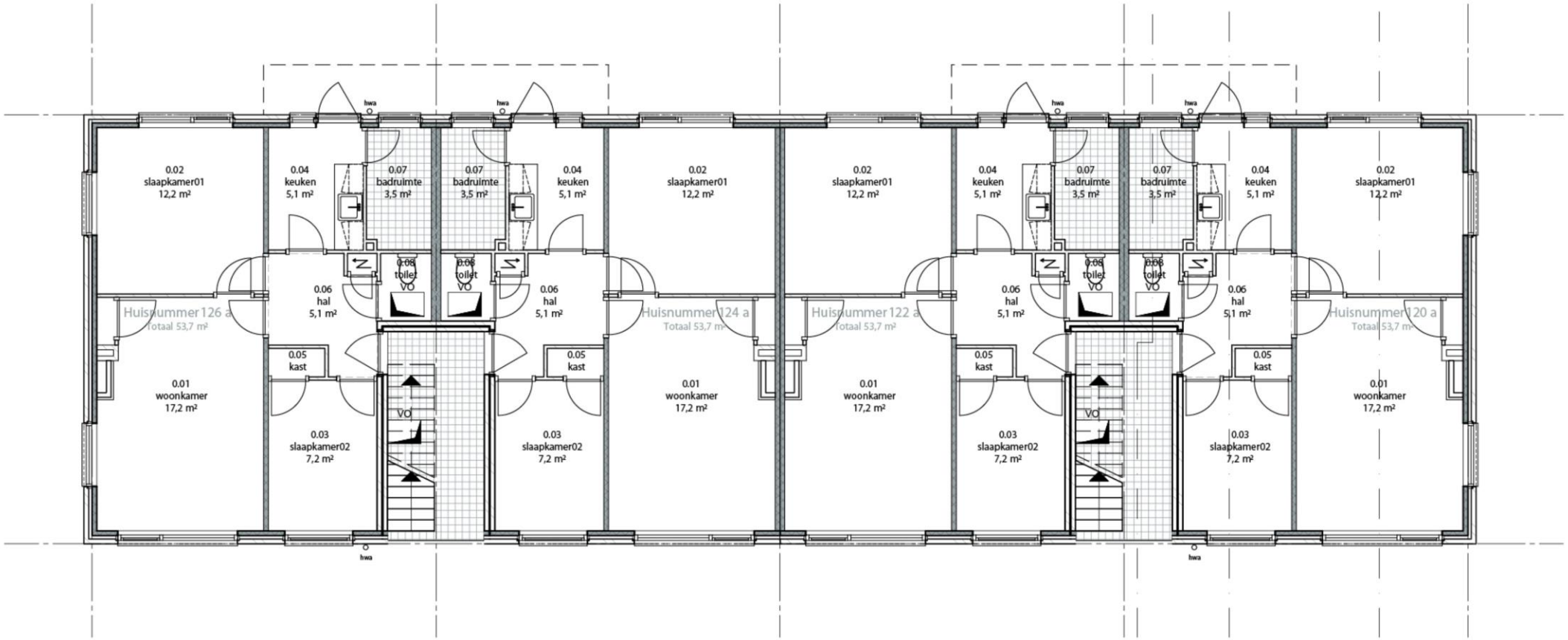
6 DESIGN

7 CONCLUSION

VLAARDINGEN

1952

Source: KAW


0.02
slaapkamer01
12,2 m²
0.04
keuken
5,1 m²
0.07
badruimte
3,5 m²
0.08
toilet
0.06
hal
5,1 m²
0.05
kast
0.01
woonkamer
17,2 m²
0.03
slaapkamer02
7,2 m²
hwa
VO
Huisnummer 126 a
Totaal 53,7 m²
Huisnummer 124 a
Totaal 53,7 m²
Huisnummer 122 a
Totaal 53,7 m²
Huisnummer 120 a
Totaal 53,7 m²

Source: KAW

Annual energy demand: 13417 kWh

Annual heating demand: 9853 kWh

FACADE

Cavity Width
[70 mm]

Cavity insulation
[uninsulated]

Window to Wall Ratio
[40%]

Windows Quality
[2.6 W/m2K]

INFILTRATION

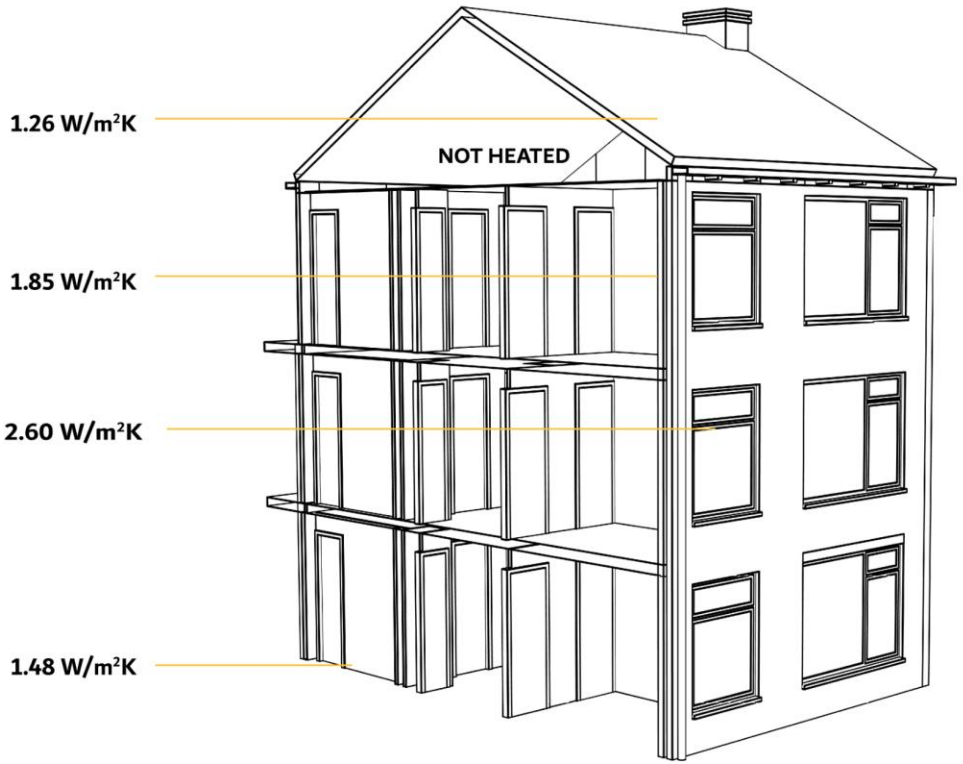
[0.6]

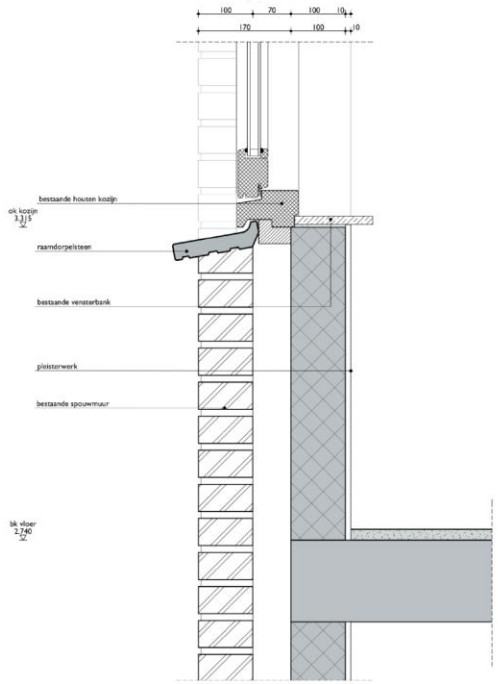
VENTILATION

[Natural inlet, mechanical exhaust]
[Bouwbesluit rates]

BUILDING SYSTEM

[HR- combi boiler operating with gas]





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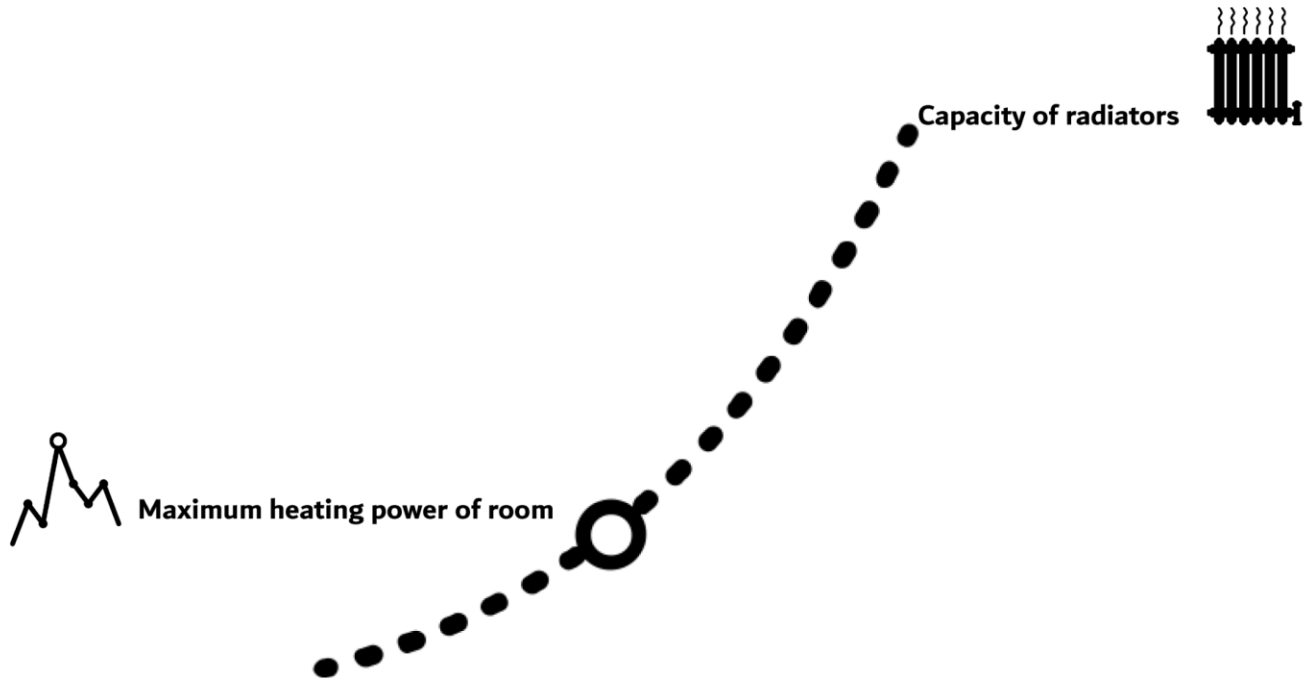
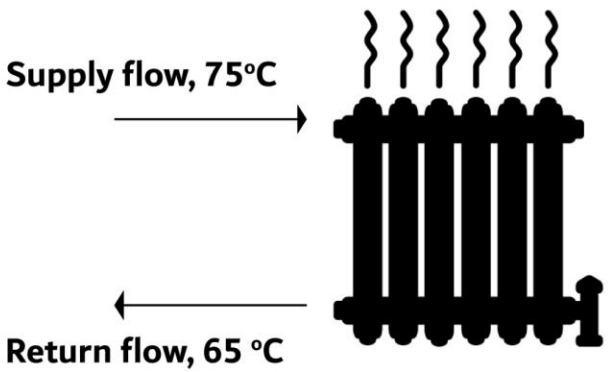
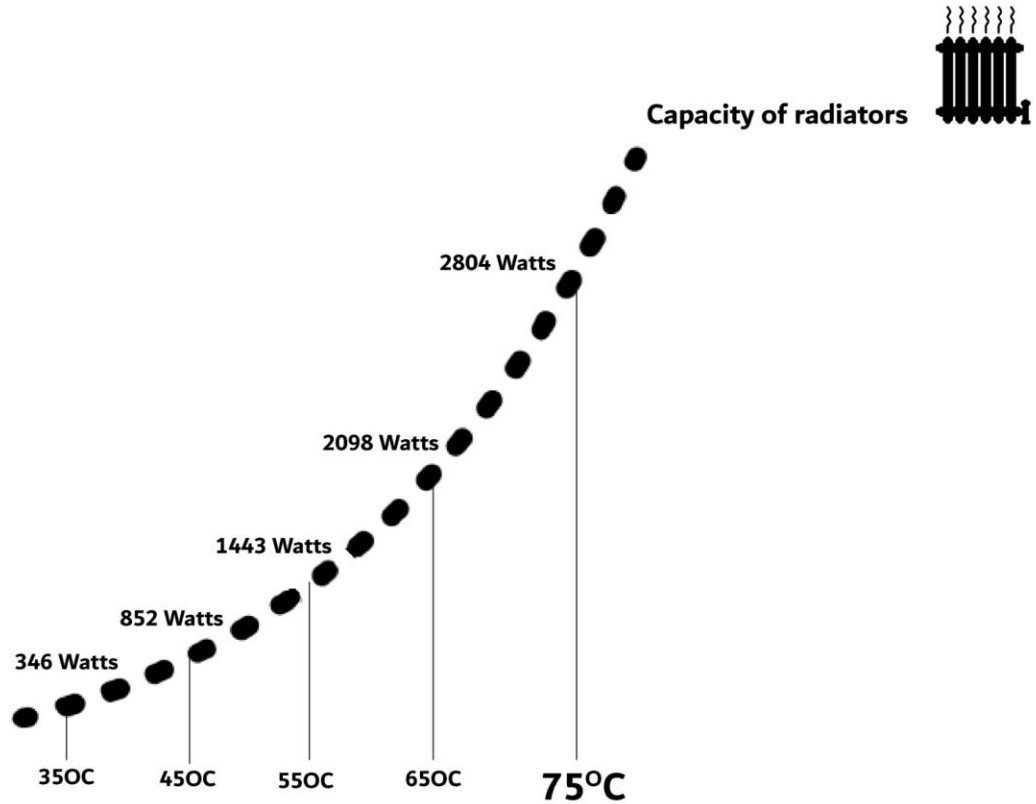
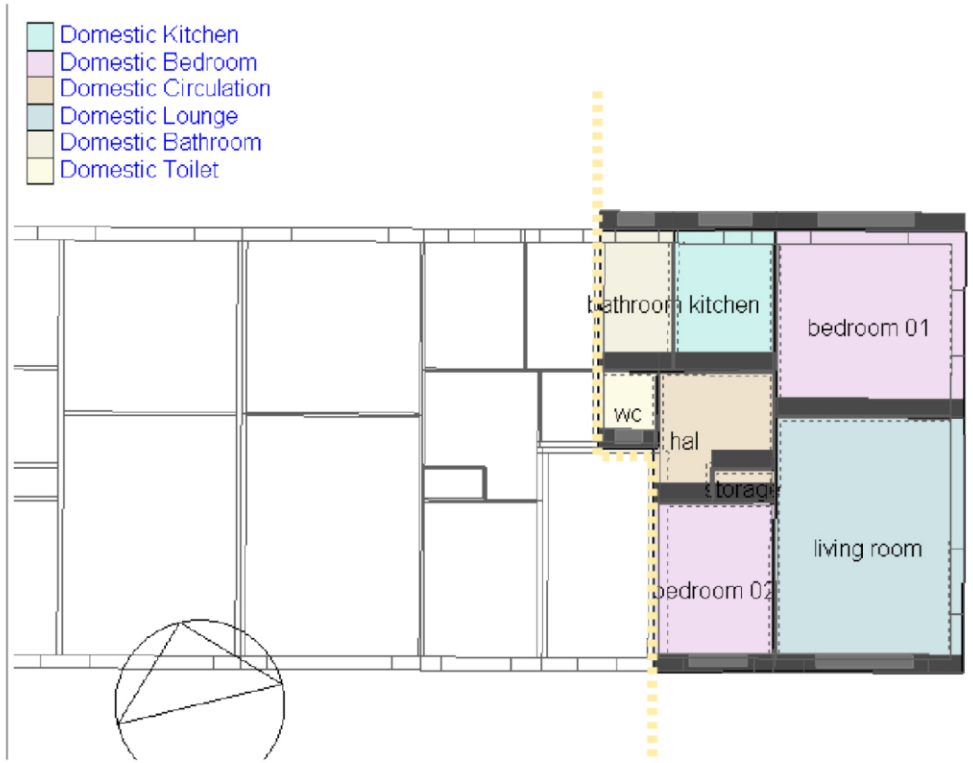

Capacity of radiators
Maximum heating power of room

CAPACITY OF RADIATORS



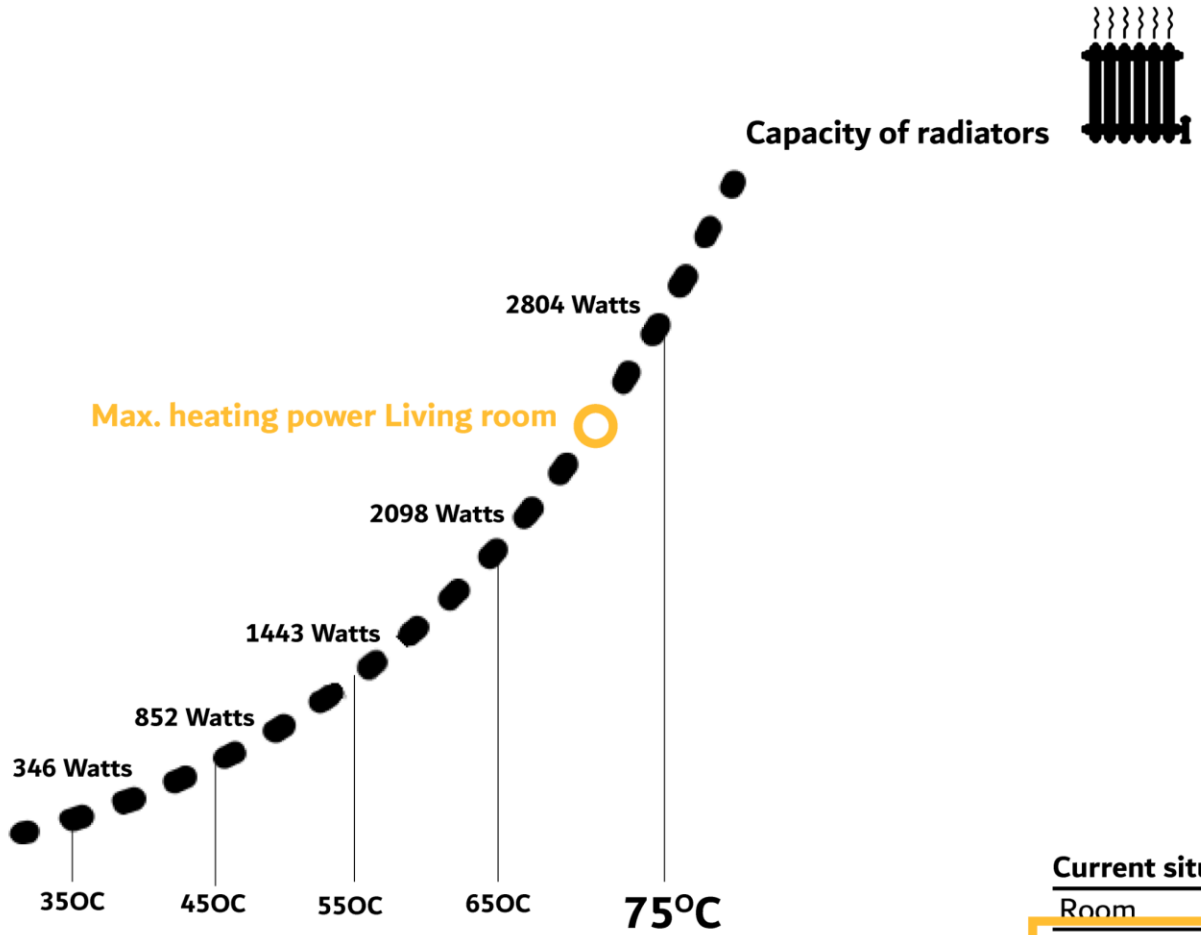


MAXIMUM HEATING POWER



Current situation

Room	Watts
Living room	2793
Kitchen	868
Bedroom1	2063
Bedroom2	1124
Bathroom	628



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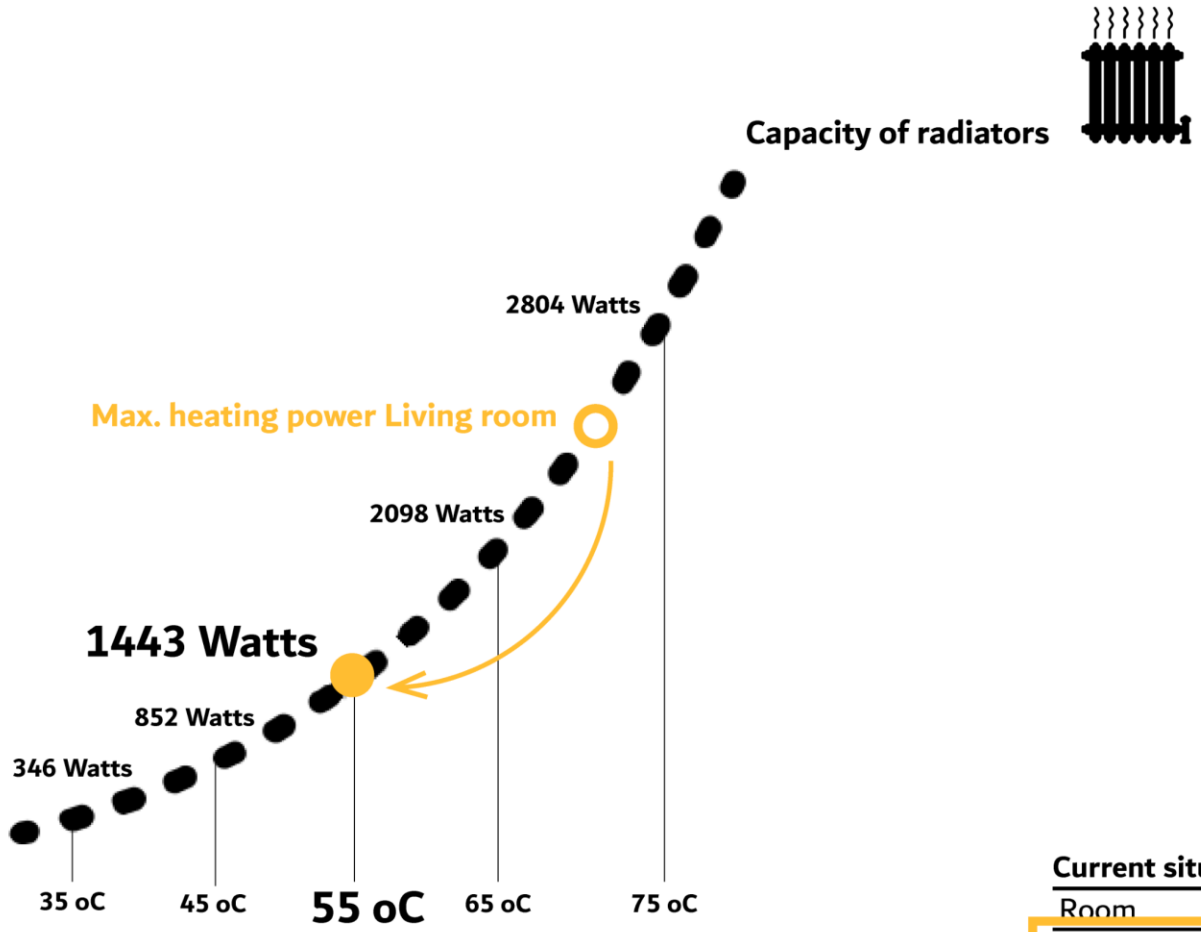

