RENOVATION FOR DIFFERENT ENERGY SYSTEMS

Prefabricated renovation approach for post-war walk-up apartments that is applicable to different energy systems

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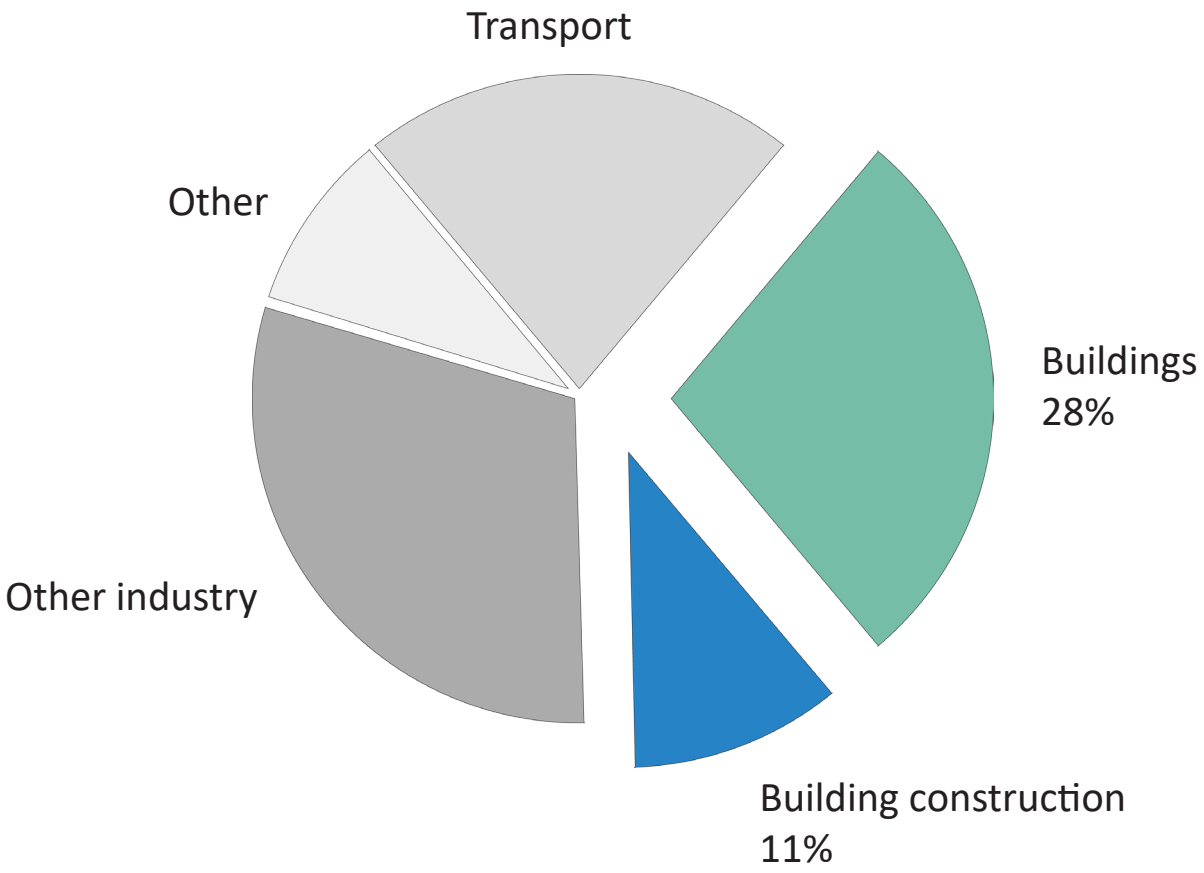
Dr. Marcin Dąbrowski

RESEARCH FRAMEWORK

GLOBAL ENERGY RELATED CO2 EMISSIONS - 2015



Adapted from (UN Environment and International Energy Agency, 2017)

Reprinted from (Hiveminer, n.d.)

RESIDENTIAL BUILDING STOCK EU

- Energy and CO2 emission targets of 2050

- Reduction needed up to 90%

- New buildings only add 1%

- Remaining 99% is already built

Reprinted from (Delft University of Technology, n.d.)

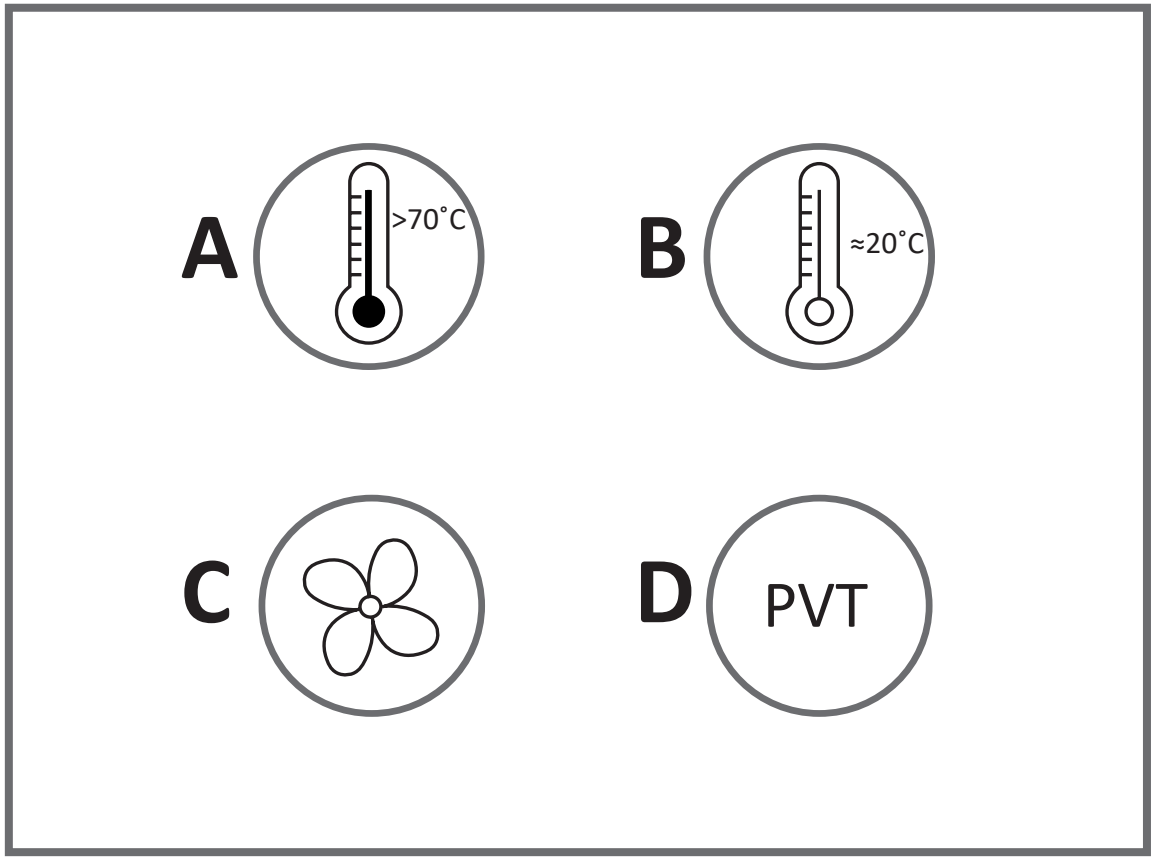
POST-WAR WALK-UP APARTMENTS

(Naoorlogse portiekwoningen)

- Post-war walk-up is 8% of total building stock in the Netherlands

- 70% of which is social housing

- In 2020 all rental dwellings with energy label B



ENERGY SYSTEMS

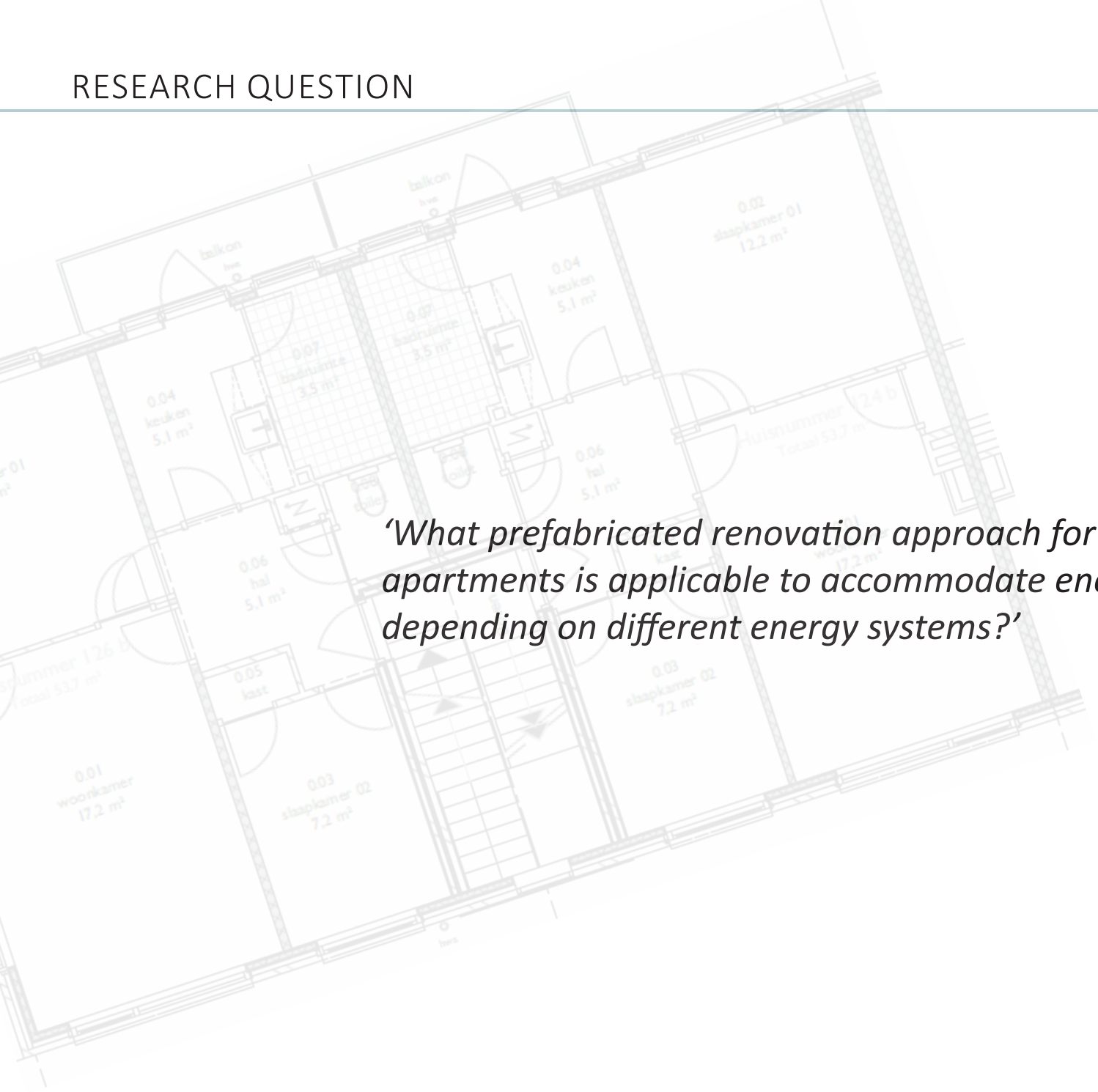
- Reuse sources

A.- District heating

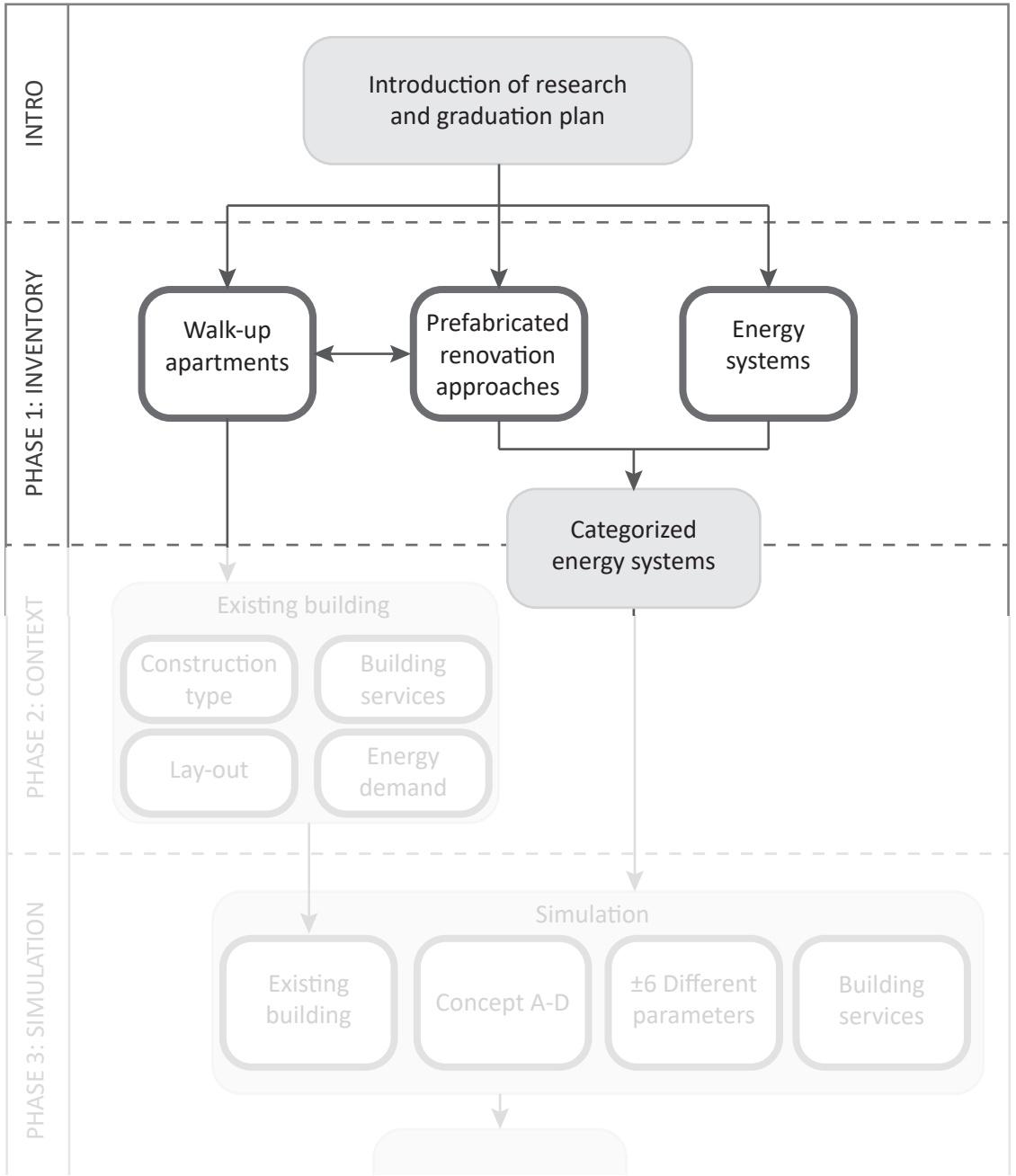
B.- Aquifer

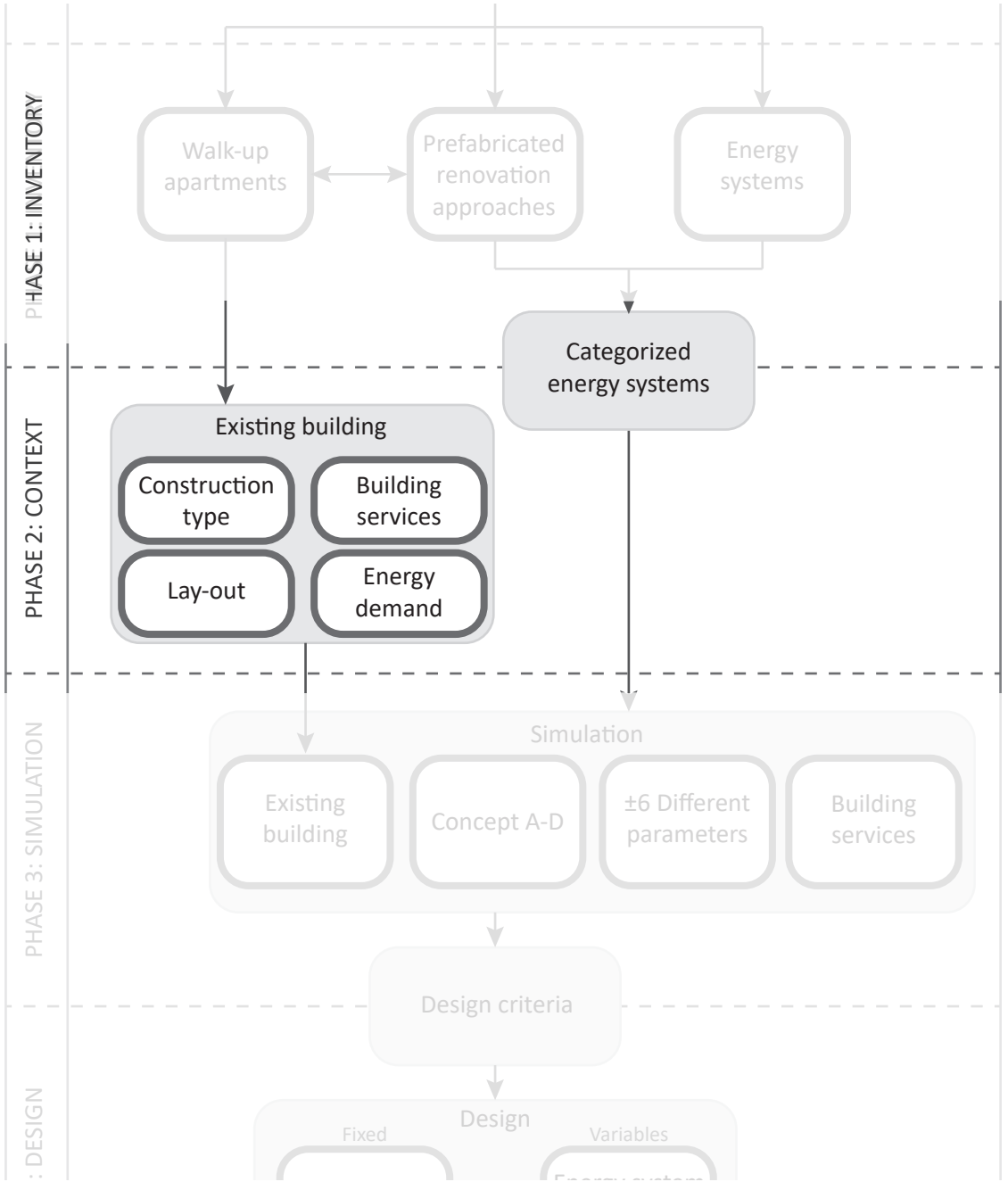
C.- Heat pump with outdoor air

D.- Heat pump with PVT panels



‘What prefabricated renovation approach for post-war walk-up apartments is applicable to accommodate energy saving measures, depending on different energy systems?’