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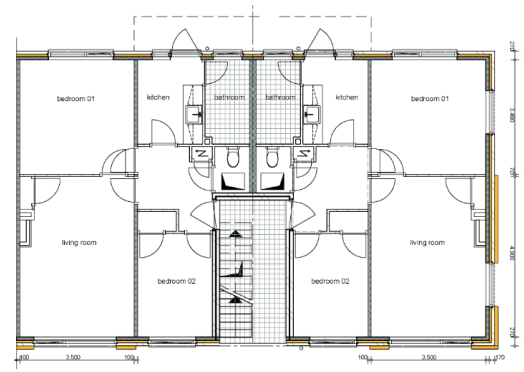
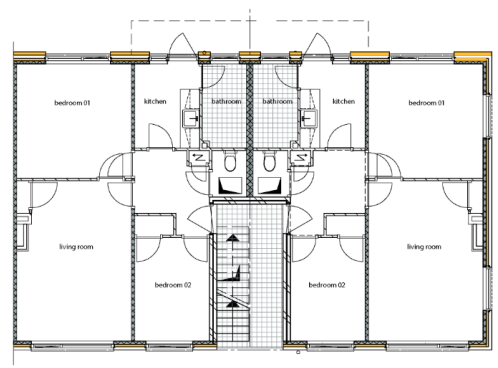
32% EXTERNAL INSULATION- LIVING ROOM

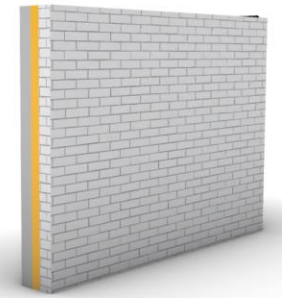


34% EXTERNAL INSULATION- NORTH



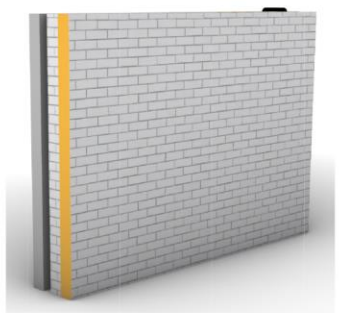
CAVITY INSULATION

Rc-value: 1.7 m^2K/W



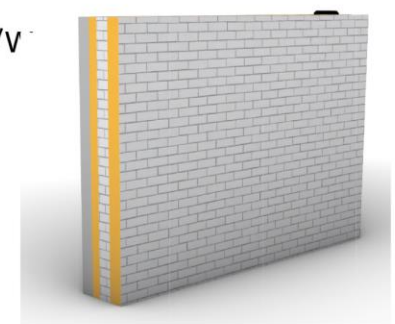
EXTERNAL INSULATION

Rc-value: 3.2 m^2K/W



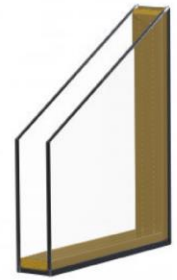
CAVITY AND EXTERNAL INSULATION

Rc-value: 4.2 m^2K/W



HR++

U- value: 1.1 W/m^2K



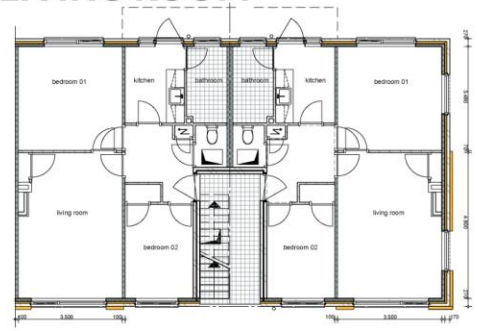
HR++ AND FRAMES

U- value: 1.2 W/m^2K

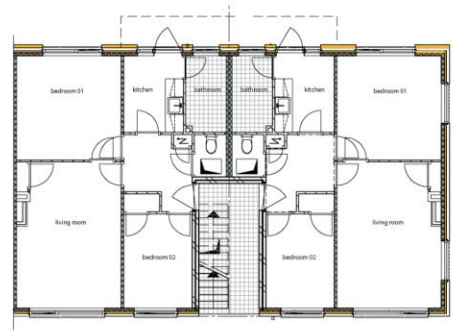
HR+++ AND FRAMES

U- value: 0.9 W/m^2K

32%- LIVING ROOM

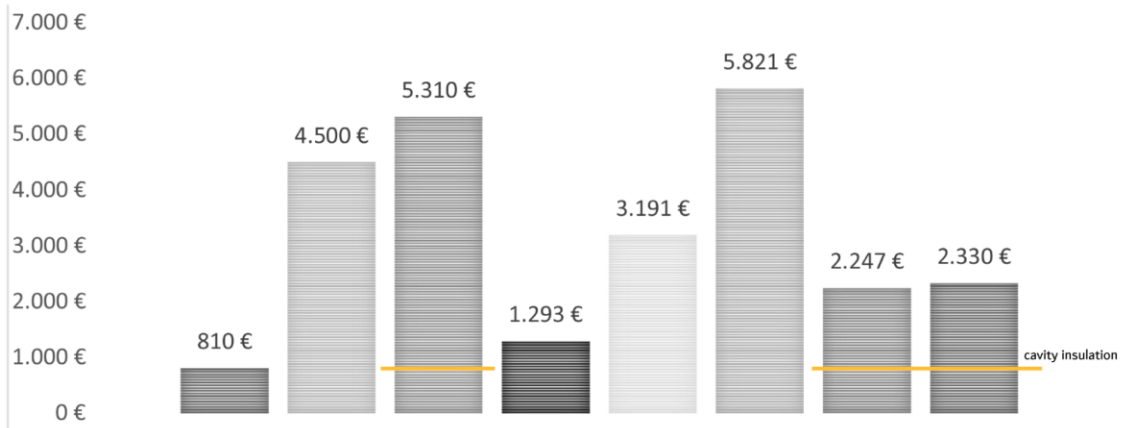


34%- NORTH



MATERIALS COST

DESCRIPTION	PRICE	INVESTMENT COST	INVESTMENT COST	PAYBACK TIME
	€/m2	€/ building	€/ apartment	
Wall				
Cavity wall insulatior	15-30	9720	810	1 year 6 months
External wall insulation (no cavity insulation)	100-150	54000	4500	8 years 3 months
External wall insulation (with cavity insulation)	115-180	63720	5310	9 years 8 months
Windows				
HR ++ glass	75	15525	1293	2 years 3 months
Aluminum frame with HR++	120- 250	38295	3191	5 years 9 months
Aluminum frame with HR+++	225-450	69862	5821	10 years 7 months
% of external insulation scenarios				
Living room- 32%	(125*138)+ 9720	26970	2247	4 years 2 months
North- 34%	(125*146)+9720	27970	2330	4 years 3 months

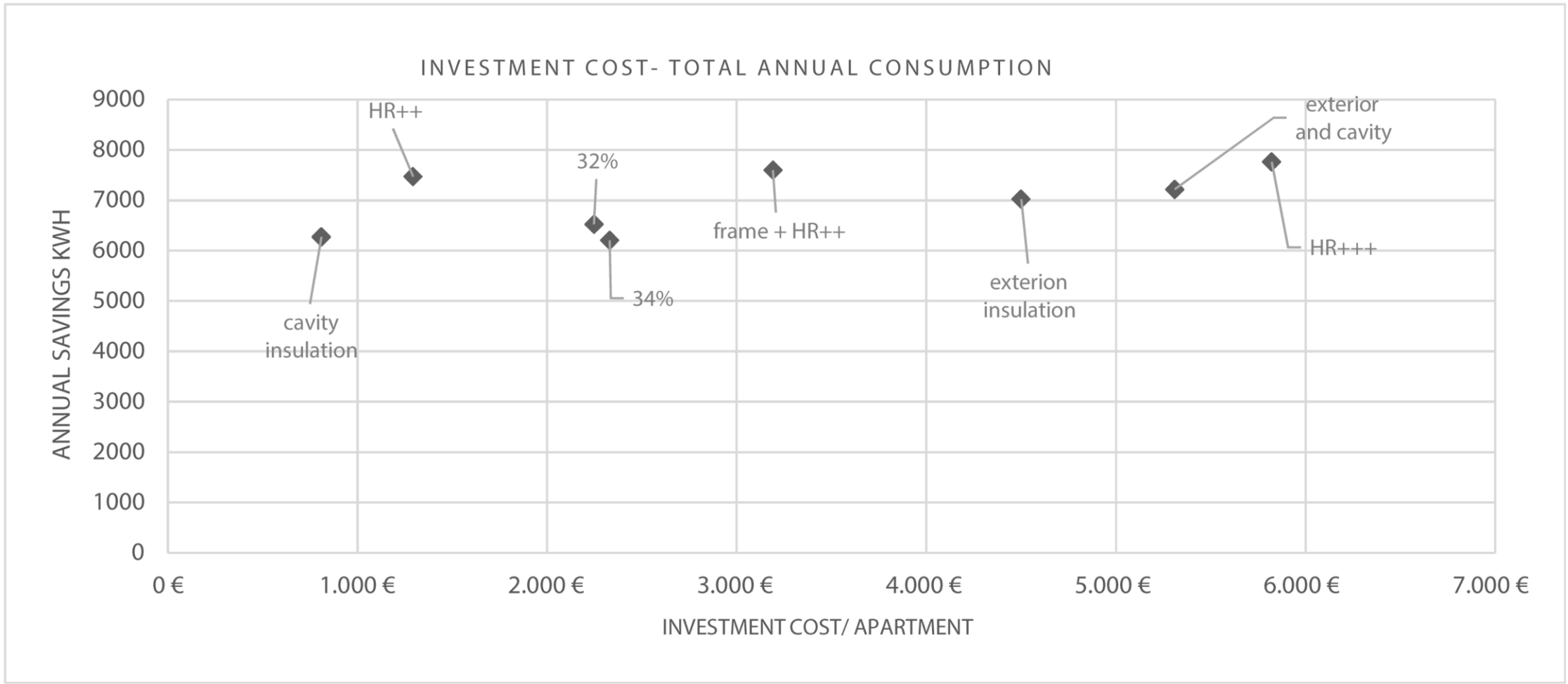


LABOUR COST

Omschrijving	Ee	Aantal	Prijs/1h	Bedrag	Manuren	Loon	Materiaal	Materieel	Oa
WERKTERREININRICHTING									
BUITENWANDEN		0,000	0,00	0,00	0,00	0,00	0,00	0,00	0,00
GEÏSOLEERD GEVELPANEEL [RC 1,38] MET VOORGEMONTEERDE STEENSTRIPS	m2	432,000	129,93	56131,50	287,57	0,00	50515,50	0,00	5616,00
geïsoleerd gevelpaneel [Rc 1,38] met voorgemonteerde steenstrips	m2	213,000	129,93	27675,95	141,79	0,00	24906,95	0,00	2769,00
geïsoleerd gevelpaneel [Rc 1,38] met voorgemonteerde steenstrips	m2	138,000	129,93	17930,90	91,86	0,00	16136,90	0,00	1794,00
BUITENWANDOPENINGEN									
HR++ beglazing 6-6	m2	207,000	75,08	15541,56	248,40	0,00	15541,56	0,00	0,00
HR++ beglazing 6-4-6	m2	207,000	153,73	31822,11	248,40	0,00	31822,11	0,00	0,00
aluminium kozijn merk A2, draairaam, buitendraaiend	m2	207,000	238,73	49417,11	647,91	0,00	49417,11	0,00	0,00

8 MEASURES SIMULATION RESULTS

Apartment type	T1 top corner					
DESCRIPTION	Total annual kWh	Energy savings kWh	Heating annual kWh	Heating Savings kWh	Max HP LR Watt	Max HP BR1 Watt
Current situation	13417	-	9853	-	2793	2063
Wall						
Cavity wall insulation	7143	6274	3883	5970	1465	1097
External wall insulation (no cavity insulation)	6396	7021	3280	6573	1289	961
External wall insulation (with cavity insulation)	6200	7217	3086	6767	1238	920
Windows						
Ordinary wooden frame with HR ++ glass	5948	7469	2696	7157	1107	805
Insulating frame with HR ++ glass	5818	7599	2573	7280	1019	721
Insulating frame with triple glass	5656	7761	2401	7452	996	703
% of external insulation scenarios						
32% Living room	6894	6523	3741	6112	1205	1061
34% North	7215	6202	4281	5572	1476	1261


INVESTMENT COST- TOTAL ANNUAL CONSUMPTION
ANNUAL SAVINGS KWH
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0 €
1.000 €
2.000 €
3.000 €
4.000 €
5.000 €
6.000 €
7.000 €
INVESTMENT COST/ APARTMENT
HR++
32%
34%
frame + HR++
exterior
and cavity
HR+++
exterion
insulation
cavity
insulation

CAVITY INSULATION

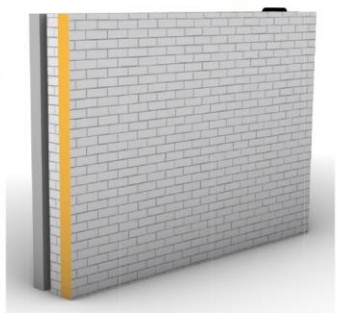
60% heating savings
46.7% total savings

Liv. room: 2793Watt >1443
Bedroom: 2063Watt >1443
Not LT-ready

EXTERNAL INSULATION

66.7 % heating savings
52.3% total savings

LT-ready sufficient

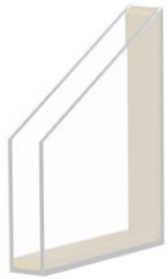


CAVITY AND EXTERNAL INSULATION

68.6% heating savings
53.7% total savings

LT-ready sufficient

HR++



HR++ AND FRAMES

73.8% heating savings
56.6% total savings

LT-ready sufficient

HR+++ AND FRAMES

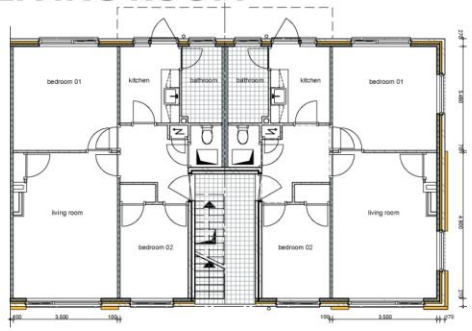
75.6% heating savings
57.8% total savings

LT-ready sufficient

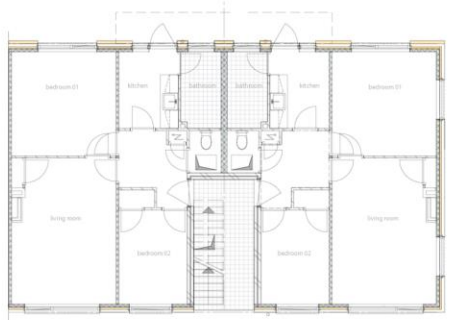
32%- LIVING ROOM

62% heating savings
48.6% total savings

LT-ready sufficient



34%- NORTH



1 FRAMEWORK

2 LITERATURE STUDY

3 CASE STUDY

4 8 MEASURES

5 SIMULATION GRASSHOPPER

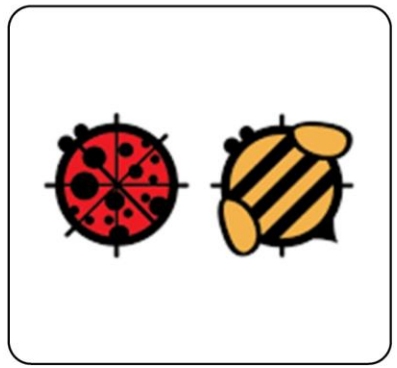
6 DESIGN

7 CONCLUSION

RHINOCEROS

GEOMETRY

HONEYBEE
LADYBAG



ENVIRONMENTAL
PLUGINS

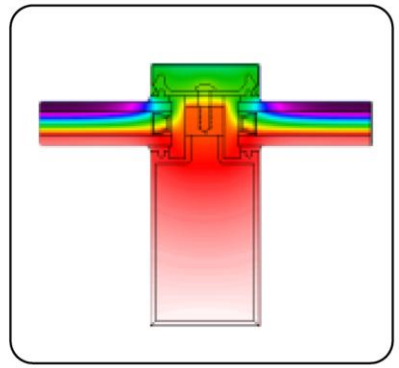
ENERGY PLUS

ENERGY
ANALYSIS

COLIBRI

ITERATIONS

THERM



ADD. HEAT LOSS
CONDENSATION CHECK

DISPLAY RESULTS

DESIGN BUILDER

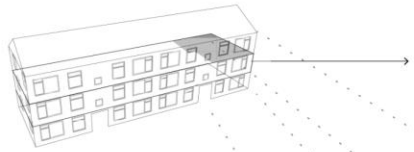
DOUBLE GLAZING

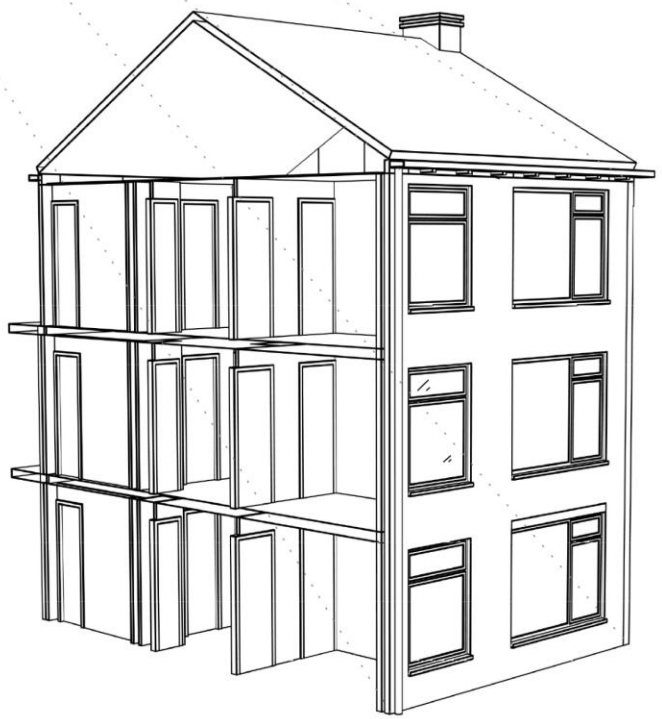
INSULATION MATERIAL

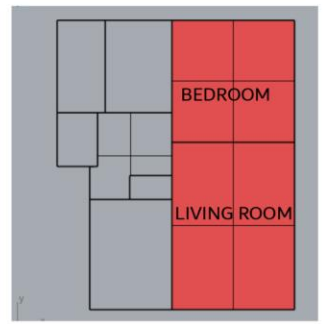
EXTERNAL INSULATION PLACEMENT

GRASSHOPPER

PROTOTYPE/ ANALYSE



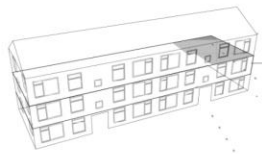




FACADE TYPOLOGY, CONTEXT, ORIENTATION, PLAN LAYOUT TAKEN AS FIXED PARAMETERS.