INTRO
Introduction of research and graduation plan
PHASE 1: INVENTORY
Walk-up apartments
Prefabricated renovation approaches
Energy systems
Categorized energy systems
PHASE 2: CONTEXT
Existing building
Construction type
Building services
Lay-out
Energy demand
PHASE 3: SIMULATION
Simulation
Existing building
Concept A-D
±6 Different parameters
Building services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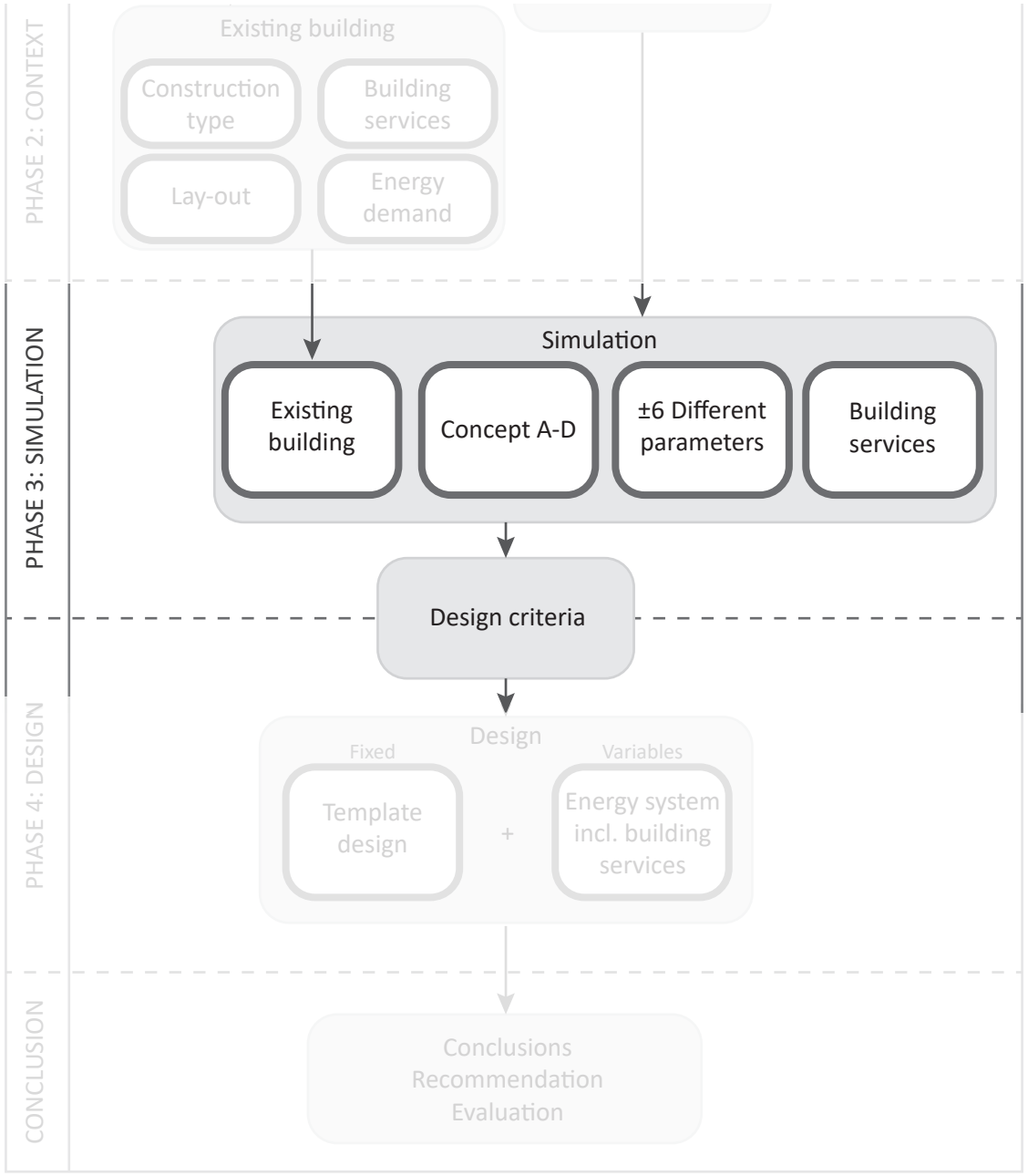
Design criteria
: DESIGN
Design
Fixed
Variables