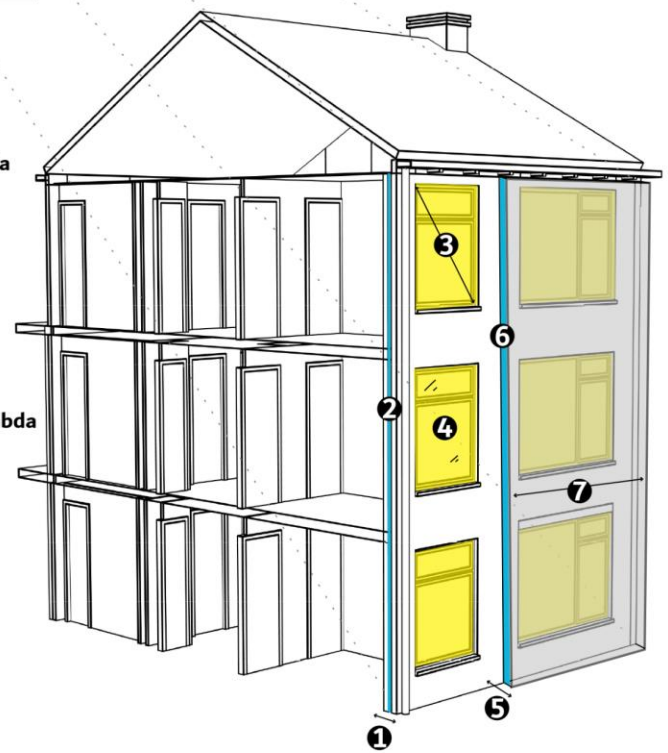
PROTOTYPE/ ANALYSE

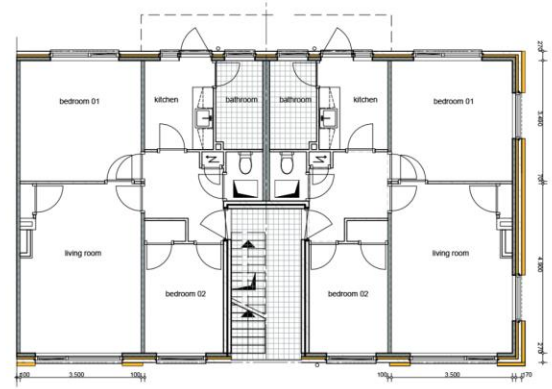
multi- VARIABLES



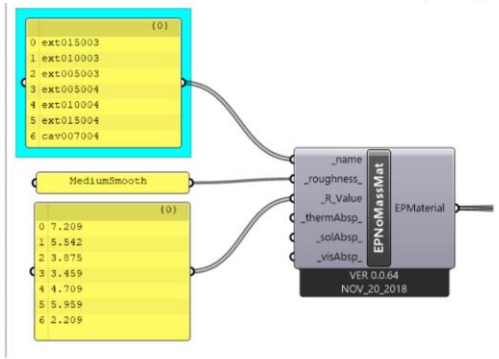
- cav. width
- cav. ins.lambda
- WWR
- windows quality
- ext.ins. thickness
- ext.ins. lambda
- ext.ins. percentage

1. **Cavity Width**
   [30/ 50/70 mm]
2. **Cavity insulation material lambda**
   [0,030/ 0,040 W/mK]
3. **Window to Wall Ratio**
   [20%/ 40%/ 60%/ 80%]
4. **Windows Quality**
   [Uvalue: 0.9/ 1.2/ 2.6 W/m2K]
5. **External Insulation Thickness**
   [50/ 100/150 mm]
6. **External Insulation Material Lambda**
   [0,030/ 0,040 W/mK]
7. **External Insulation Percentage**
   [35%/ 50%]





[50%]



CAVITY WIDTH + CAVITY LAMBDA COMBINED INTO CAVITY WALL, AN Rc- VALUE

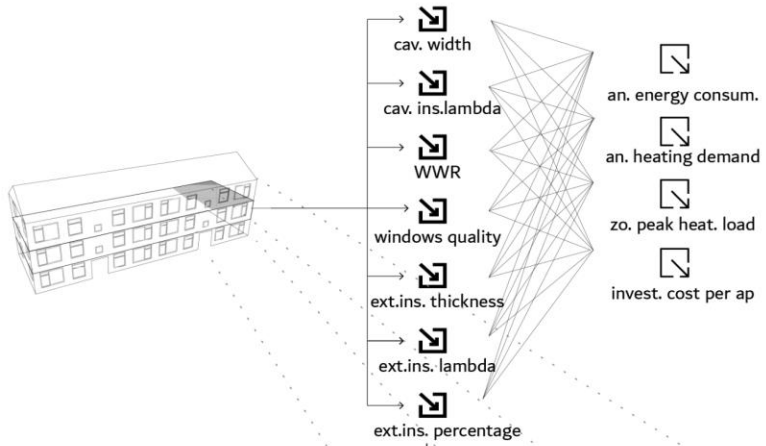
EXTERNAL INSULATION THICKNESS + eXTERNAL INSULATION LAMBDA COMBINED INTO EXTERNAL INSULATION Rc-VALUE

WHEN CAVITY WALL AS CONSTRUCTION INPUT FOR BEDROOM WALLS, THEN 32% INSULATED.

PROTOTYPE/ ANALYSE

multi- **VARIABLES**

multi- **OUTPUTS**



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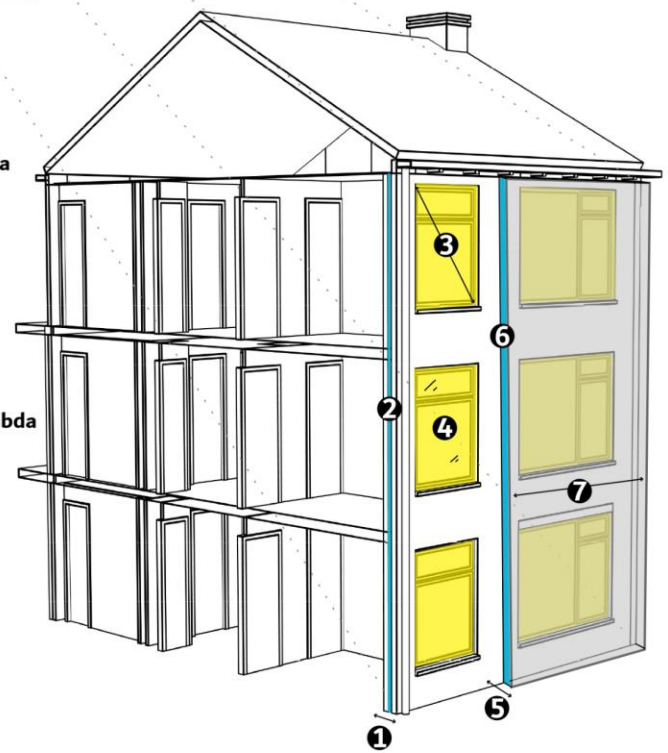
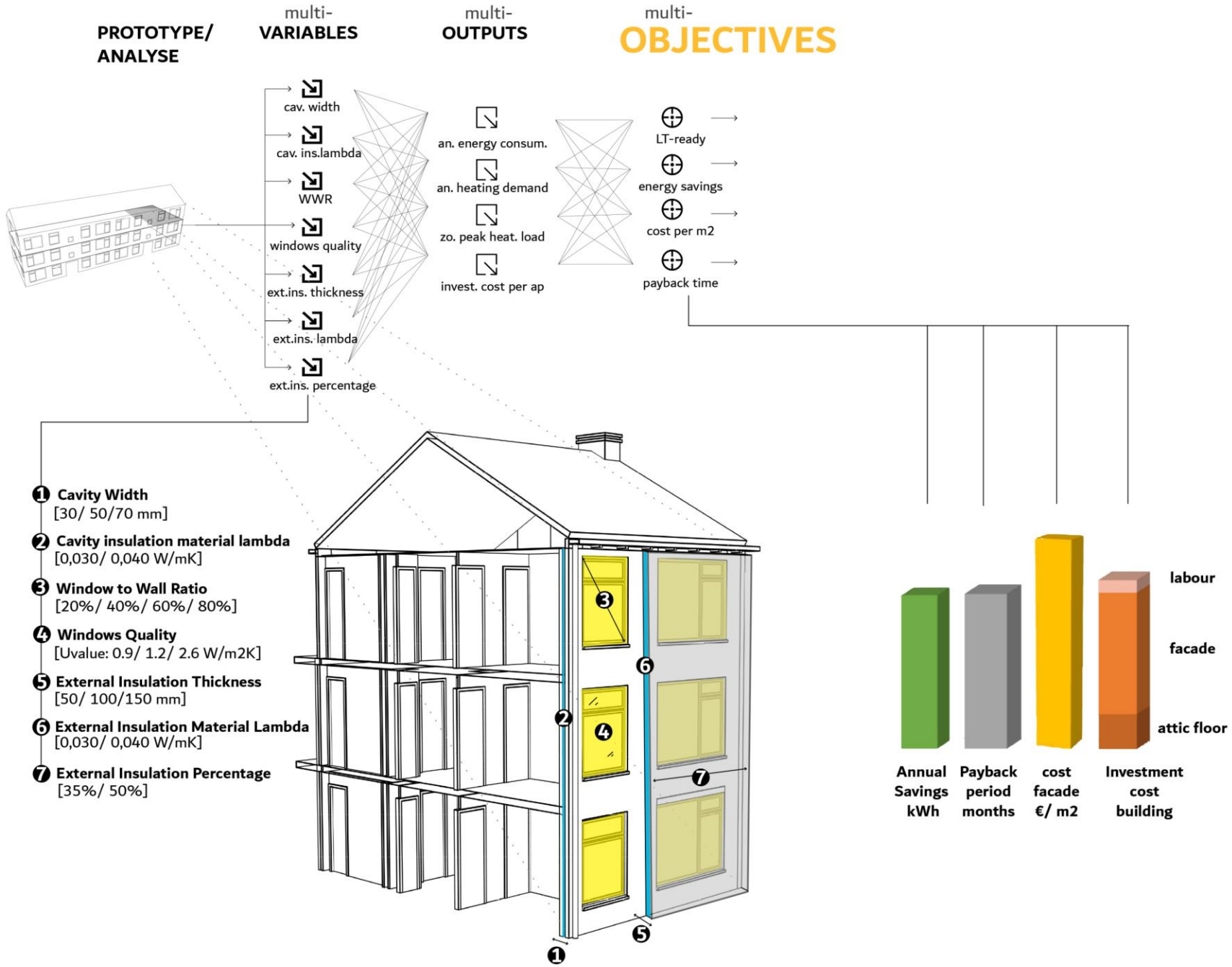


INVESTMENT COST PER APARTMENT
FROM LITERATURE STUDY


PROTOTYPE/
ANALYSE
multi-
VARIABLES
multi-
OUTPUTS
multi-
OBJECTIVES
cav. width
cav. ins.lambda
WWR
windows quality
ext.ins. thickness
ext.ins. lambda
ext.ins. percentage
an. energy consum.
an. heating demand
zo. peak heat. load
invest. cost per ap
LT-ready
energy savings
cost per m2
payback time
1 Cavity Width
[30/ 50/70 mm]
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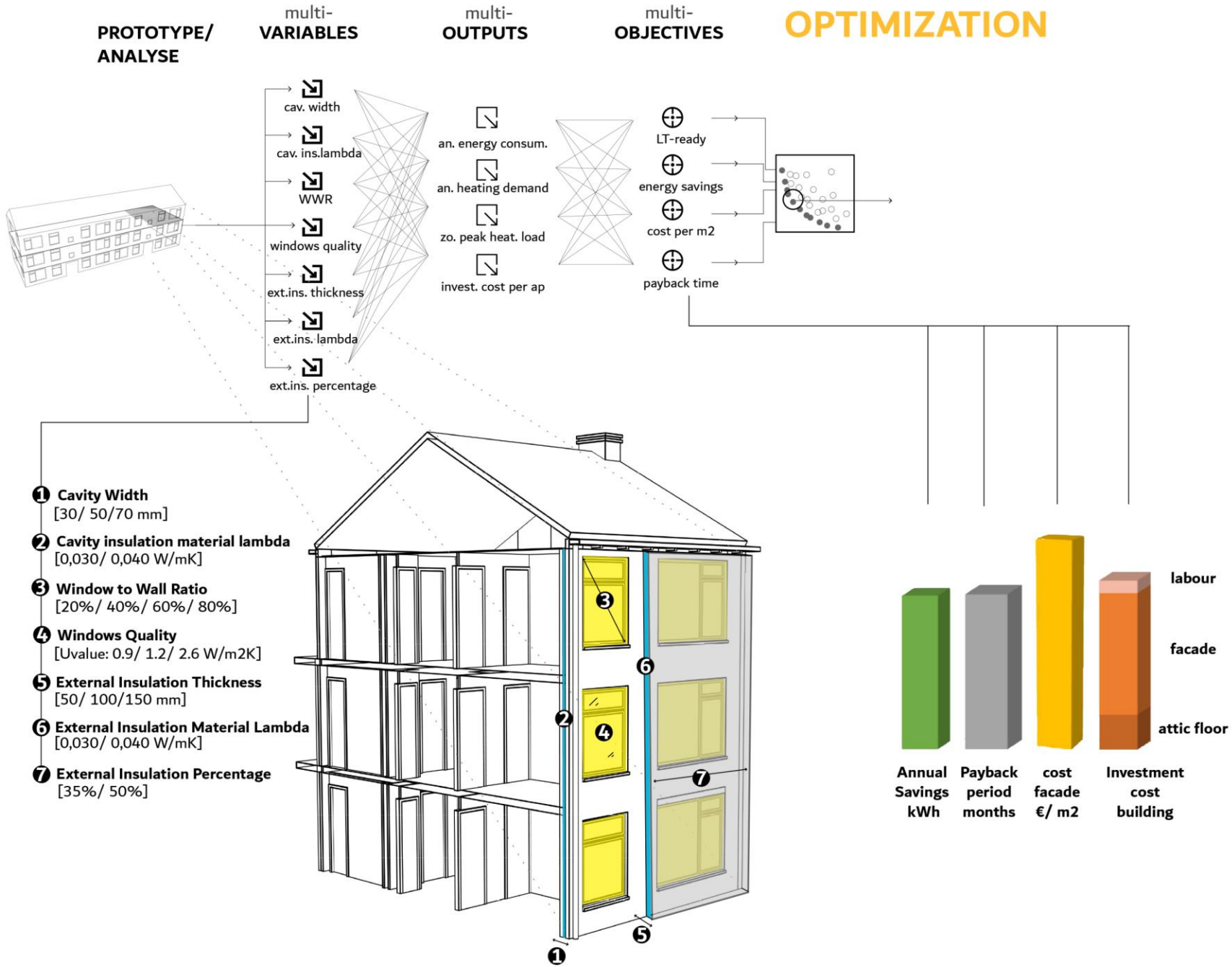
[0,030/ 0,040 W/mK]
7 External Insulation Percentage
[35%/ 50%]
labour
facade
attic floor
Annual Savings kWh
Payback period months
cost facade €/ m2
Investment cost building


PROTOTYPE/
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[35%/ 50%]
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Annual Savings kWh
Payback period months
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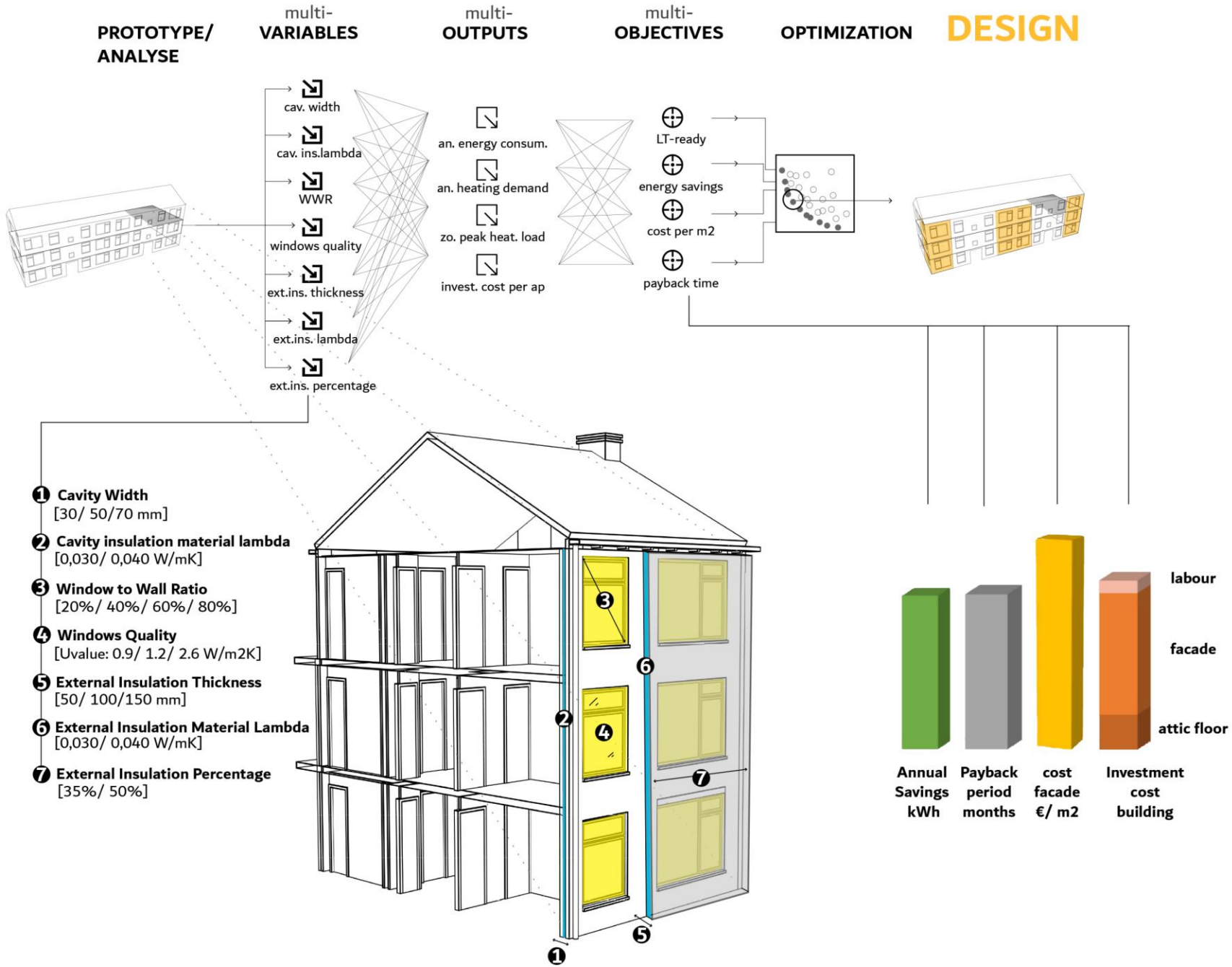
Investment cost building


PROTOTYPE/ ANALYSE
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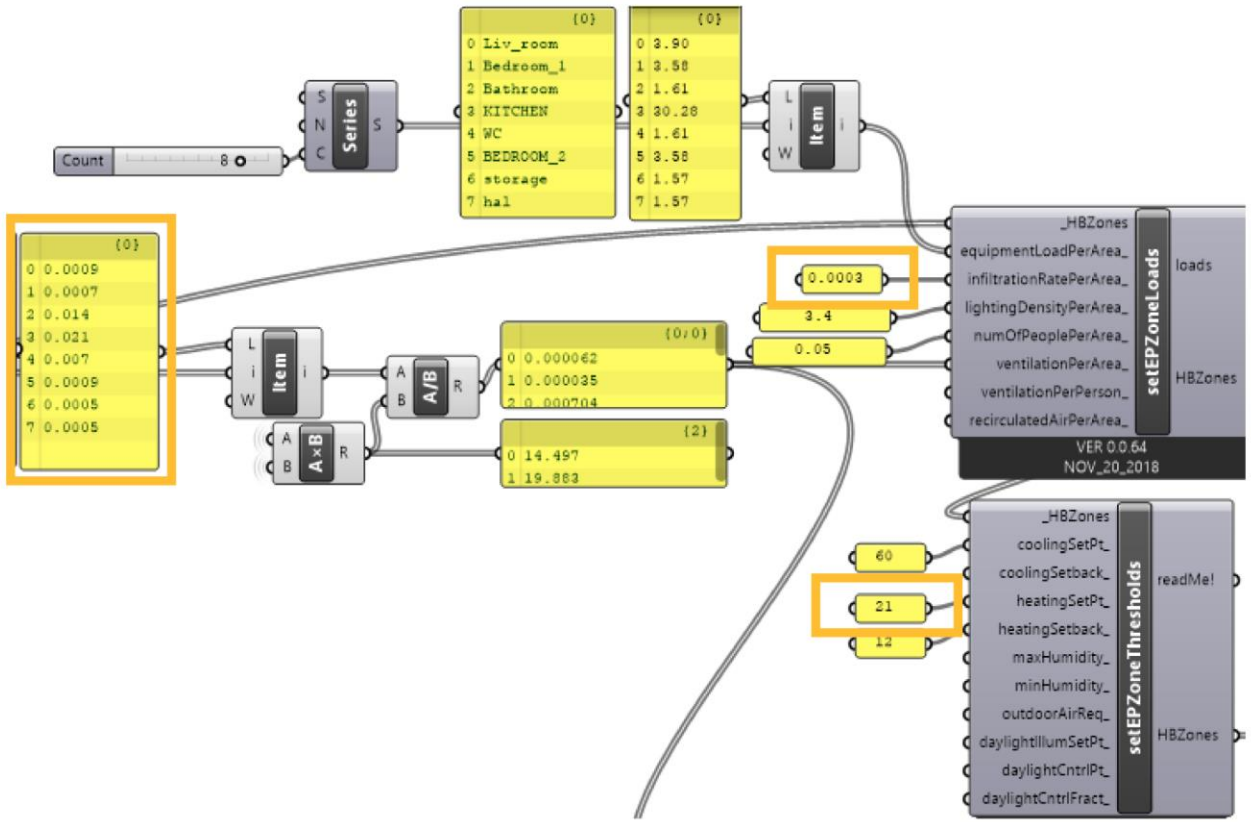
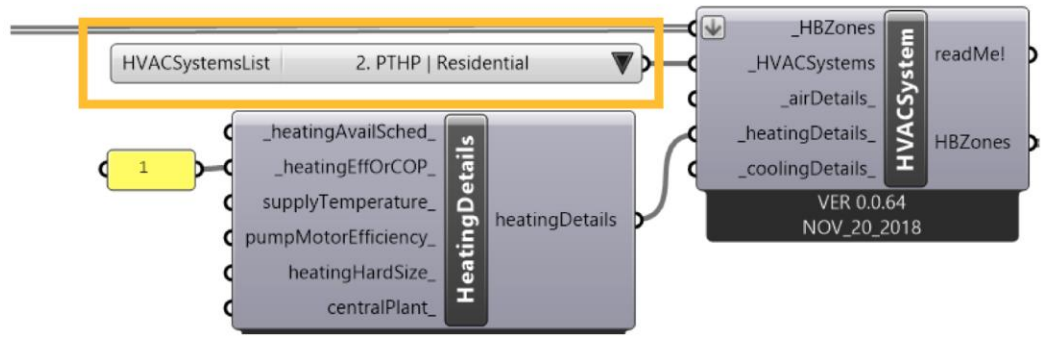
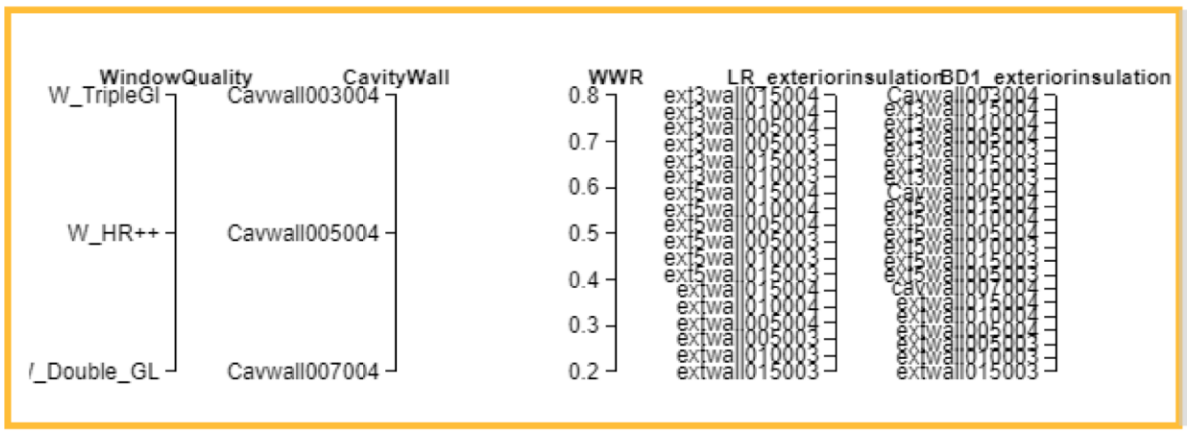
labour
facade
attic floor
Annual Savings kWh
Payback period months
cost facade €/ m2
Investment cost building

GRASSHOPPER

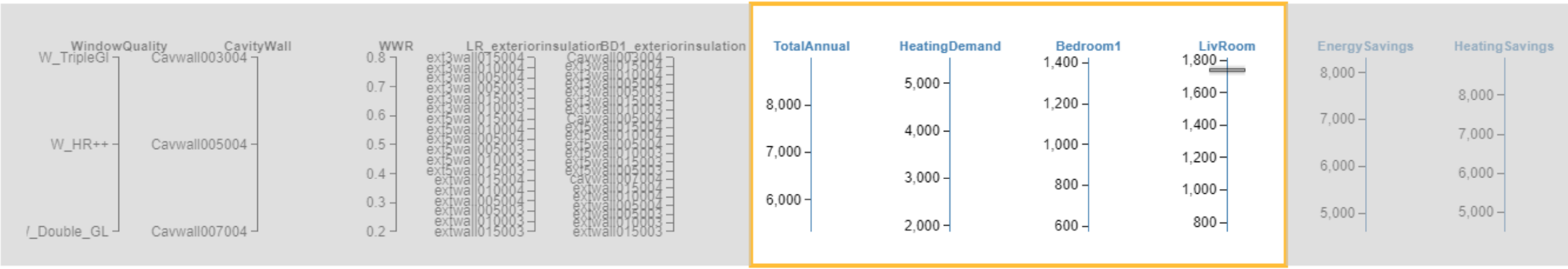




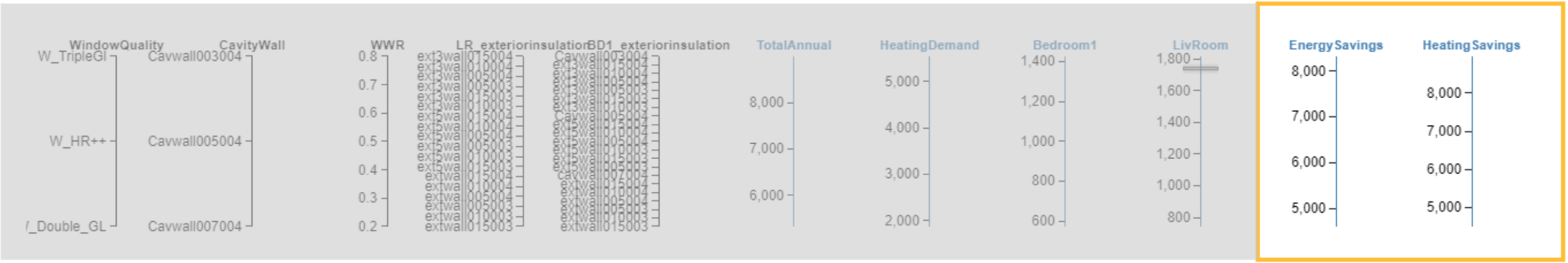
VARIABLES IN DESIGN EXPLORER



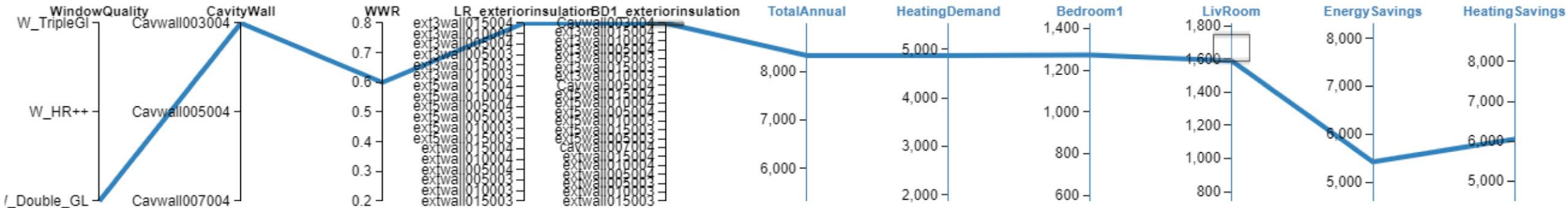
OUTPUTS IN DESIGN EXPLORER



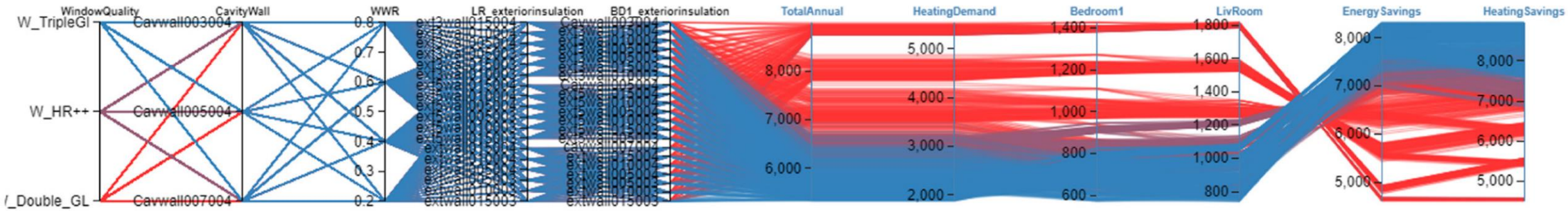
OUTPUTS IN DESIGN EXPLORER



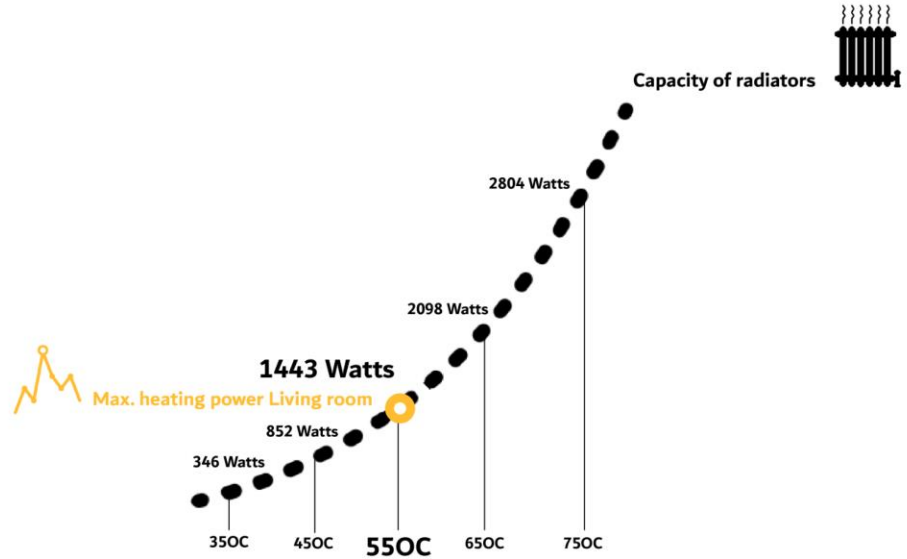
OUTPUTS IN DESIGN EXPLORER



LT READY IN DESIGN EXPLORER

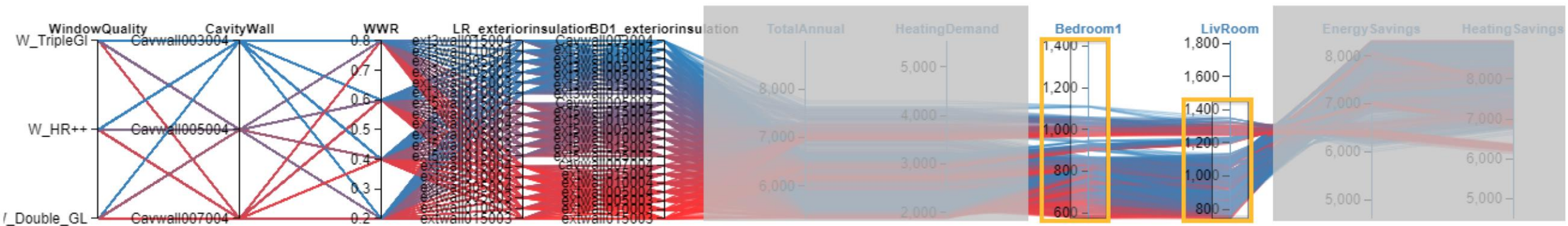


LT READY IN DESIGN EXPLORER

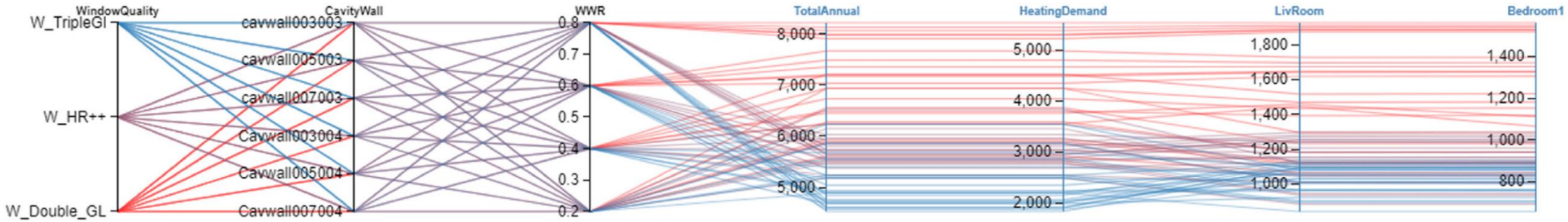


VARIABLES

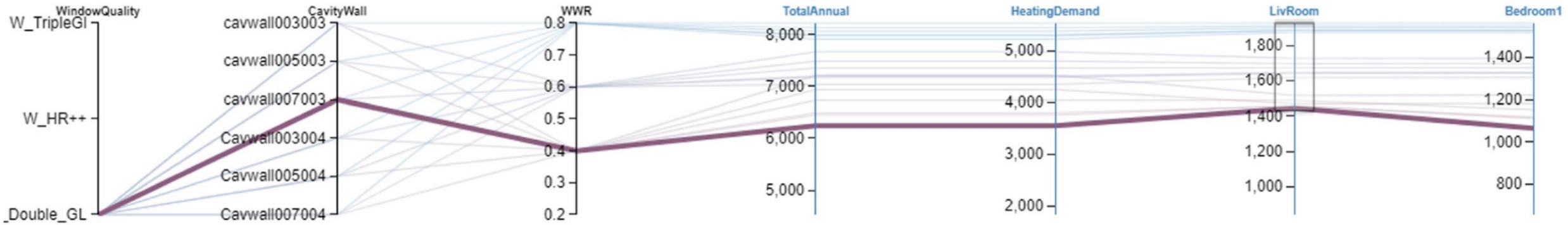
LT- READY

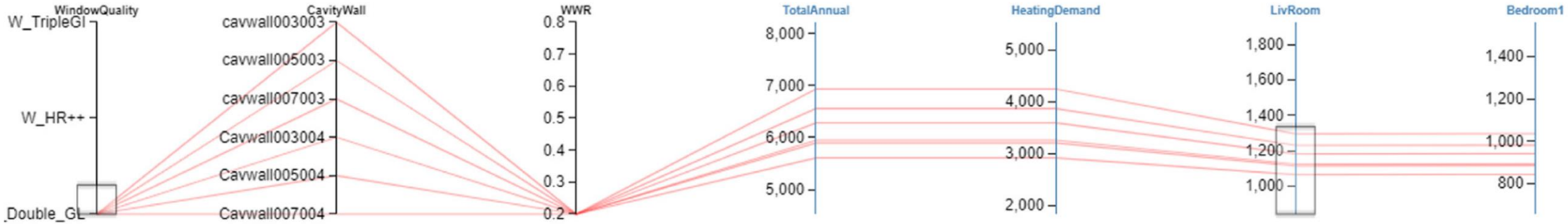


RESULTS- ONLY CAVITY INSULATION

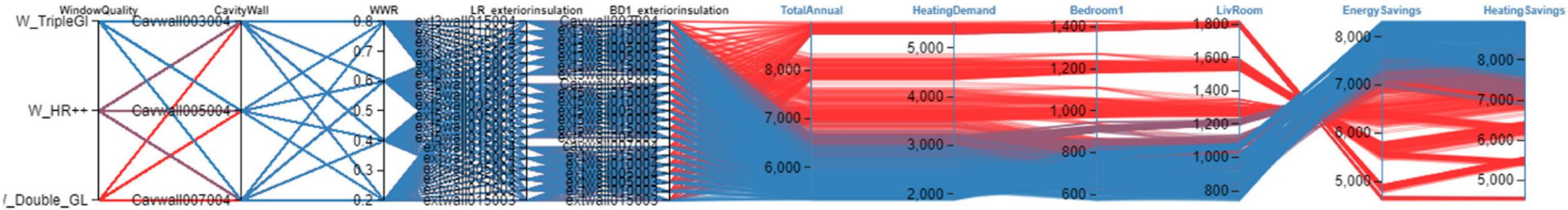


RESULTS- ONLY CAVITY INSULATION





RESULTS- EXTERIOR INSULATION



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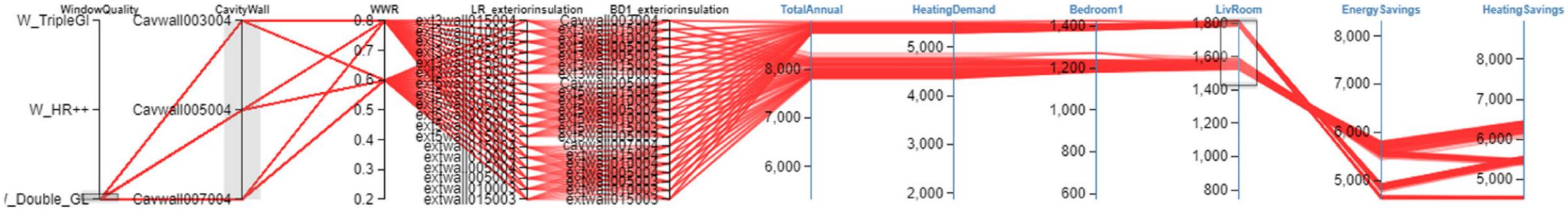
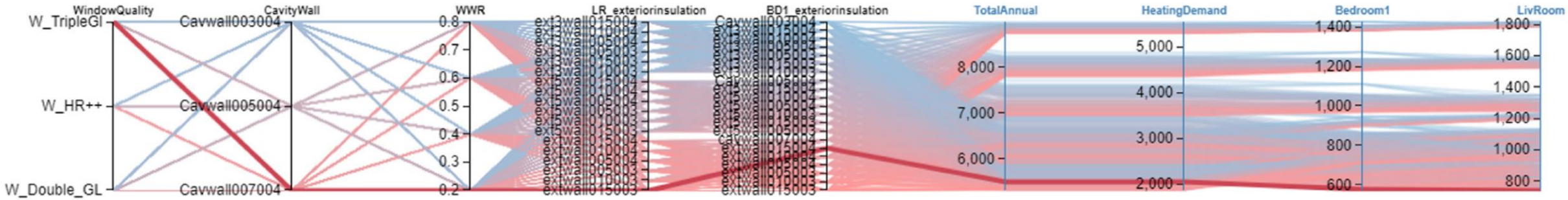
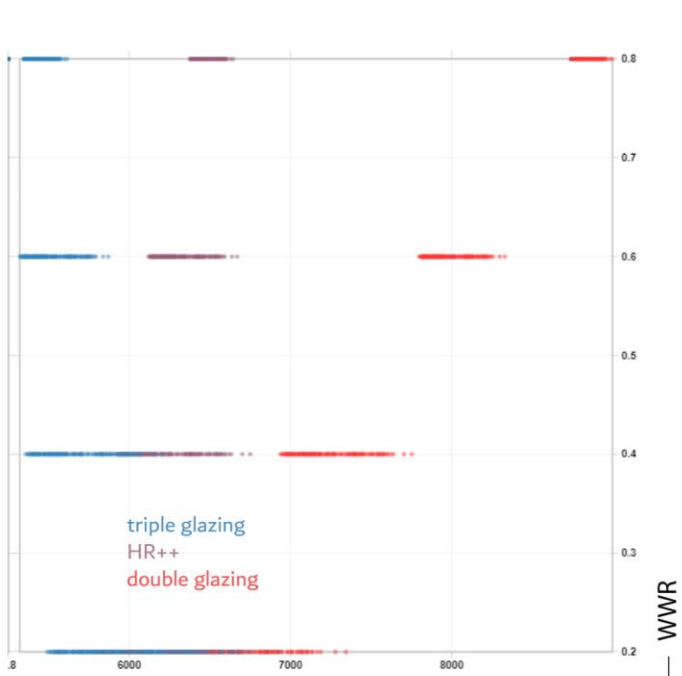
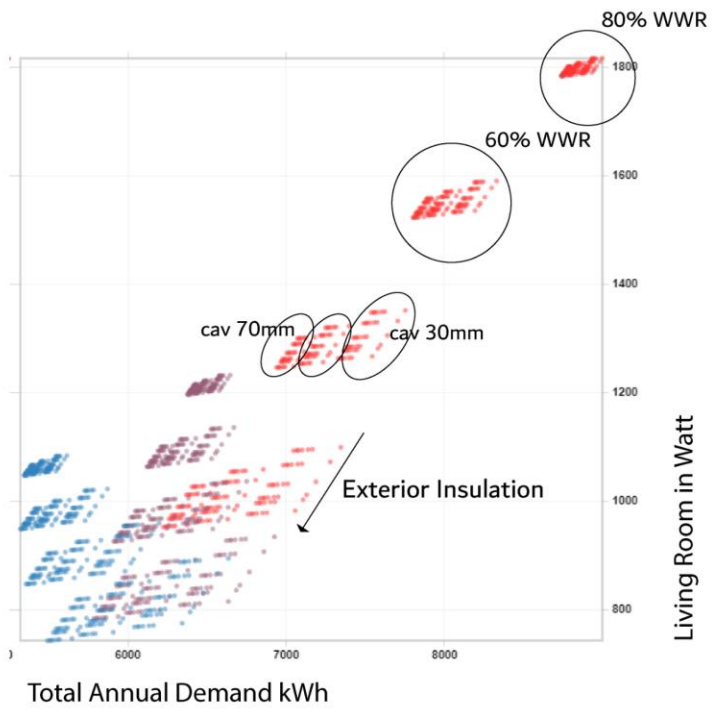