PHASE 2: CONTEXT
Existing building
Construction type
Building services
Lay-out
Energy demand
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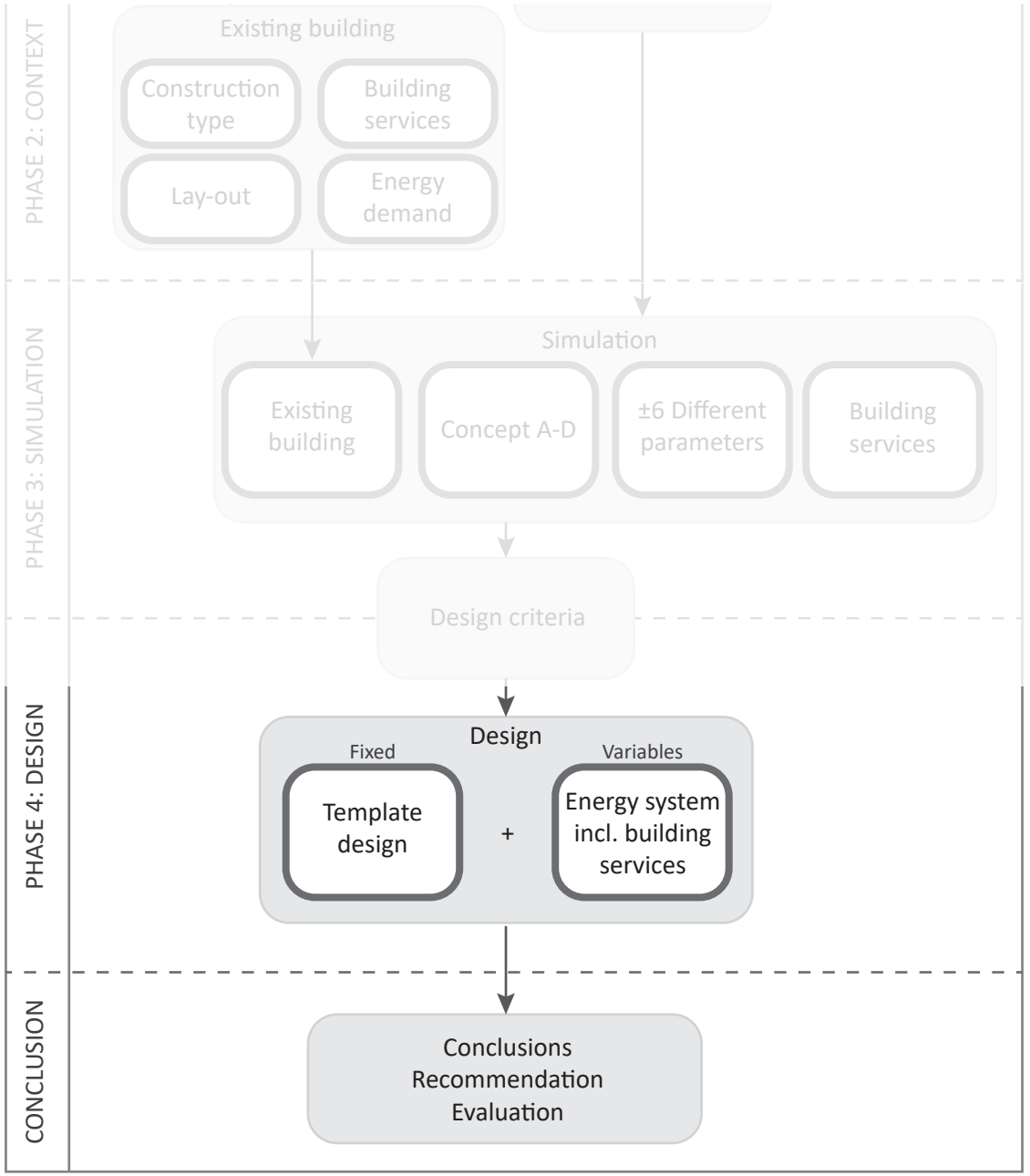
Concept A-D
±6 Different parameters
Building services
Design criteria
PHASE 4: DESIGN
Design
Fixed
Variables
Template design
+
Energy system incl. building services
CONCLUSION
Conclusions
Recommendation
Evaluation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+
Energy system incl. building services
CONCLUSION
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PHASE 2: CONTEXT

SOENDALAAN VLAARDINGEN

- Building constructed in 1952

- 12 apartments

- Three stories high

- Central staircase, characteristic for walk-up apartment building

Reprinted from (Stedenbouw & Van der Beek, 2018)

SOENDALAAN VLAARDINGEN

- Unoccupied attic

- Symmetric facade lay-out

- Balconies are cold connected

- Kitchen and bathroom located at balcony side

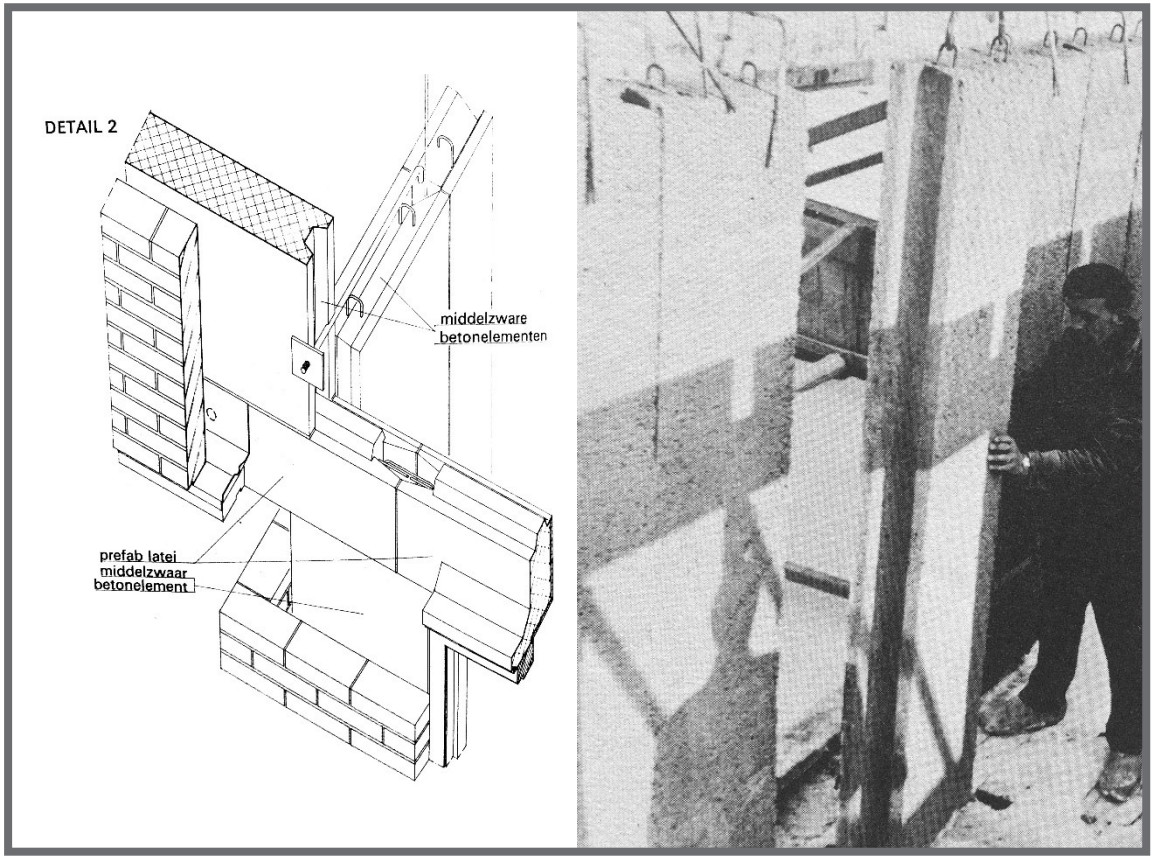
Reprinted from (Climate-KIC, n.d.)

CONSTRUCTION

- Prefabricated concrete elements

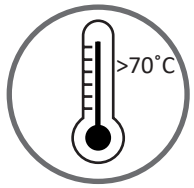
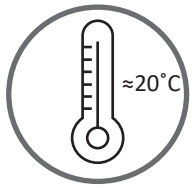
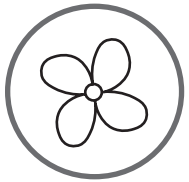
- Not possible to remove parts of facade

- Simplex - Aircavity - Masonry



Reprinted from (Van Elk & Priemus, 1971)

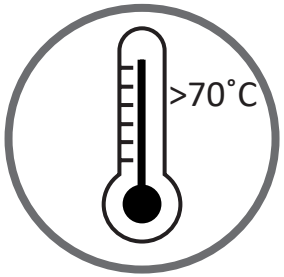
PHASE 3 : SIMULATION

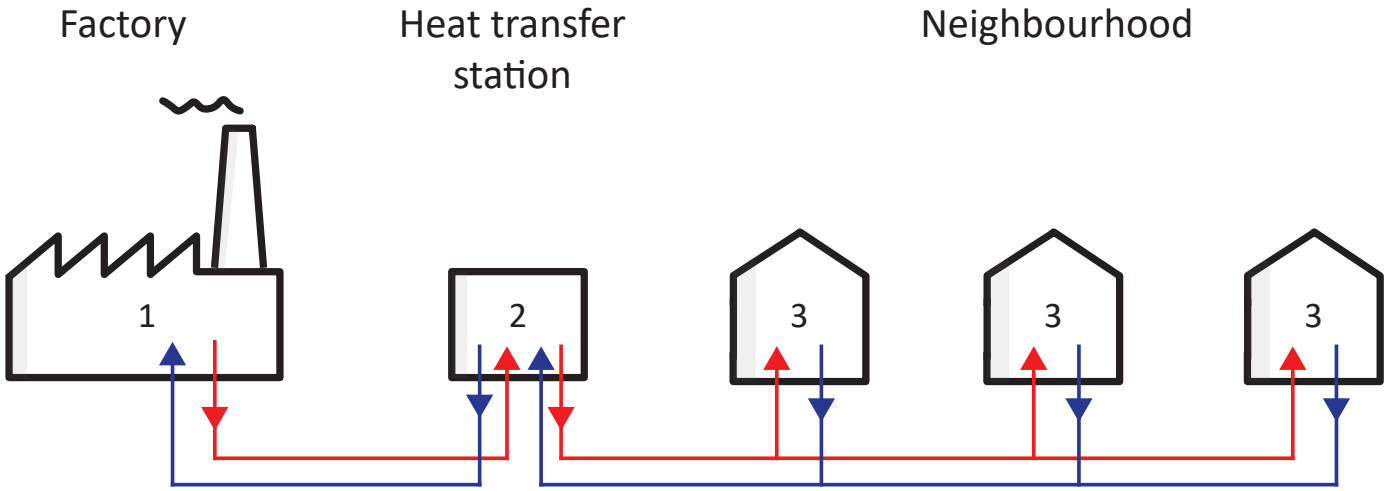
	HIGH TEMPERATURE	LOW TEMPERATURE
COLLECTIVE SYSTEMS	**A** 	**B** 
INDIVIDUAL SYSTEMS	**D** 	**C** 