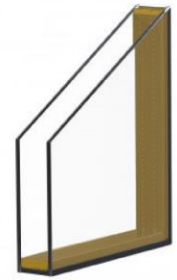
AFFECT WWR- GLAZING





HR++

little affect
at smaller WWR



HR++ AND FRAMES

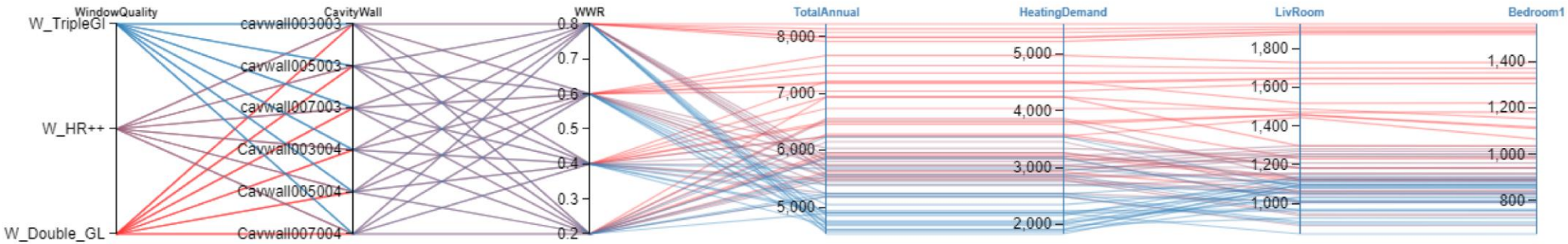
more important at bigger WWR

HR+++ AND FRAMES

more important at bigger WWR

EXAMPLE 1_AMSTERDAM

- SINGLE AND DOUBLE GLAZING WITH WOODEN FRAMES
- 50mm CAVITY UNINSULATED
- WWR 20%



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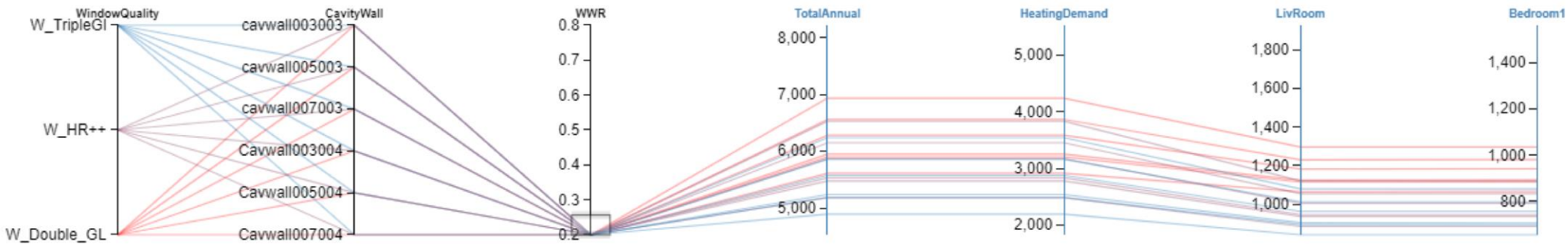
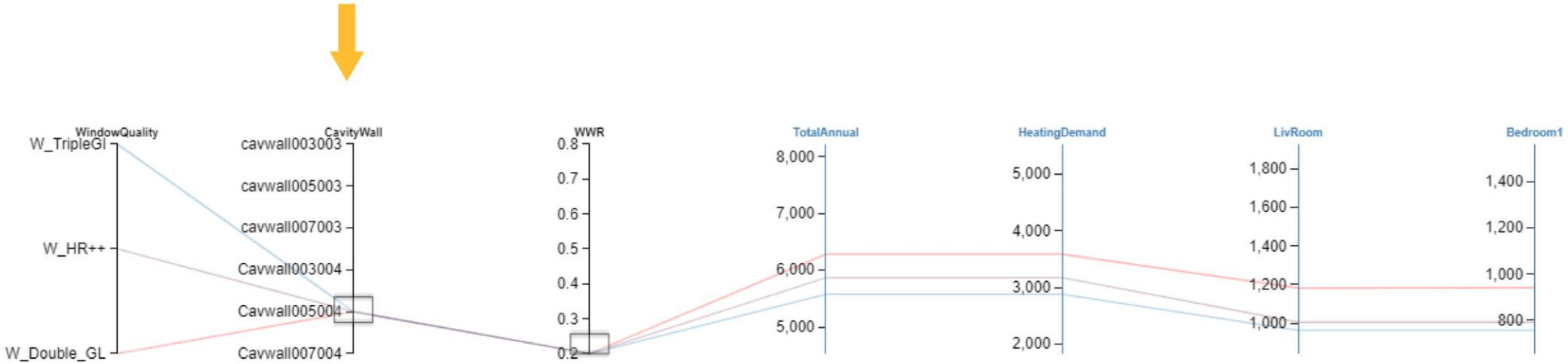


EXAMPLE 1_AMSTERDAM

- SINGLE AND DOUBLE GLAZING WITH WOODEN FRAMES
- 50mm CAVITY ~~UN~~INSULATED WITH EPS = CAV WALL 005 004
- WWR 20%



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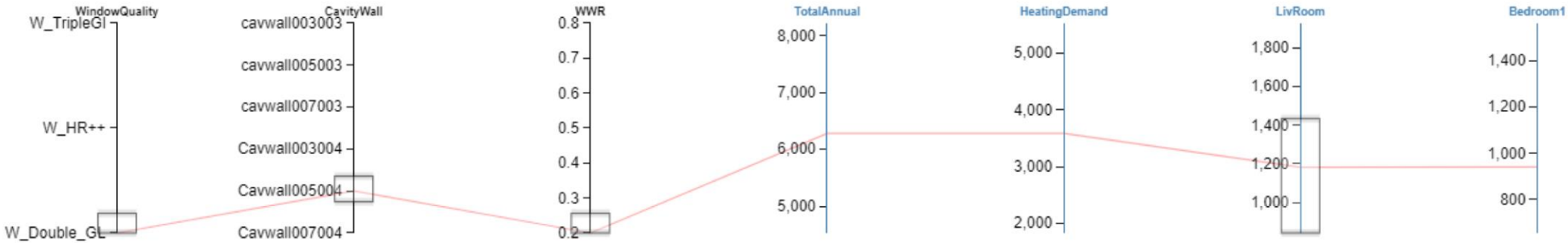
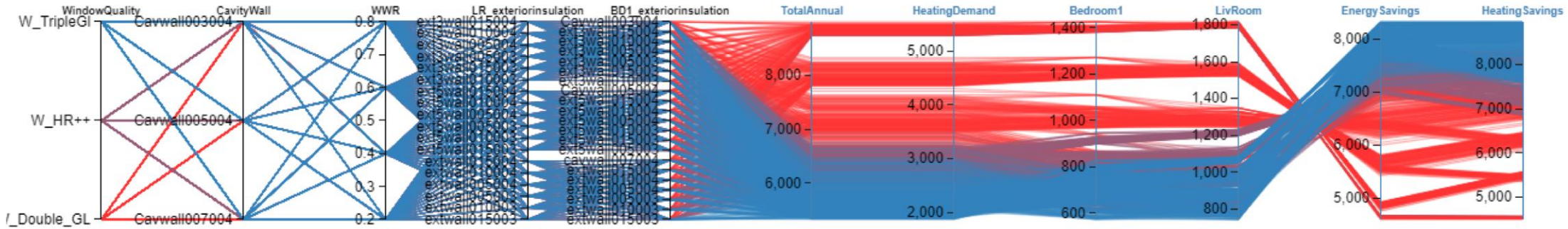


EXAMPLE 2_ROTTERDAM

- DOUBLE GLAZING WITH UPVC FRAMES
- 50mm CAVITY UNINSULATED
- WWR 60%



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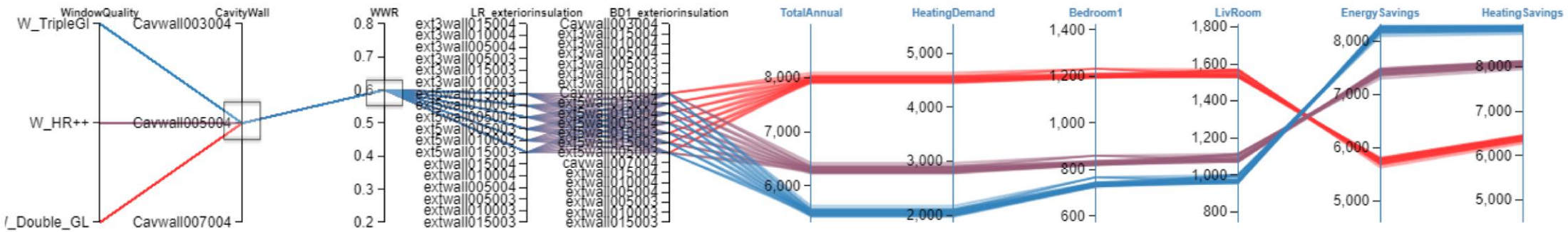
- DOUBLE GLAZING WITH UPVC FRAMES
- 50mm CAVITY ~~UN~~INSULATED WITH EPS = CAV WALL 005 004
- WWR 60%

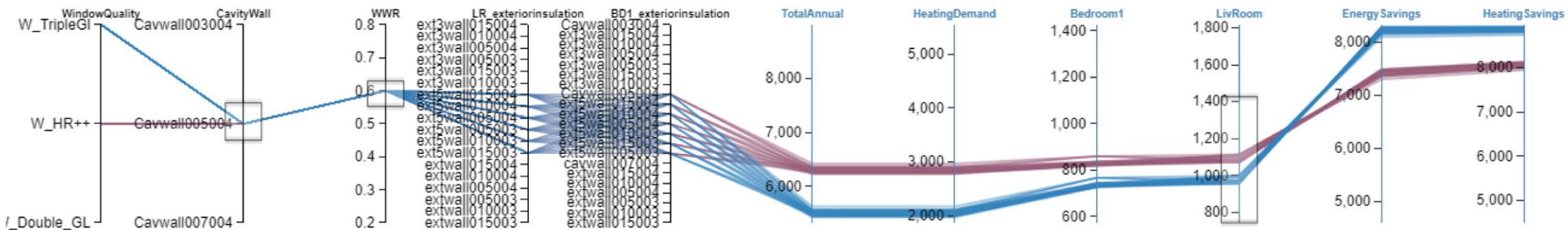


EXAMPLE 2_ROTTERDAM

UPGRADE WINDOWS

50mm CAVITY ~~UN~~INSULATED WITH EPS = CAV WALL 005 004

WWR 60%



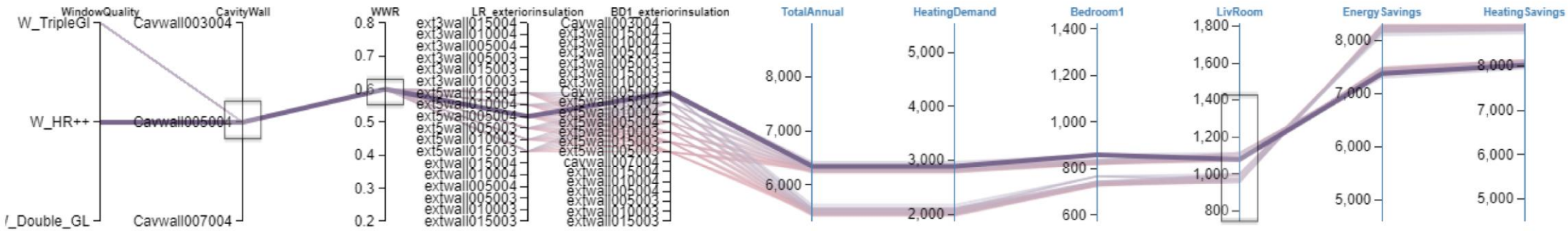
EXAMPLE 2_ROTTERDAM

- UPGRADE WINDOWS
- 50mm CAVITY ~~UN~~INSULATED WITH EPS = CAV WALL 005 004
- WWR 60%

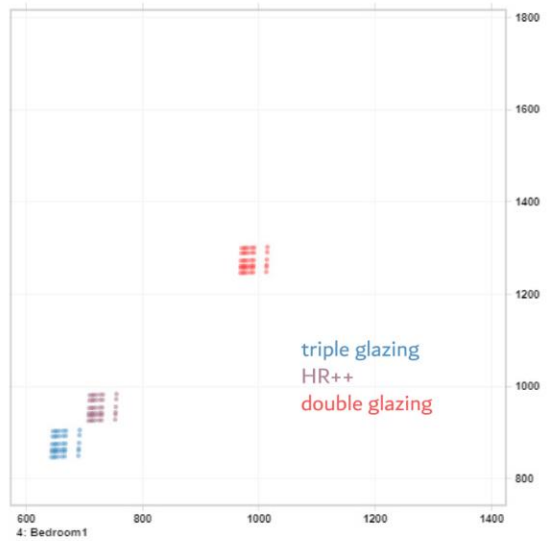
LIVING ROOM: EXT WALL 005 004

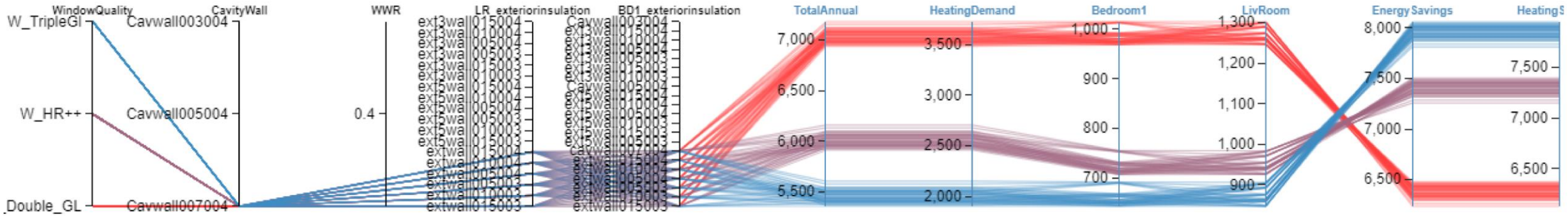
BEDROOM_1: CAV WALL 005 004

32%

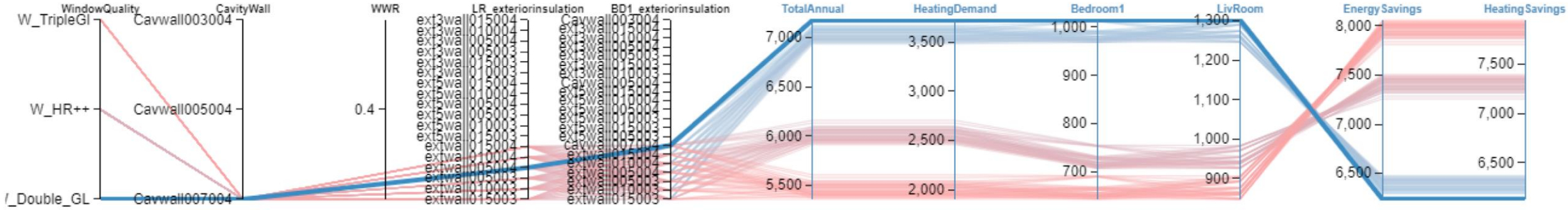


CASE STUDY


triple glazing
HR++
double glazing
4: Bedroom1


WindowQuality
CavityWall
WWR
LR_exteriorinsulation
BD1_exteriorinsulation
TotalAnnual
HeatingDemand
Bedroom1
LivRoom
Energy Savings
W_TripleGl
W_HR++
Double_GL
Cavwall003004
Cavwall005004
Cavwall007004
0.4