CONCEPT A

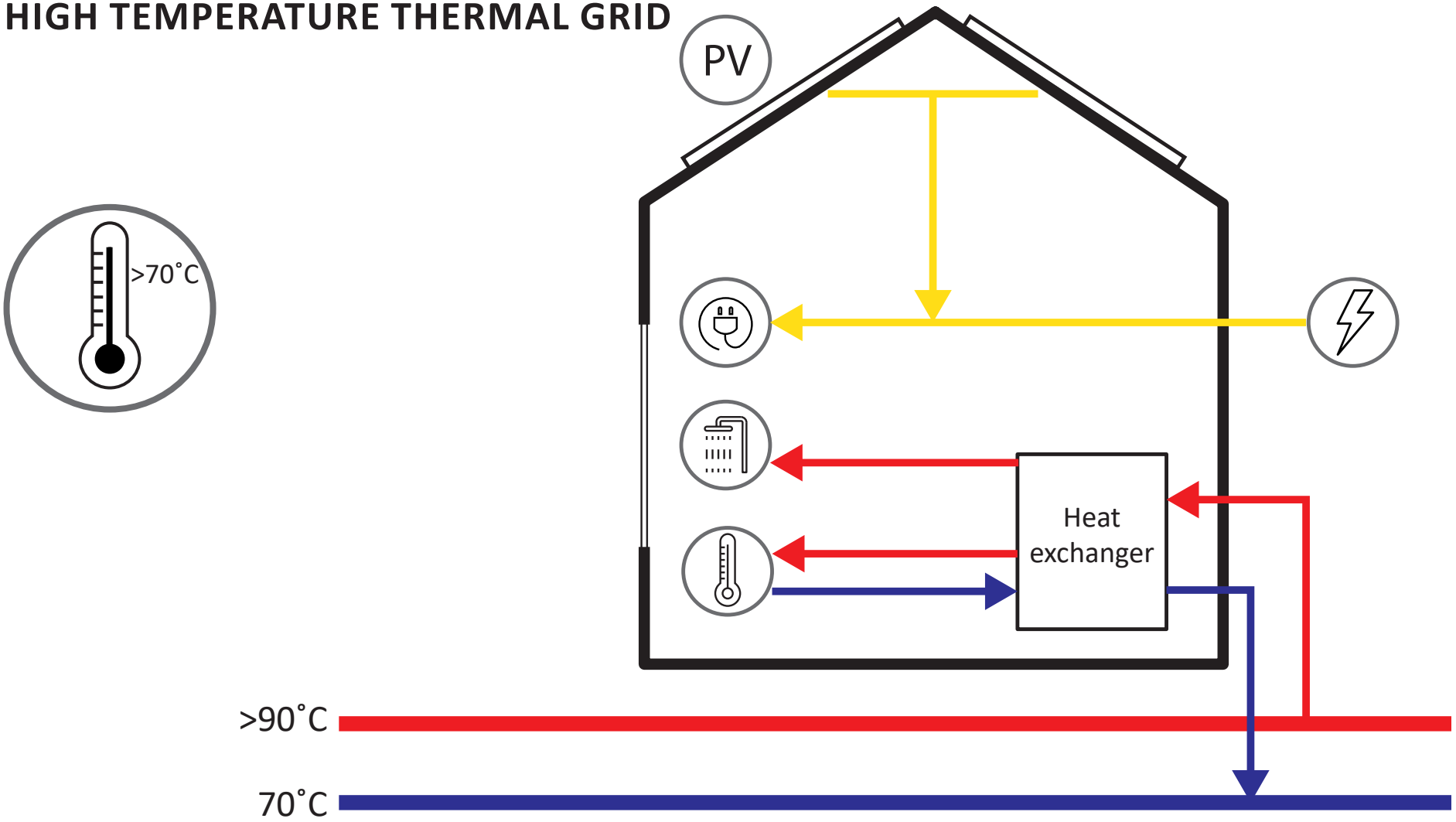
DISTRICT HEATING

(Stadsverwarming)

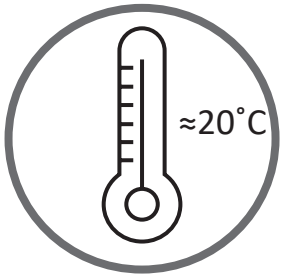


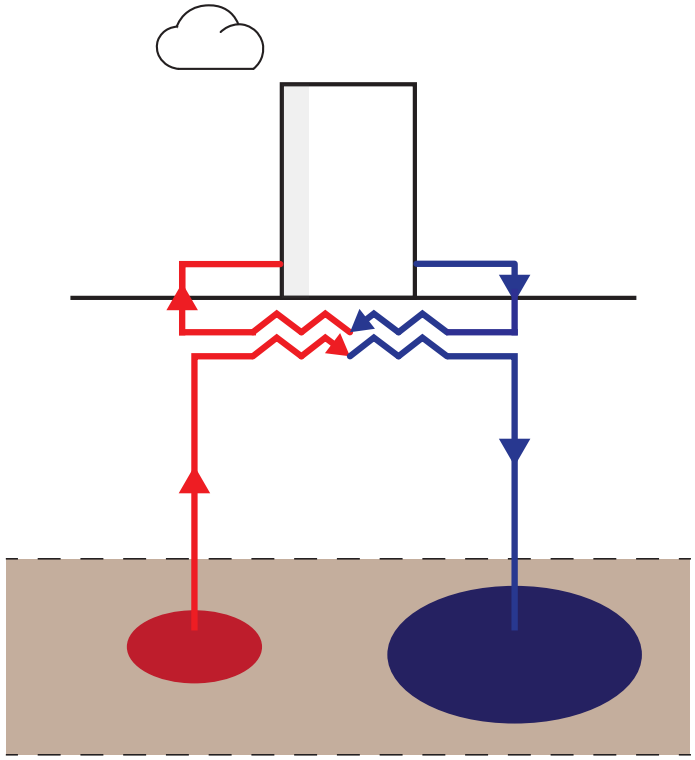


CONCEPT A
HIGH TEMPERATURE THERMAL GRID

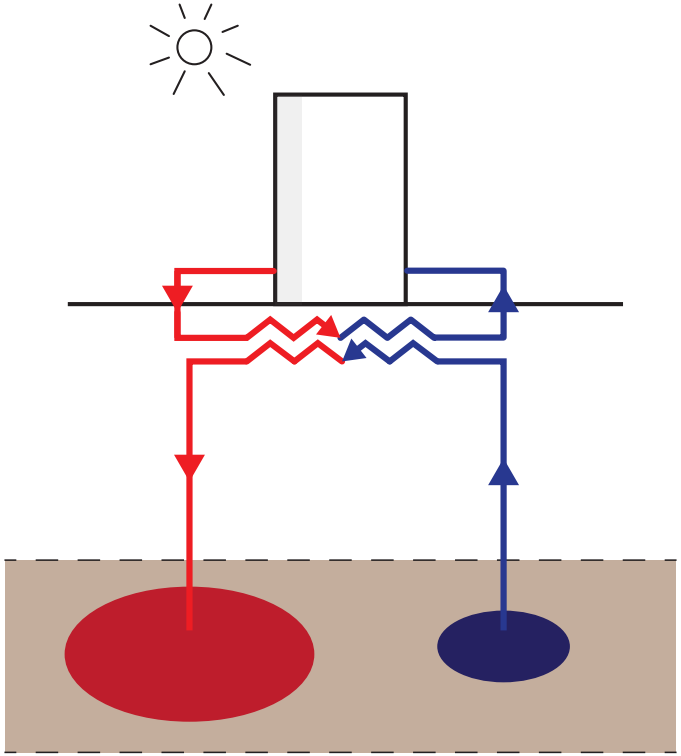


CONCEPT B
AQUIFER





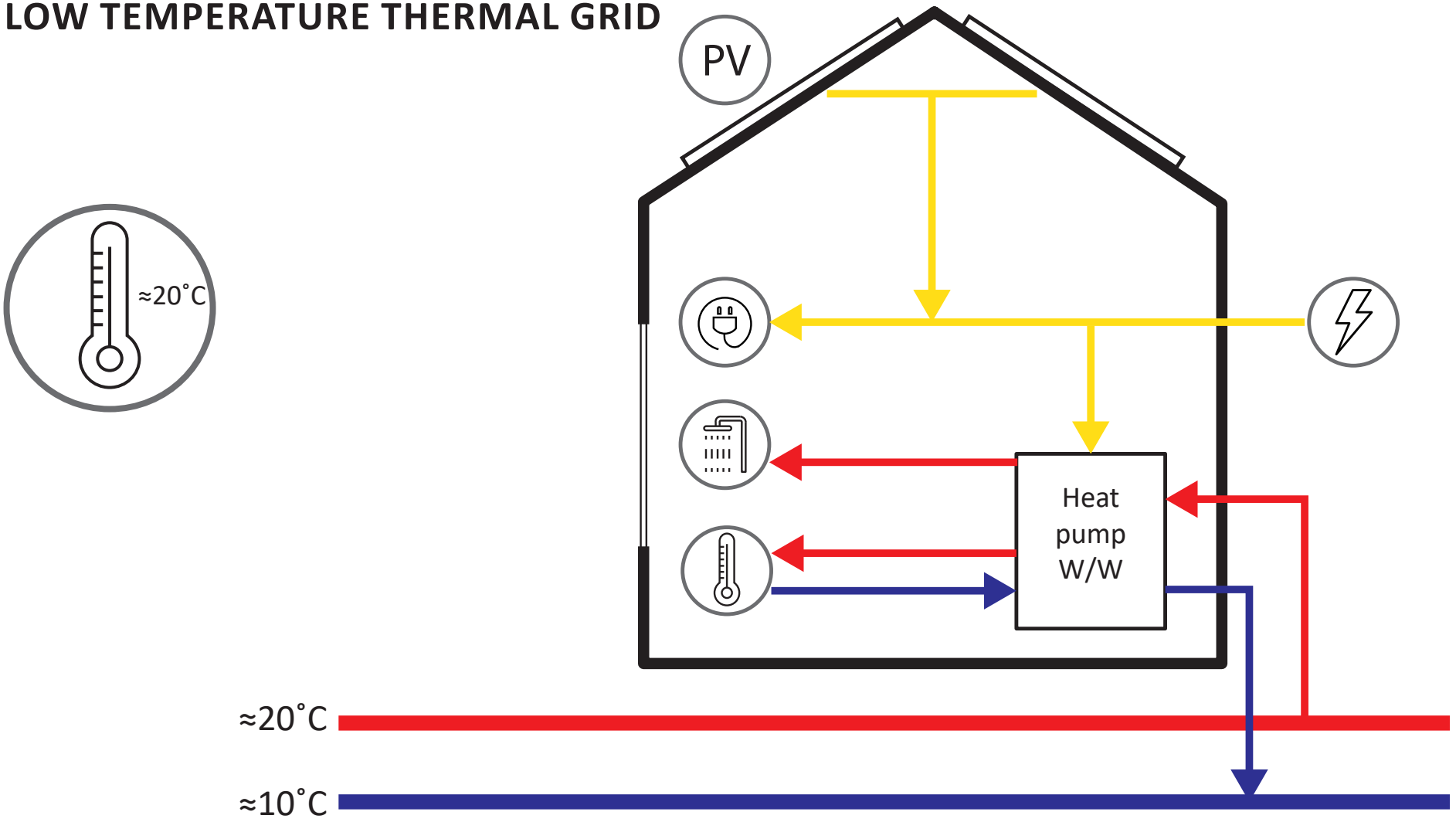
WINTER



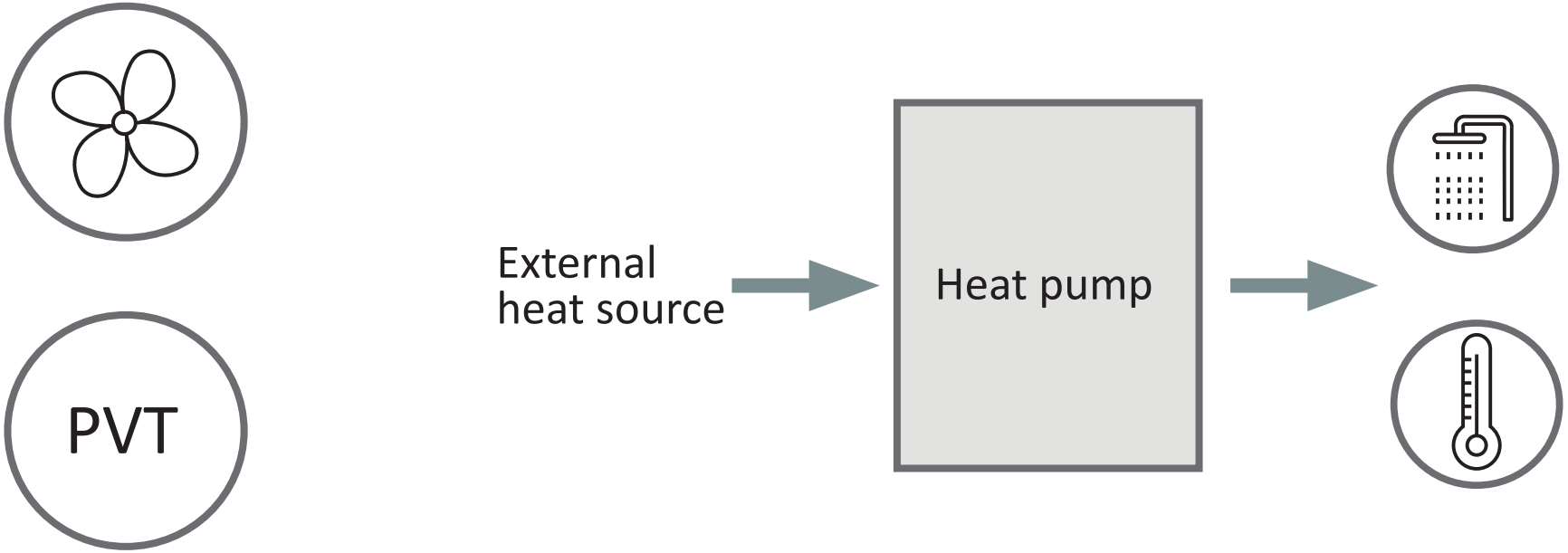