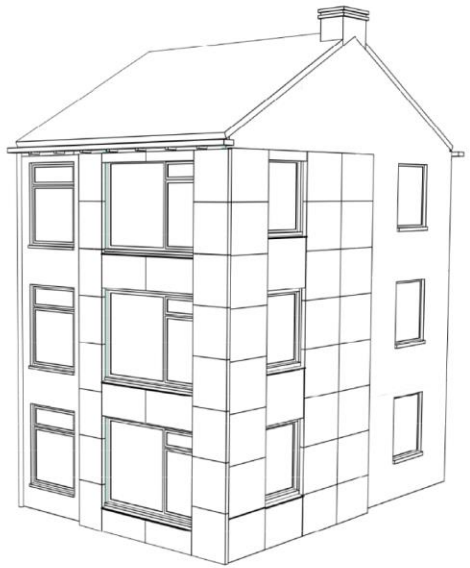
OPTIMIZED IN TERMS OF COSTS

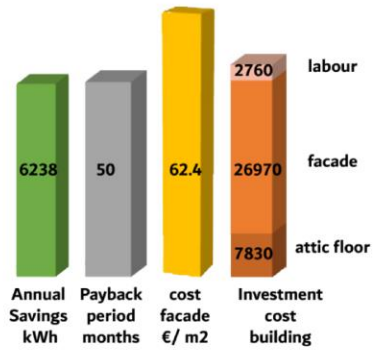


windows quality: double

ext.ins. Rc-value: 3.5 m2K/W

ext.ins. percentage: 32%





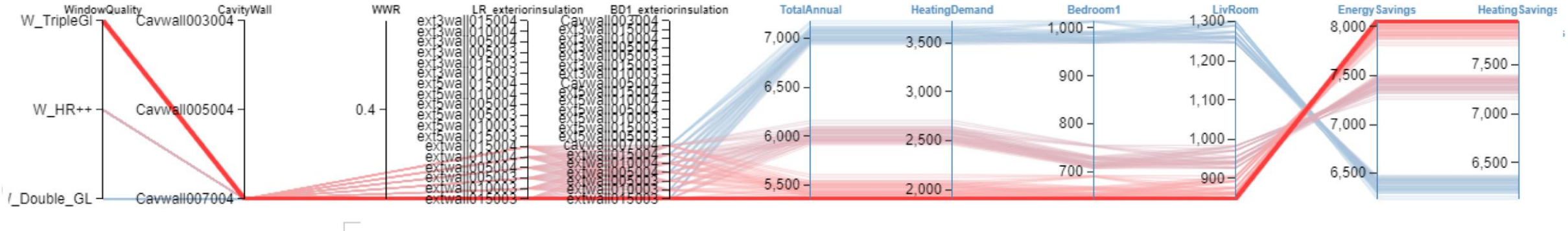
LT-ready: YES 55°C

Energy savings 46%

Cost: 62.4€ per m2

Payback time: 50 months

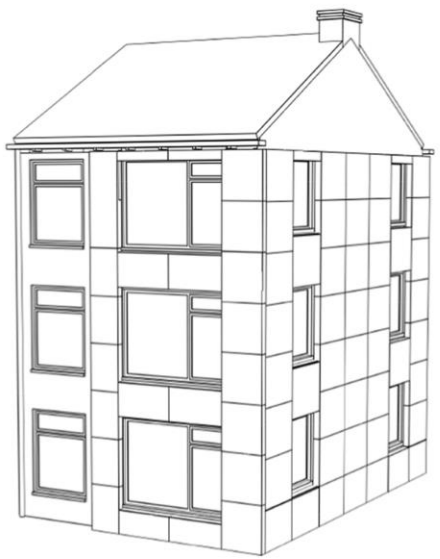
OPTIMIZED IN TERMS OF ENERGY

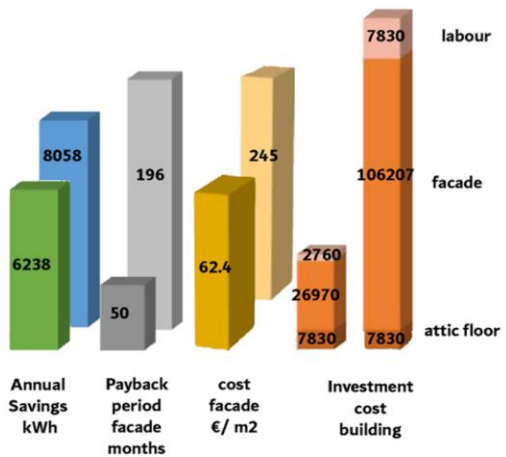


windows quality: triple

ext.ins. Rc-value: 7.2 m2K/W

ext.ins. percentage: 50%





LT-ready: YES 45°C

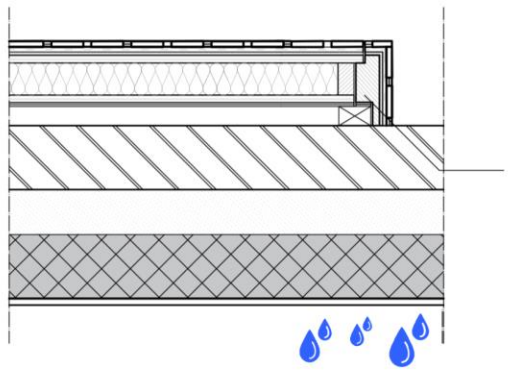
Energy savings 60%

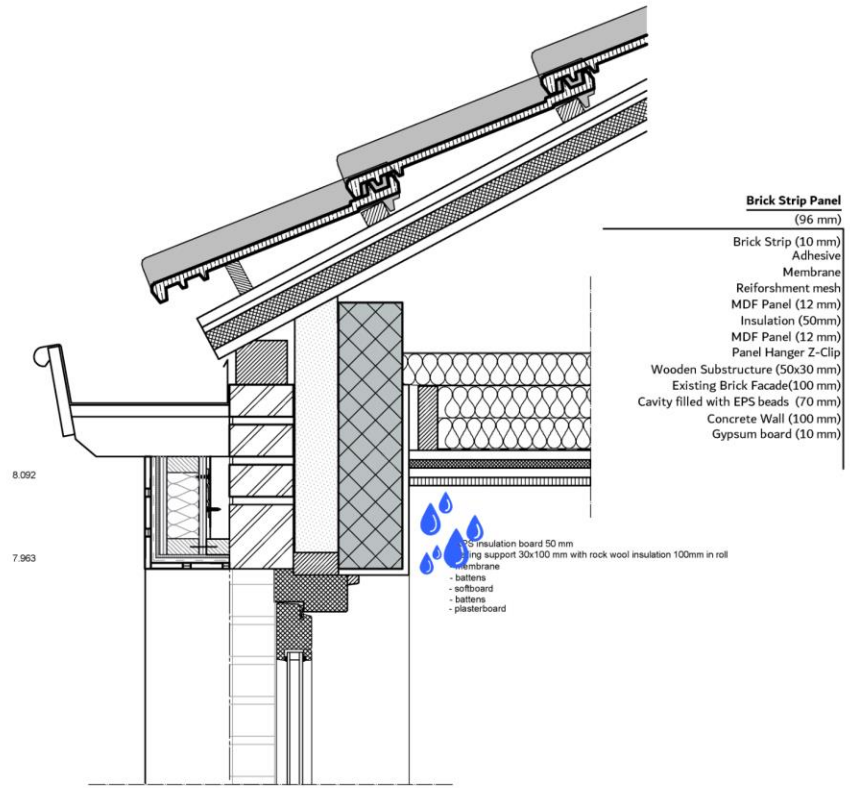
Cost: 245€ per m2

Payback time: 196 months

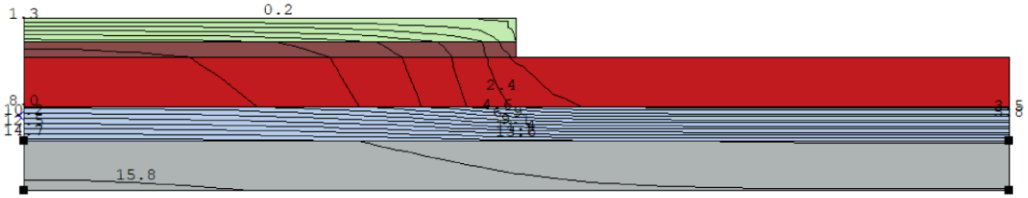
Heating savings 81%

CONDENSATION CHECK

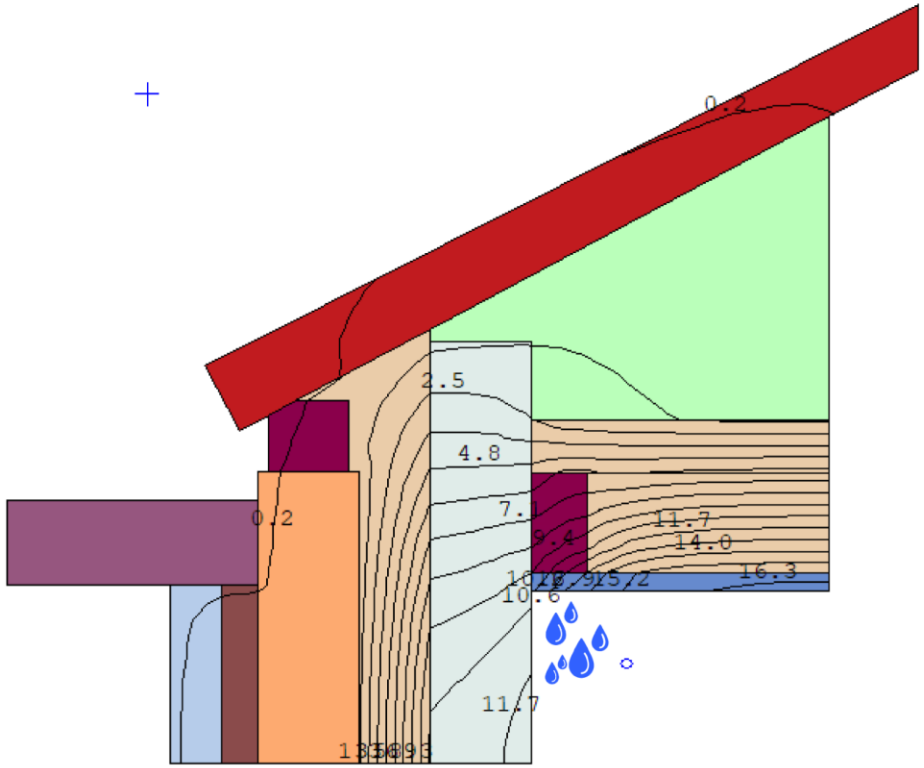




CONDENSATION CHECK

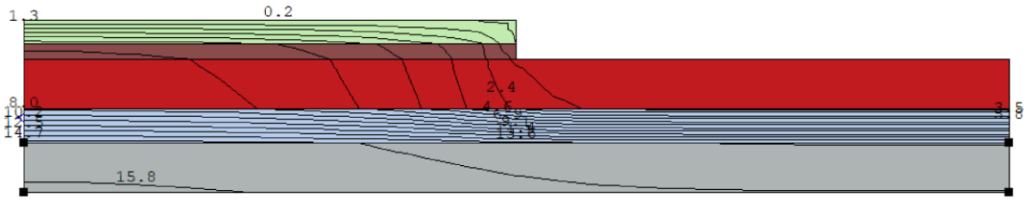


f = Tismin- Te / Ti- Te= 15.8-0 /18- 0 = 0.87 > 0.65

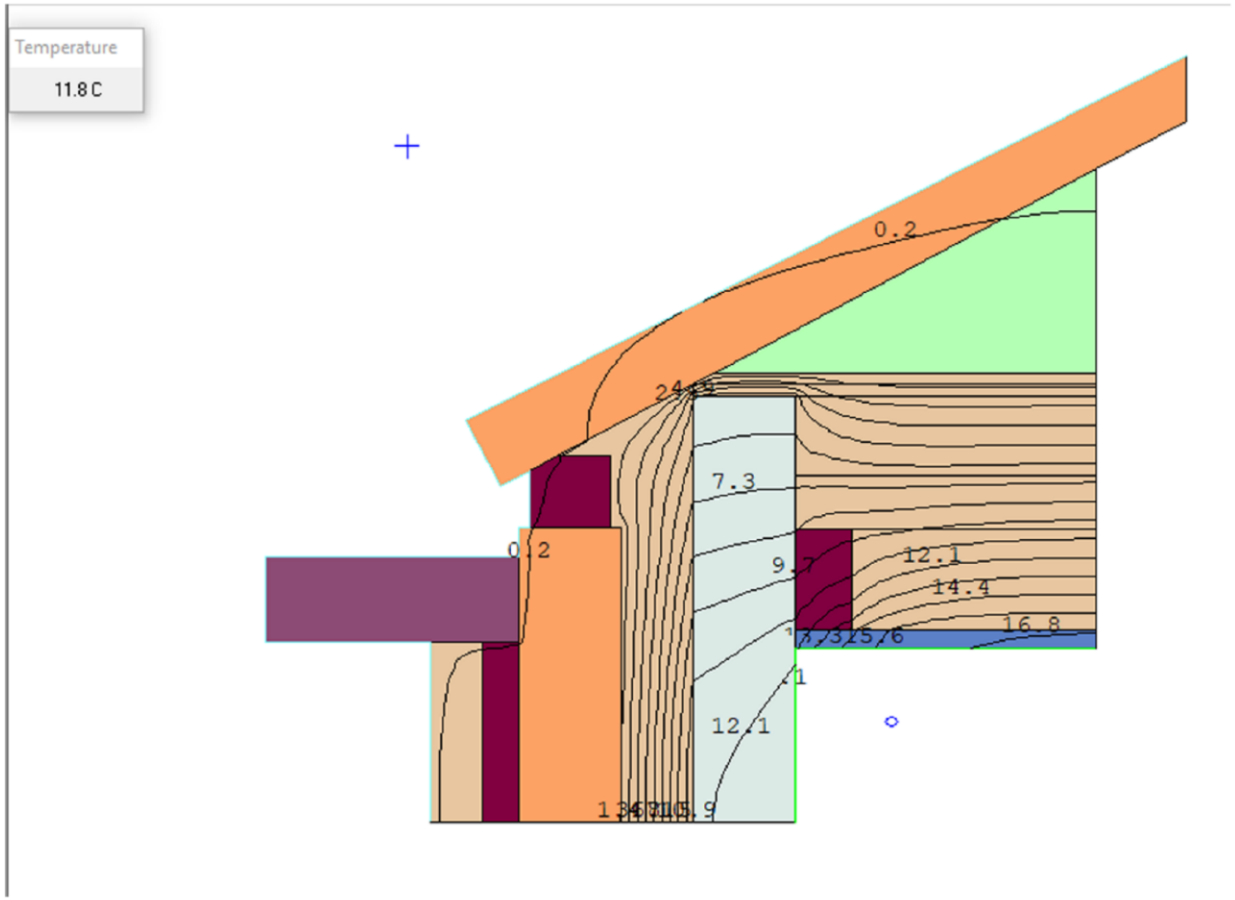


f = Tismin- Te / Ti- Te= 10.6-0 /18- 0 = 0.59 < 0.65

CONDENSATION CHECK



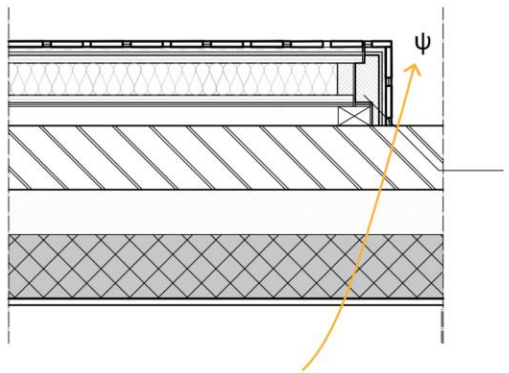
f = Tismin- Te / Ti- Te= 15.8-0 /18- 0 = 0.87 > 0.65

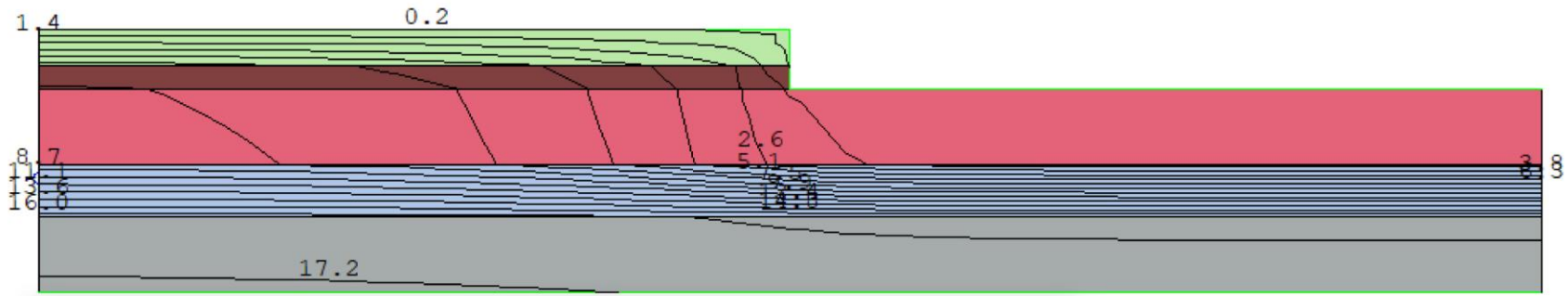


f = Tismin- Te / Ti- Te= 11.8-0 /18- 0 = 0.656> 0.65

ADDITIONAL HEAT LOSS

2.47 Watt





1 FRAMEWORK

2 LITERATURE STUDY

3 CASE STUDY

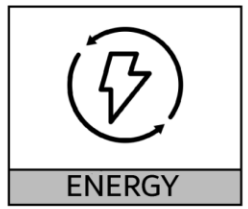
4 8 MEASURES

5 SIMULATION GRASSHOPPER

6 DESIGN

7 CONCLUSION

DESIGN CRITERIA



ENERGY

32% INSULATED

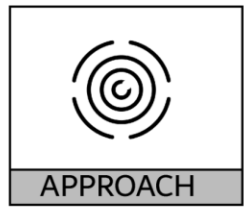
Rc-VALUE CAVITY 2.2 m2K/W

Rc-VALUE EXTERNAL 3.9 m2K/W

U-VALUE WINDOWS 2.6 W/m2K

U-VALUE ATTIC FLOOR 0.35 W/m2K

EXT. INS. THICKNESS 50mm



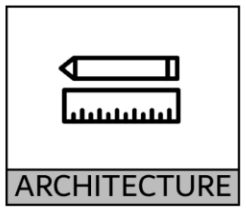
APPROACH

REDUCED APPLICATION TIME

REDUCED NUISANCE

ABLE TO CONTINUE IN THE FUTURE

LOWER FINANCIAL INVESTMENT

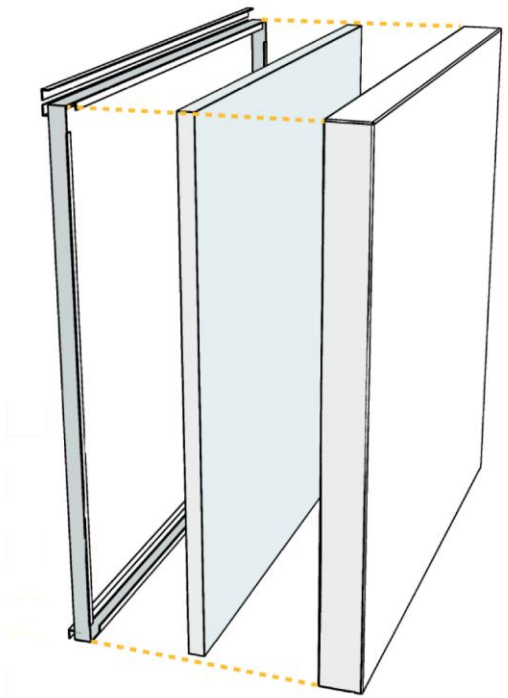


ARCHITECTURE

ADAPTABLE

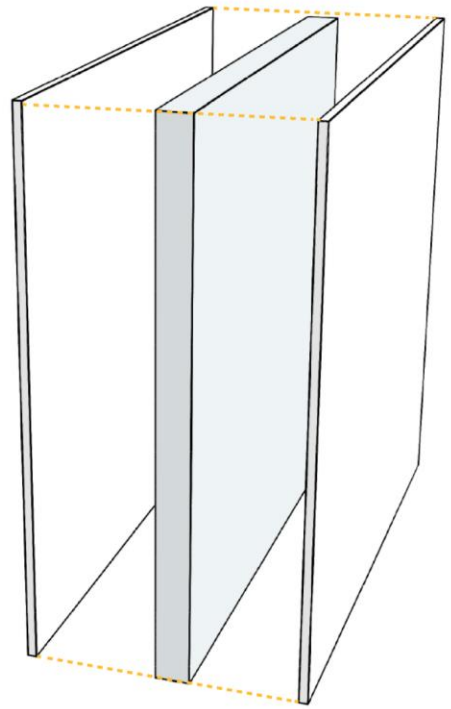
OPTIONS FOR CLADDING

LAYERS OF THE PANEL



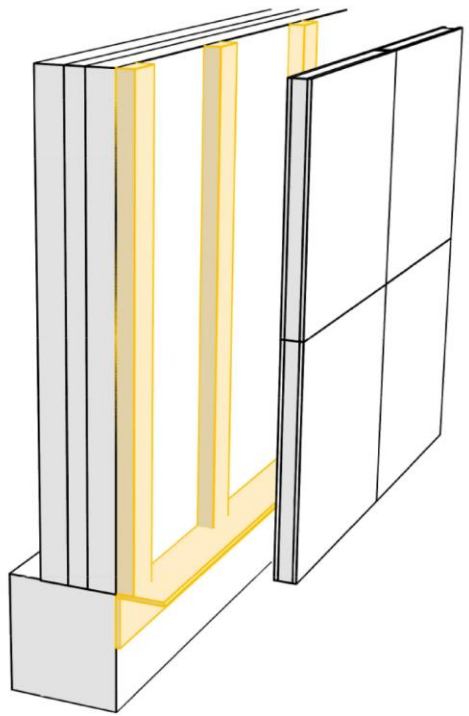
FRAME PANEL

OR



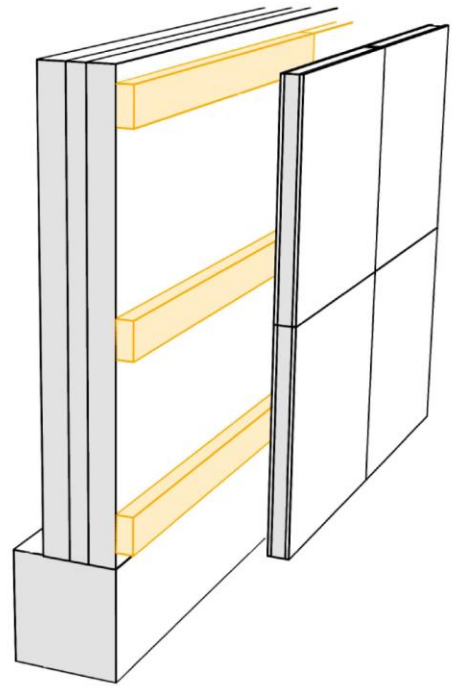
SANDWICH PANEL

CONSTRUCTION



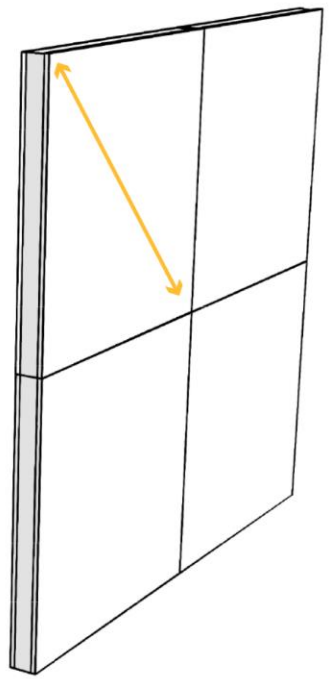
STANDING

OR



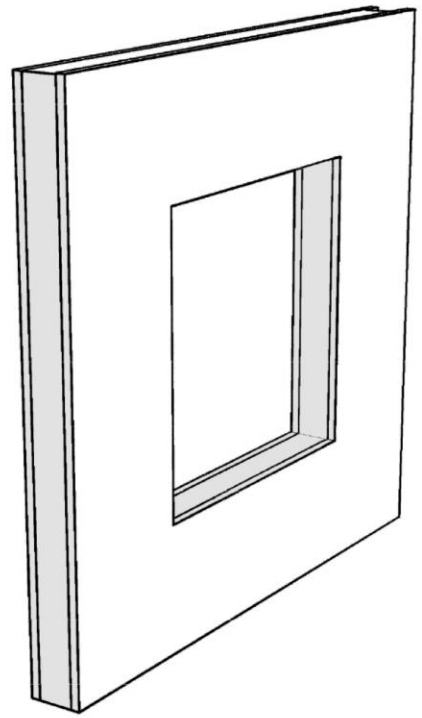
SUSPENDED

SIZE OF THE PANEL



SIZE

OR



WINDOWS INTEGRATED

FIXING METHOD

Source: marvelengineeringworks.com

Z CLIP

OR

hacktronics.co.in

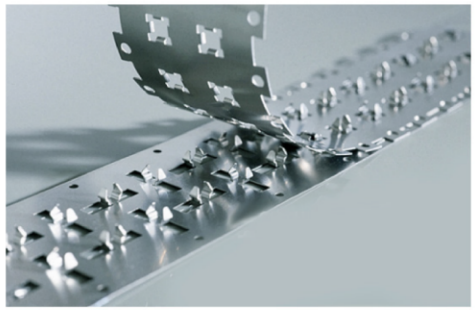
METAL STRIP

OR

grandvoltage.ro

STEEL U PROFILE

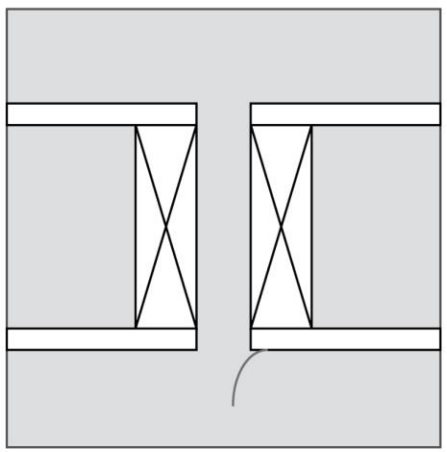
OR



metaklett.com

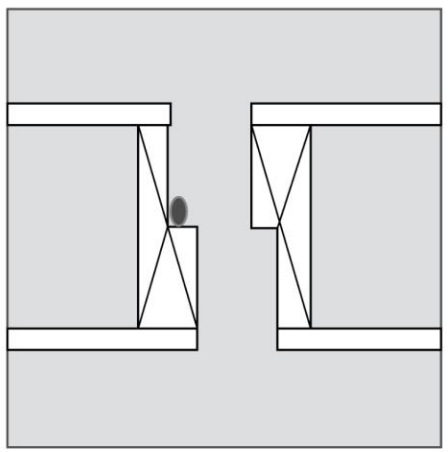
INDUSTRIAL VELCRO

CHAINING METHOD



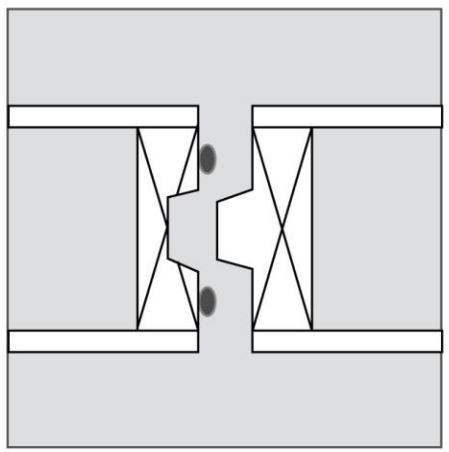
FLUSH JOINT

OR



REBATE

OR

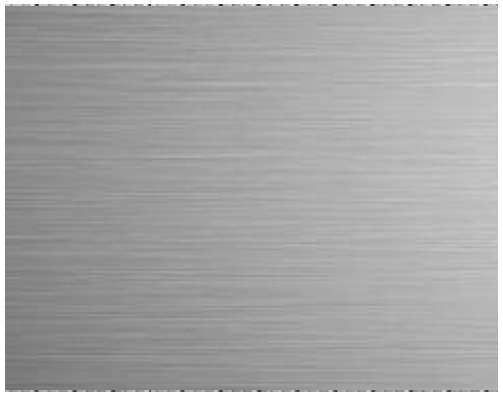


TONGUE IN GROOVE

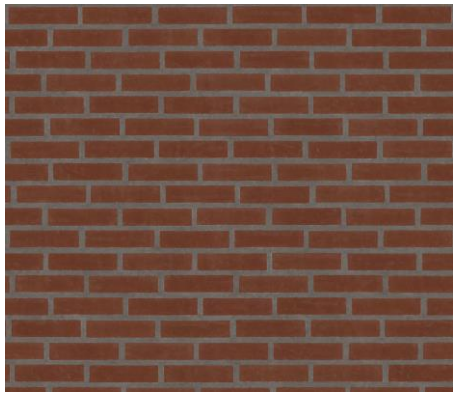
CLADDING

Wood

Plaster



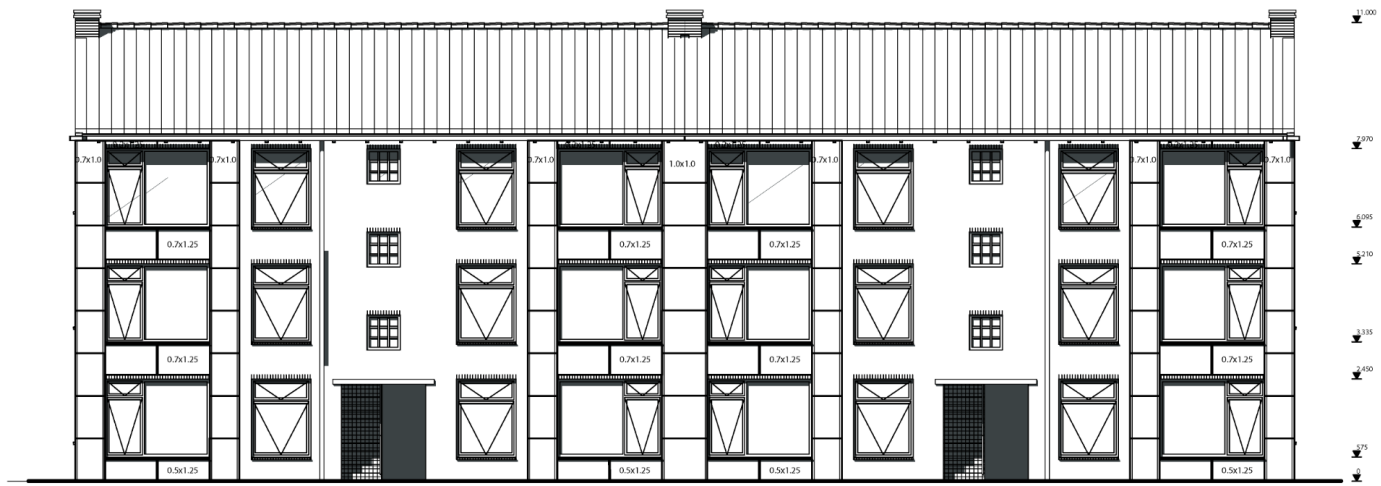
Metal

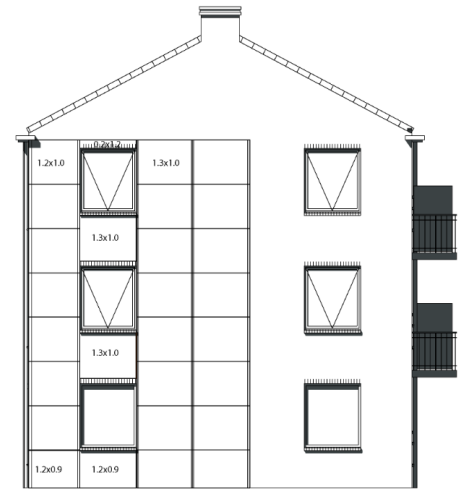


Brick strips

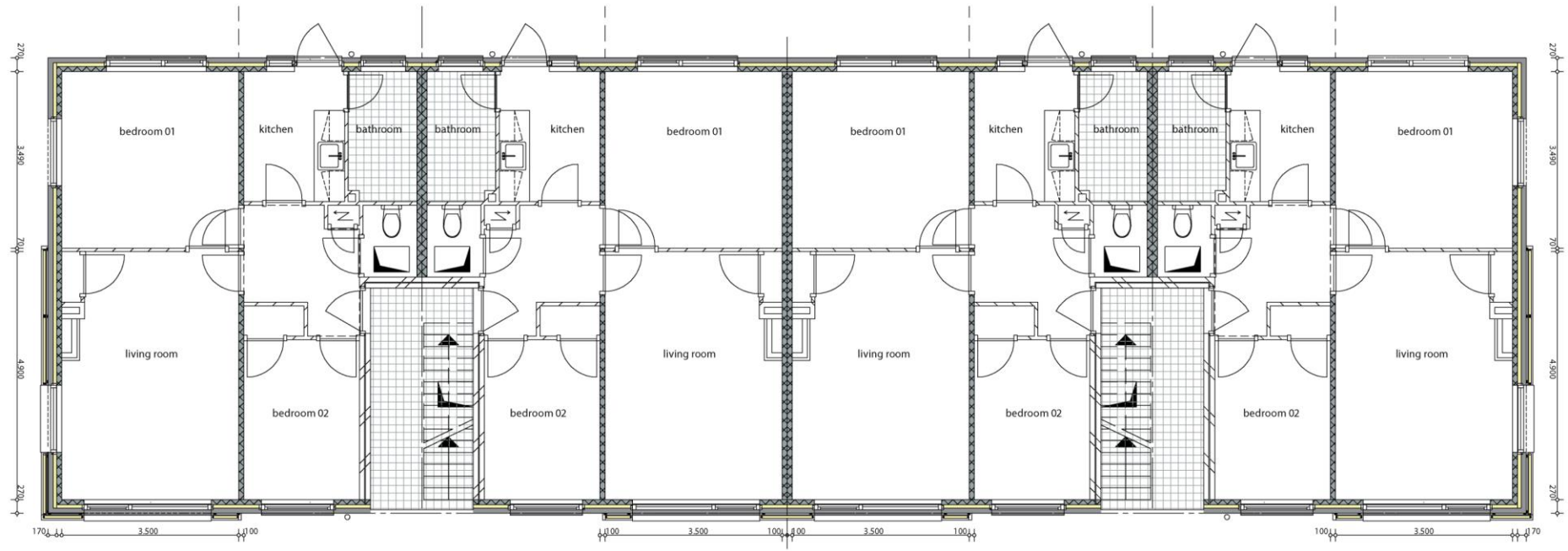
Source: textures.com

APPLICATION

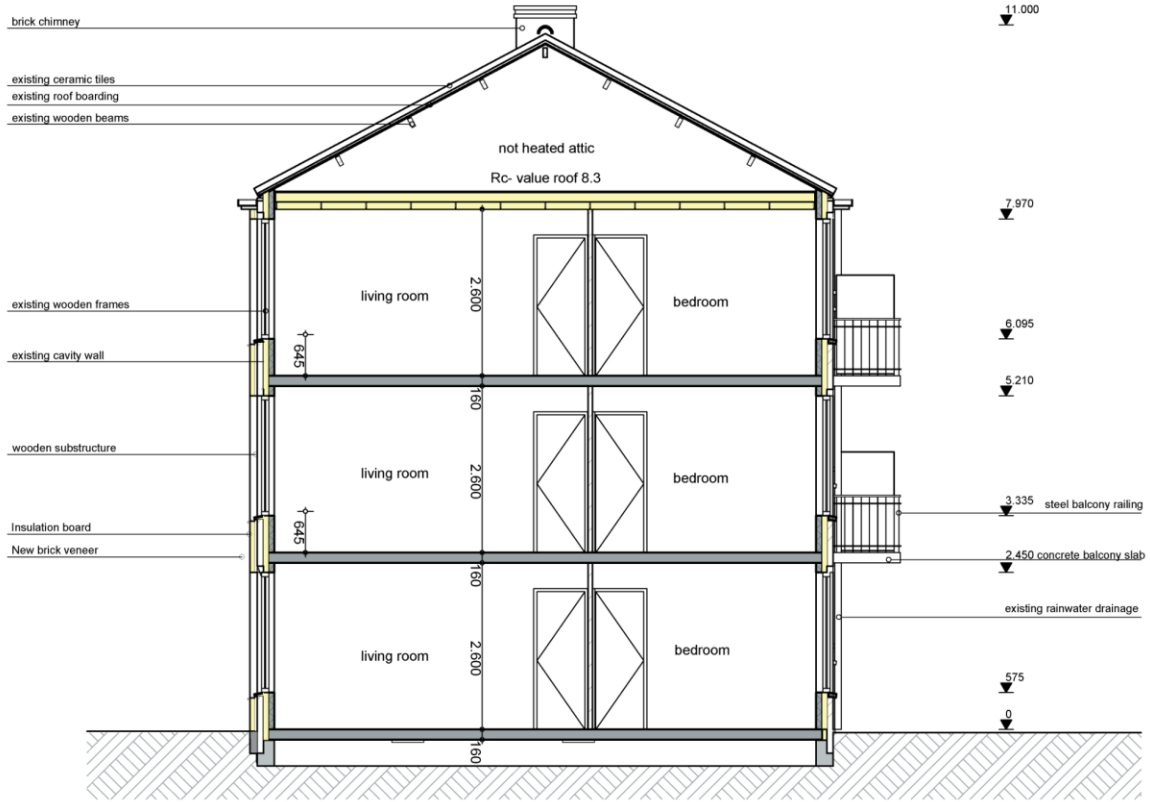




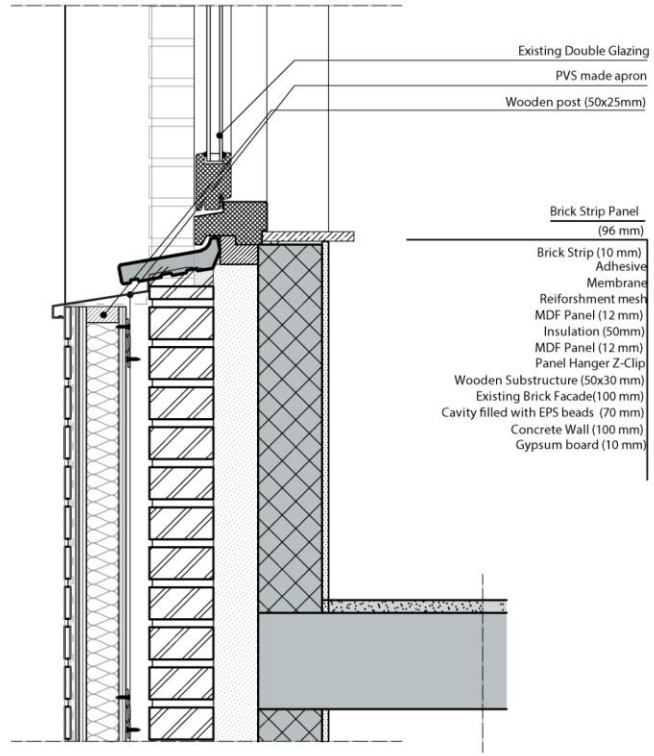
FLOOR PLAN


bedroom 01
kitchen
bathroom
bathroom
kitchen
bedroom 01
bedroom 01
kitchen
bathroom
bathroom
kitchen
bedroom 01
living room
bedroom 02
bedroom 02
living room
living room
bedroom 02
bedroom 02
living room
270
3,490
700
4,900
270
170
3,500
100
100
3,500
100
100
3,500
100
100
3,500
170

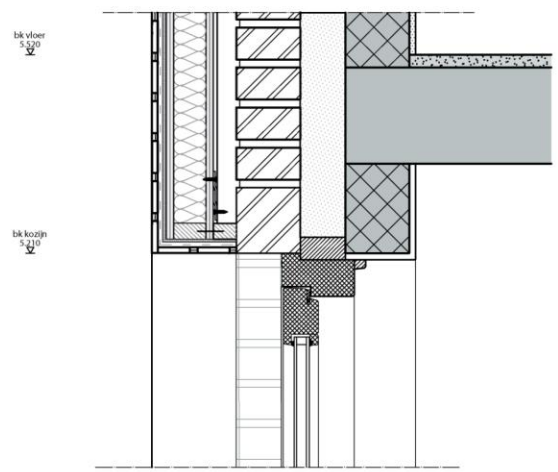
SECTION


brick chimney
existing ceramic tiles
existing roof boarding
existing wooden beams
not heated attic
Rc- value roof 8.3
existing wooden frames
existing cavity wall
wooden substructure
Insulation board
New brick veneer
living room
bedroom
living room
bedroom
living room
bedroom
2.600
645
160
2.600
645
160
2.600
160
11.000
7.970
6.095
5.210
3.335
steel balcony railing
2.450 concrete balcony slab
existing rainwater drainage
575
0

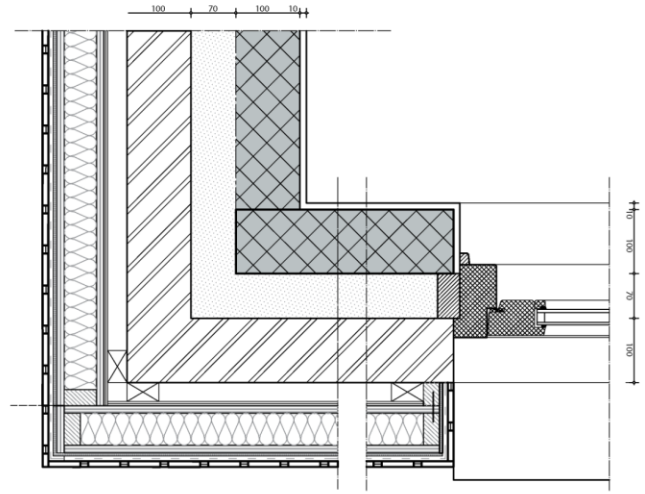
DETAIL A



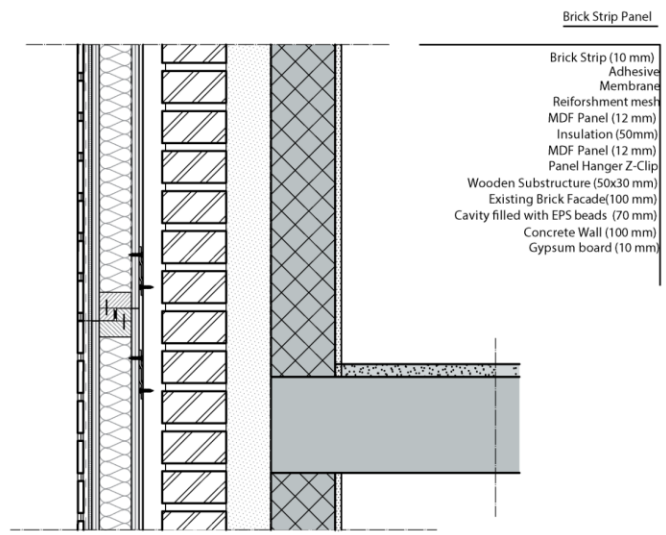
DETAIL B



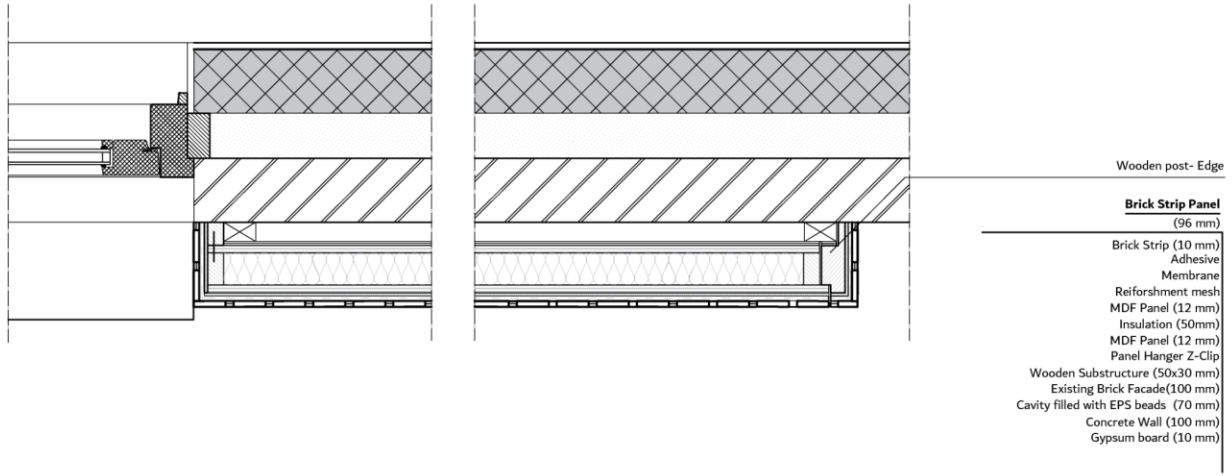
DETAIL C



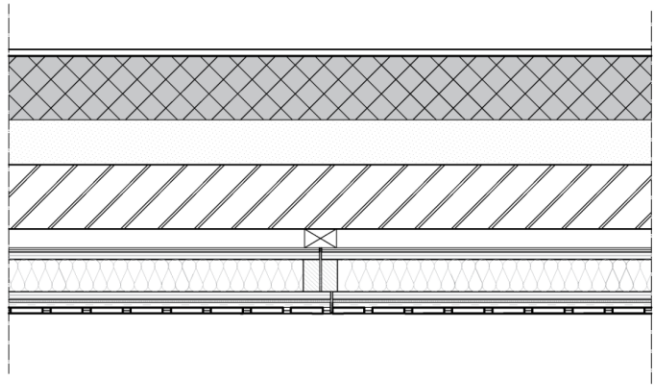
DETAIL D



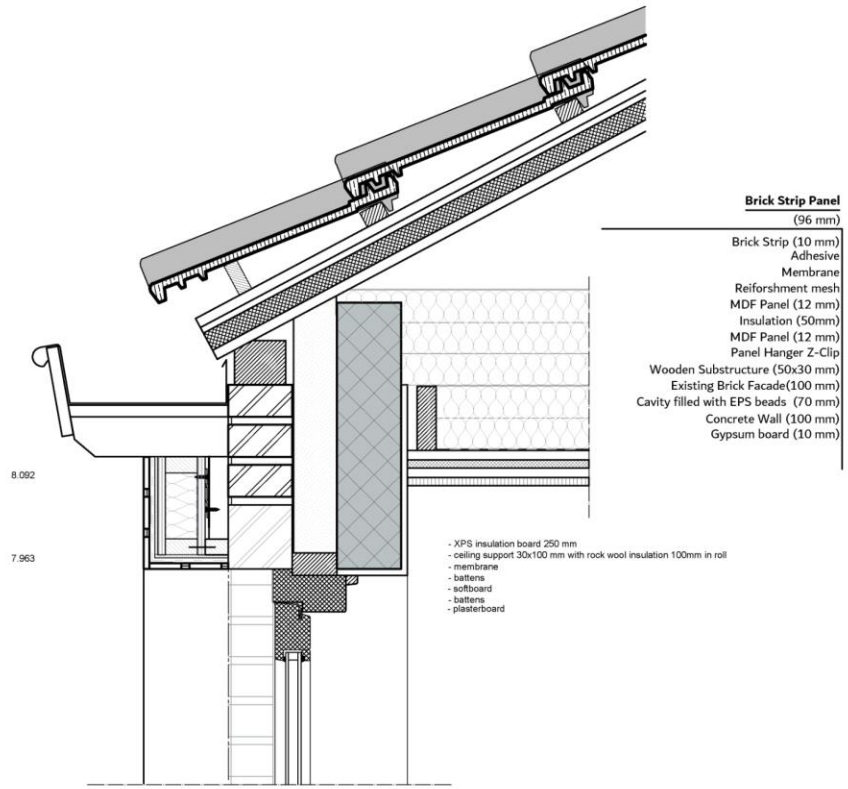
DETAIL E



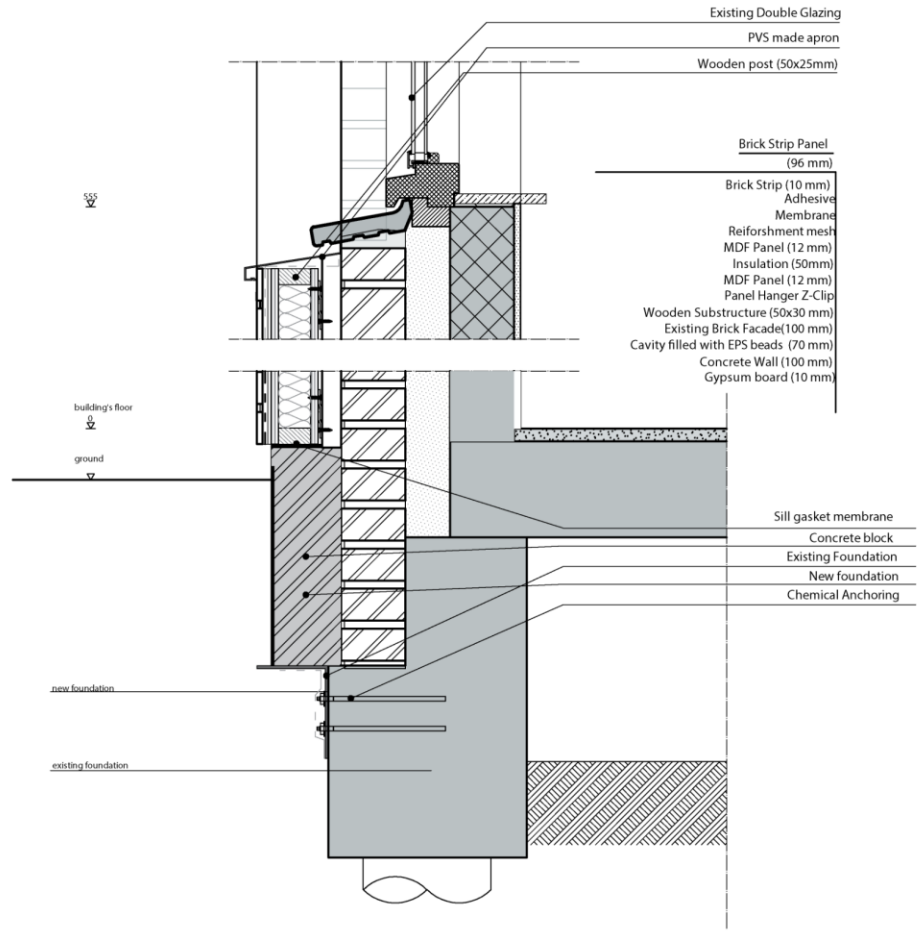
DETAIL F



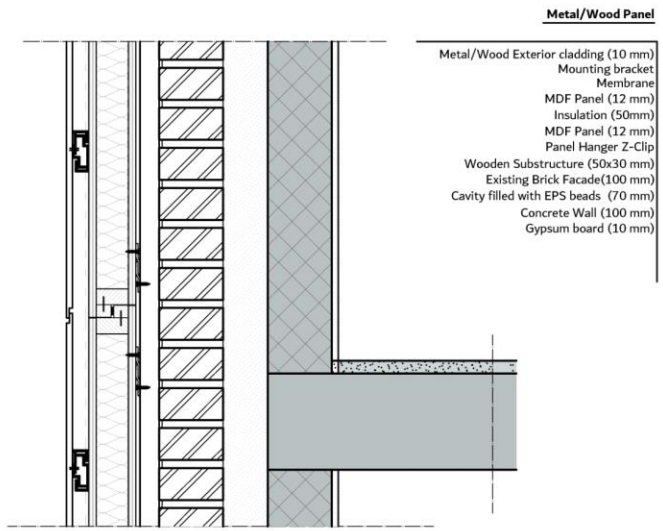
DETAIL G


Brick Strip Panel
(96 mm)
Brick Strip (10 mm)
Adhesive
Membrane
Reiforshment mesh
MDF Panel (12 mm)
Insulation (50mm)
MDF Panel (12 mm)
Panel Hanger Z-Clip
Wooden Substructure (50x30 mm)
Existing Brick Facade(100 mm)
Cavity filled with EPS beads (70 mm)
Concrete Wall (100 mm)
Gypsum board (10 mm)
8.092
7.963
- XPS insulation board 250 mm
- ceiling support 30x100 mm with rock wool insulation 100mm in roll
- membrane
- battens
- softboard
- battens
- plasterboard

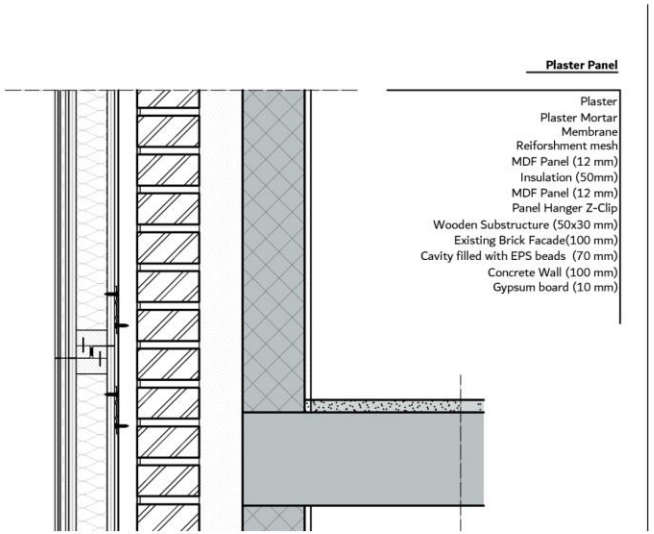
DETAIL H

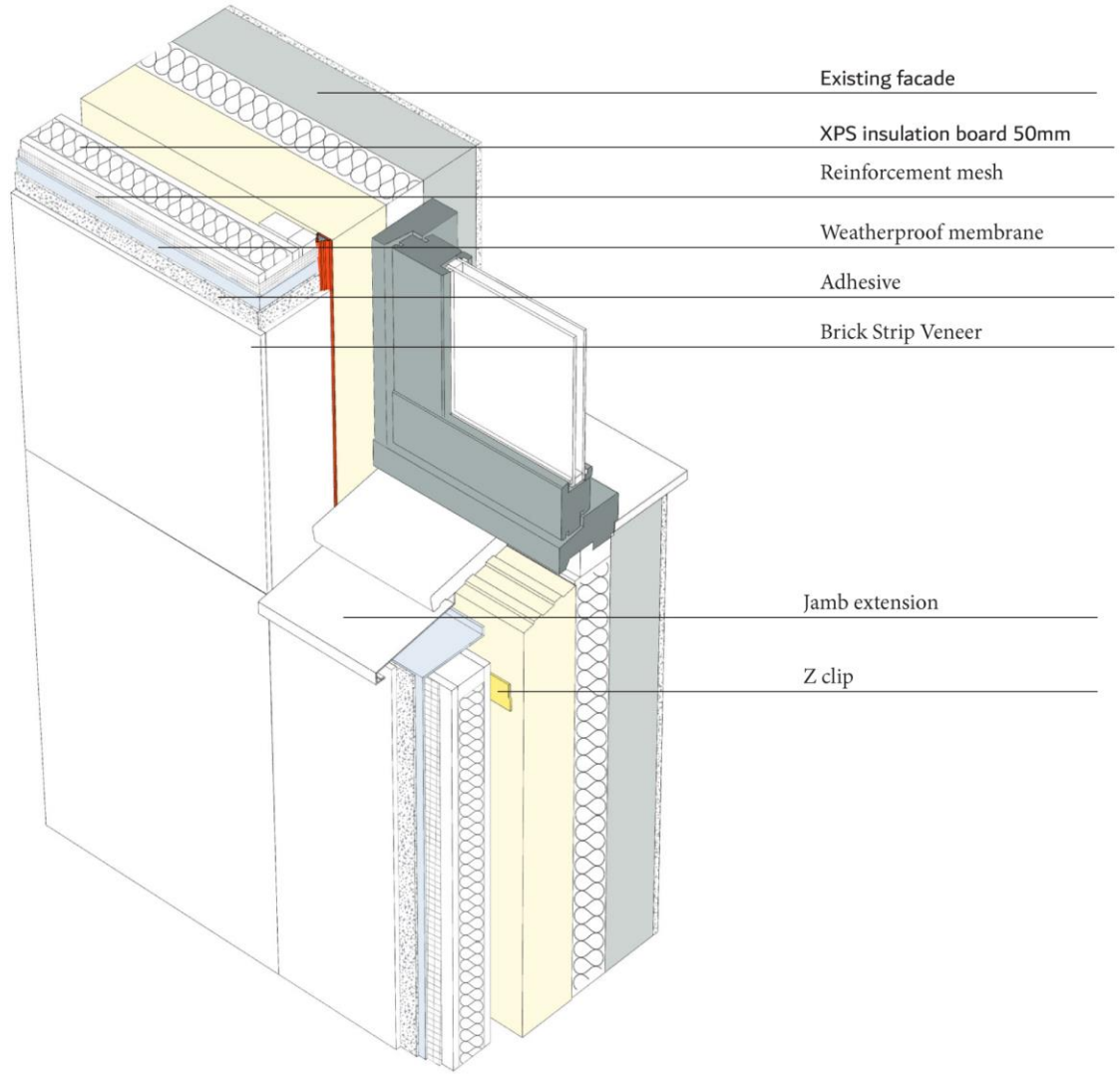

Existing Double Glazing
PVS made apron
Wooden post (50x25mm)
Brick Strip Panel
(96 mm)
Brick Strip (10 mm)
Adhesive
Membrane
Reiforshment mesh
MDF Panel (12 mm)
Insulation (50mm)
MDF Panel (12 mm)
Panel Hanger Z-Clip
Wooden Substructure (50x30 mm)
Existing Brick Facade(100 mm)
Cavity filled with EPS beads (70 mm)
Concrete Wall (100 mm)
Gypsum board (10 mm)
555
building's floor
0
ground
Sill gasket membrane
Concrete block
Existing Foundation
New foundation
Chemical Anchoring
new foundation
existing foundation

DETAIL I



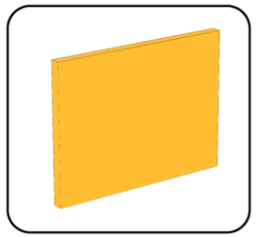
DETAIL J



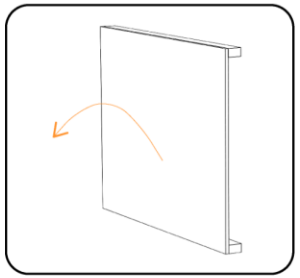

Existing facade
XPS insulation board 50mm
Reinforcement mesh
Weatherproof membrane
Adhesive
Brick Strip Veneer
Jamb extension
Z clip

CONSTRUCTION SEQUENCE

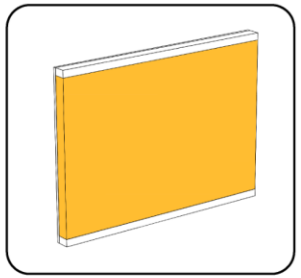
OFF-SITE CONSTRUCTION



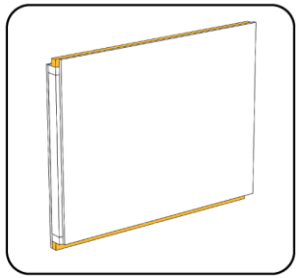
INSULATION PRODUCTION



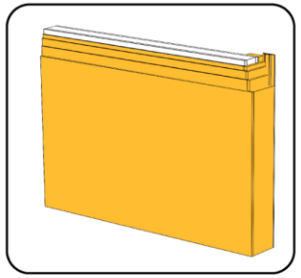
WOODEN FRAME



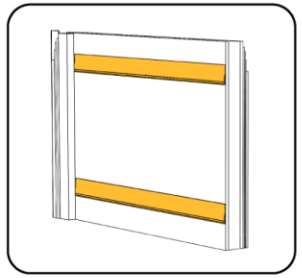
PLACING INSULATION



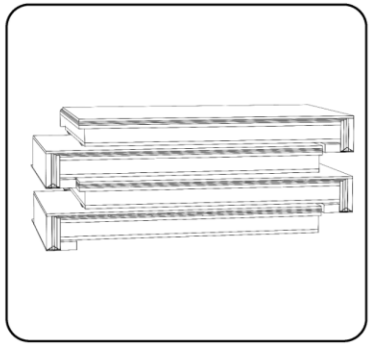
ASSEMBLE PANEL



ADDING CLADDING AND FLASHINGS

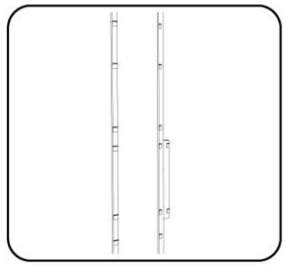


SIZING AND FIXING OF Z- CLIPS



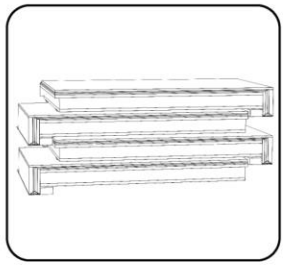
SHIPPING PANELS

CONSTRUCTION SEQUENCE

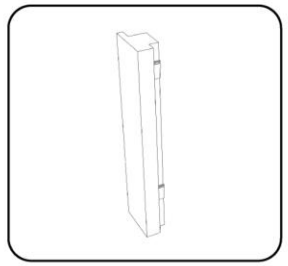


SUBSTRUCTURE PRODUCTION LINE

OFF-SITE CONSTRUCTION



PREFAB PANELS



EDGE PIECES

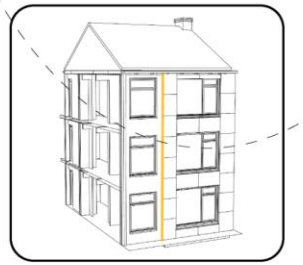
ON-SITE CONSTRUCTION

FOUNDATION WORK

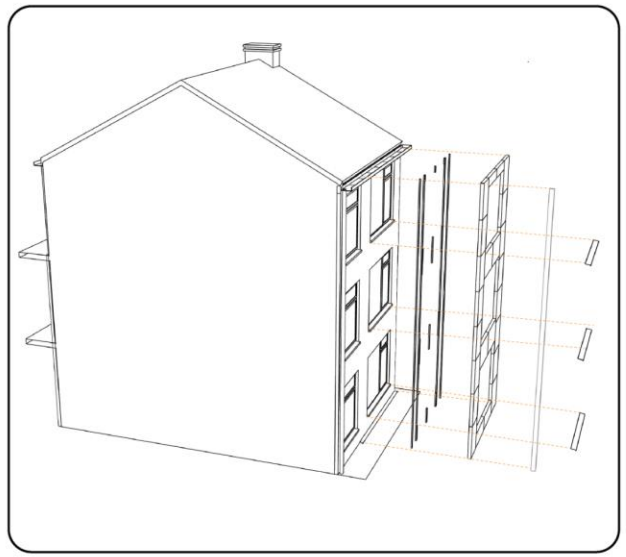
MOUNTING THE SUBSTRUCTURE

PLACING THE JAMB EXTENSIONS AND THE UNDER THE WINDOWS PANELS

PLACING THE PANELS



FITTING THE EDGE PIECES



BRICK

PLASTER

WOOD

METAL

1 FRAMEWORK

2 LITERATURE STUDY

3 CASE STUDY

4 8 MEASURES

5 SIMULATION GRASSHOPPER

6 DESIGN

7 CONCLUSION

RESEARCH QUESTION

Which design strategy is needed in order to achieve a faster, economically feasible and LT-ready refurbishment for post-war portiek apartments?

ANSWER TO RESEARCH QUESTION

Which design strategy is needed in order to achieve a faster, economically feasible and LT-ready refurbishment for post-war portiek apartments?

- Maintain the existing windows with double glazing and wooden frames.
- Maintain the building's services and radiators.
- Insulate the attic floor.
- Fill the cavity with insulation material.
- Insulate 32% of the facade externally with an Rc-value of 3.5 m2K/W, to the parts where it is needed (living room walls) so that heating 55 degrees can be done and disconnect from the gas.
- Insulate externally with small size fully prefabricated sandwich panels, with the cladding and the connections to the windows integrated as much as possible.

LIMITATIONS

- Lack of information regarding the costs.
- Lack of information for the original form of the case study, such as the radiators installed.
- Time is a limitation in such optimization process with a lot of iterations.
- Simplifications were made such as the orientation and plan layout of the case study were taken as a fixed parameter for all iterations.
- The behaviour of the users has not been taken into consideration in any part of the study

RECOMMENDATIONS

- Circularity. Demountable panel.
- The embodied energy of the materials and their impact on the environment.
- Investigation on how the design works with different energy systems.

COMPARISON

SOLUTION 1

COST EFFICIENT

62,4 €/m2

37100 €/building

68 months

46%

62%

SOLUTION 2

100 EPS EXTERNAL

100- 150 €/m2

67570 €/building

125 months

52%

66%

SOLUTION 3

MOST SUSTAINABLE

245 €/m2

123077 €/building

228 months

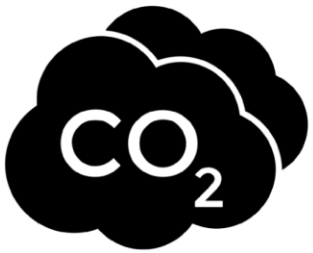
60%

80%

BUILDING STOCK

190000 PORTIEKAPARTMENTS

5.789.300.000€

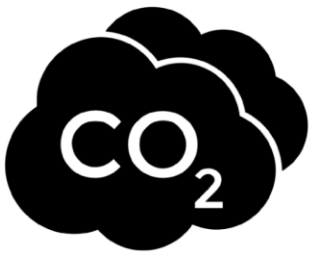


4.08 megatons/ YEAR

BUILDING STOCK

850.393 VEHICLES

1 COAL-FIRED POWER PLANT

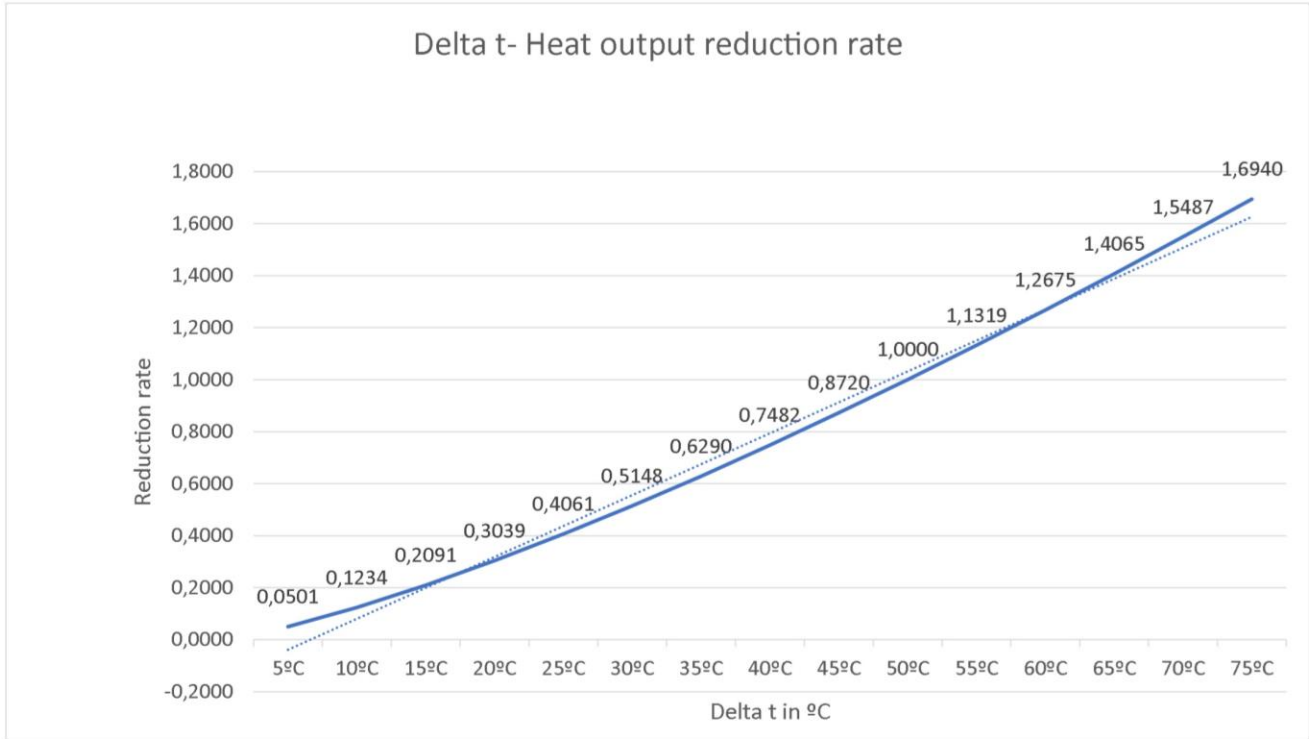


4.08 megatons/ YEAR

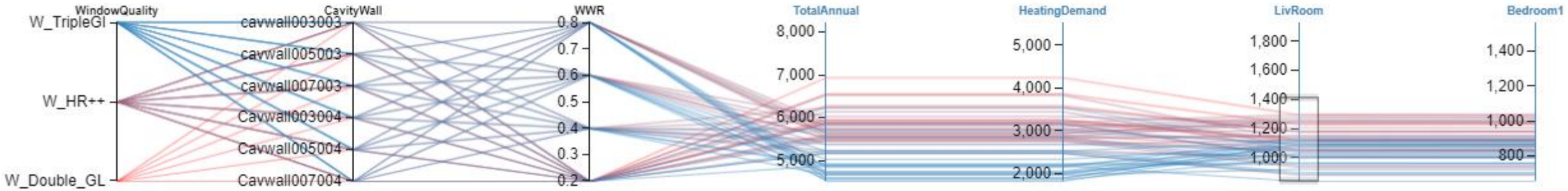
THANK YOU

	Low cost	100 mm EPS external	High energy savings
Façade insulation materials			
	62,4 €/m2	100- 150 €/m2	245 €/m2
	2247 €/ apartment	4500 €/ apartment	8850 €/ apartment
	26970 €/building	54000 €/building	106207 €/building
Payback time for materials / building	50 months	99 months	196 months
Façade insulation labour (placing the panels)	91 hours x 20€=1820€/ building	287 hours x 20€= 5740€/ building	141 hours x 20€= 2820€/ building
(change windows)	_	_	647 hours x 20€= 5740€/ building
(cavity insulation)	24 hoursx 20= 480 €/ building	_	24 hoursx 20= 480 €/ building
Attic floor insulation/ building	7.830 €	7.830 €	7.830 €
Investment cost / building	37100 €/building	67570 €/building	123077 €/building
Payback time	68 months	125 months	228 months
Investment cost /apartment	3091 €/ apartment	5630 €/ apartment	10256 €/ apartment
Energy savings/ apartment	46%	52%	60%
Heating savings/ apartment	62%	66%	80%

5ºC	0,0501
10ºC	0,1234
15ºC	0,2091
20ºC	0,3039
25ºC	0,4061
30ºC	0,5148
35ºC	0,6290
40ºC	0,7482
45ºC	0,8720
50ºC	1,0000
55ºC	1,1319
60ºC	1,2675
65ºC	1,4065
70ºC	1,5487
75ºC	1,6940

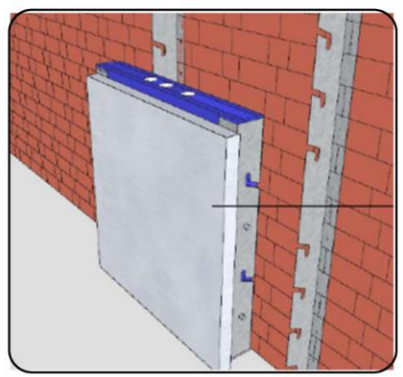


Watts						
Delta T factors in ºC other than 50ºC, Exponent n=1.3	5ºC	140	30ºC	1443	55ºC	3174
	10ºC	346	35ºC	1764	60ºC	3554
	15ºC	586	40ºC	2098	65ºC	3944
	20ºC	852	45ºC	2445	70ºC	4343
	25ºC	1139	50ºC	2804	75ºC	4750


WindowQuality
W_TripleGl
W_HR++
W_Double_GL
CavityWall
cavwall003003
cavwall005003
cavwall007003
Cavwall003004
Cavwall005004
Cavwall007004
WWR
0.8
0.7
0.6
0.5
0.4
0.3
0.2
TotalAnnual
8,000
7,000
6,000
5,000
HeatingDemand
5,000
4,000
3,000
2,000
LivRoom
1,800
1,600
1,400
1,200
1,000
Bedroom1
1,400
1,200
1,000
800

ARNHEM

2ND SKIN



PORTUGAL

BELGIUM