SUMMER

CONCEPT B

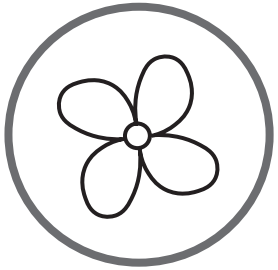
LOW TEMPERATURE THERMAL GRID

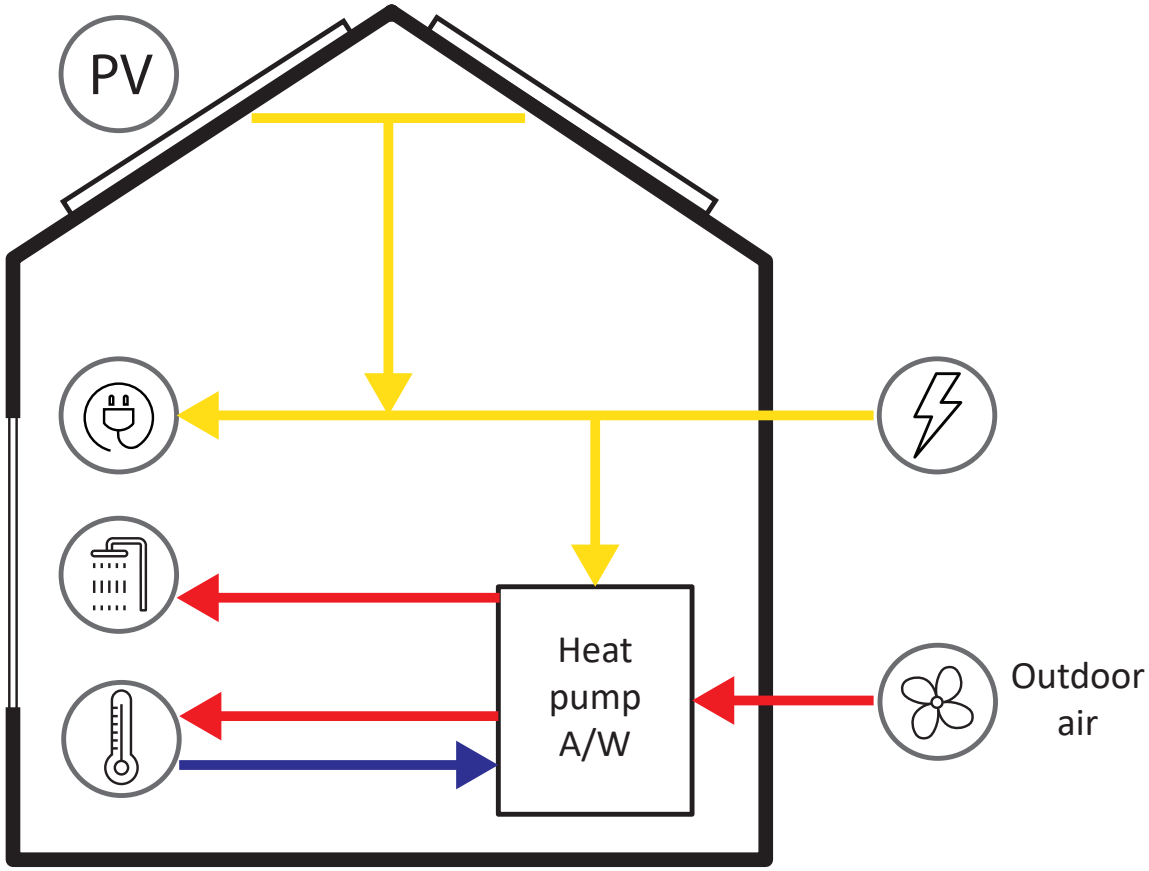


CONCEPT C - D
HEAT PUMP



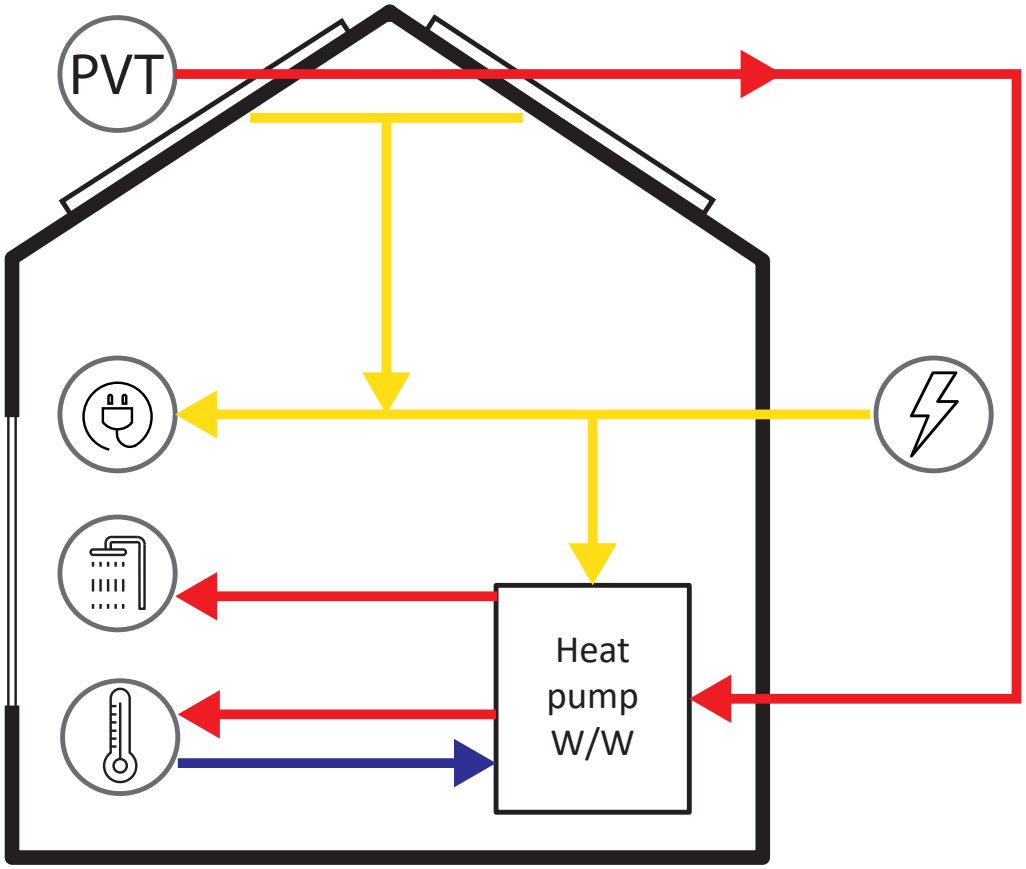
CONCEPT C
OUTDOOR AIR



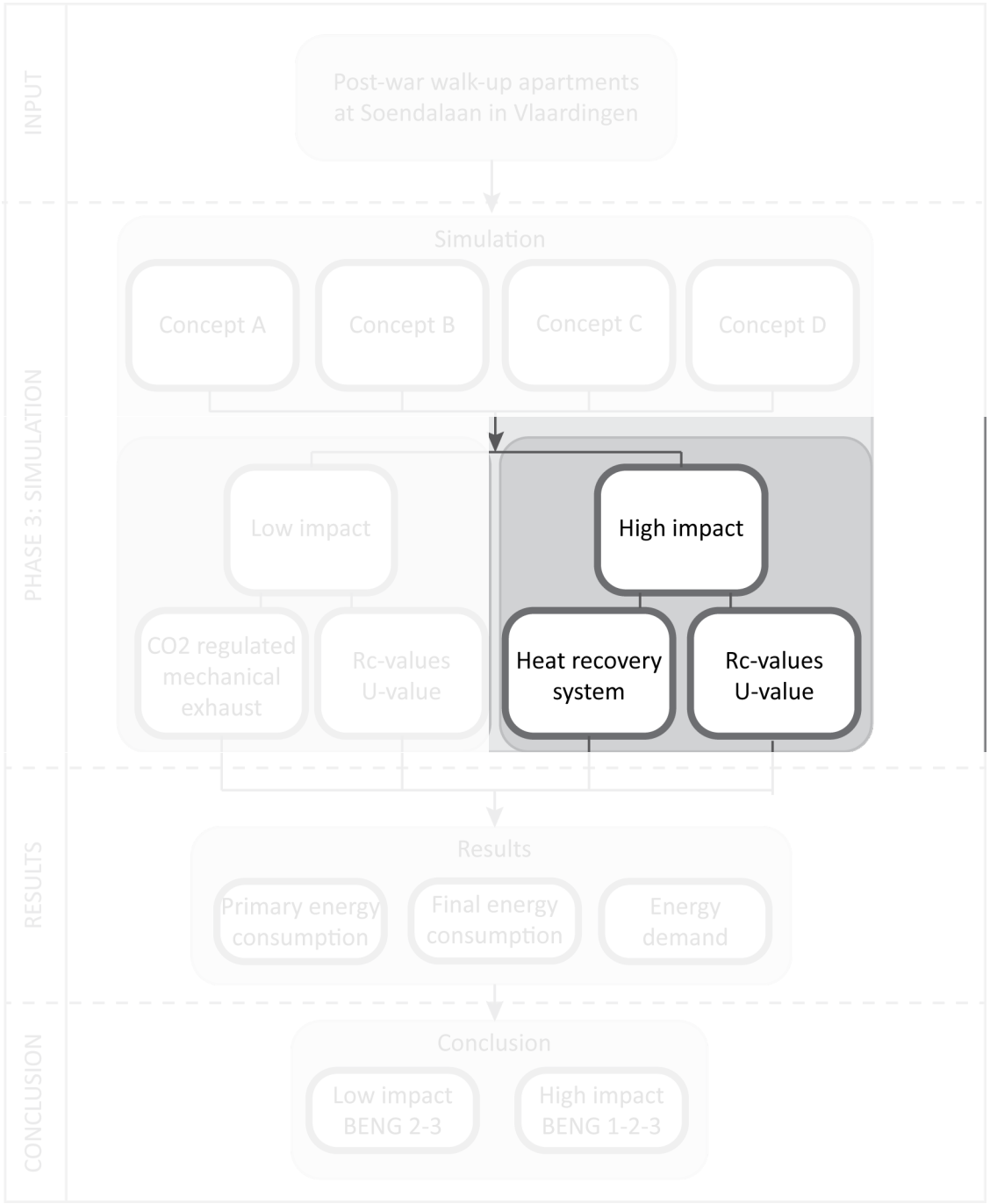


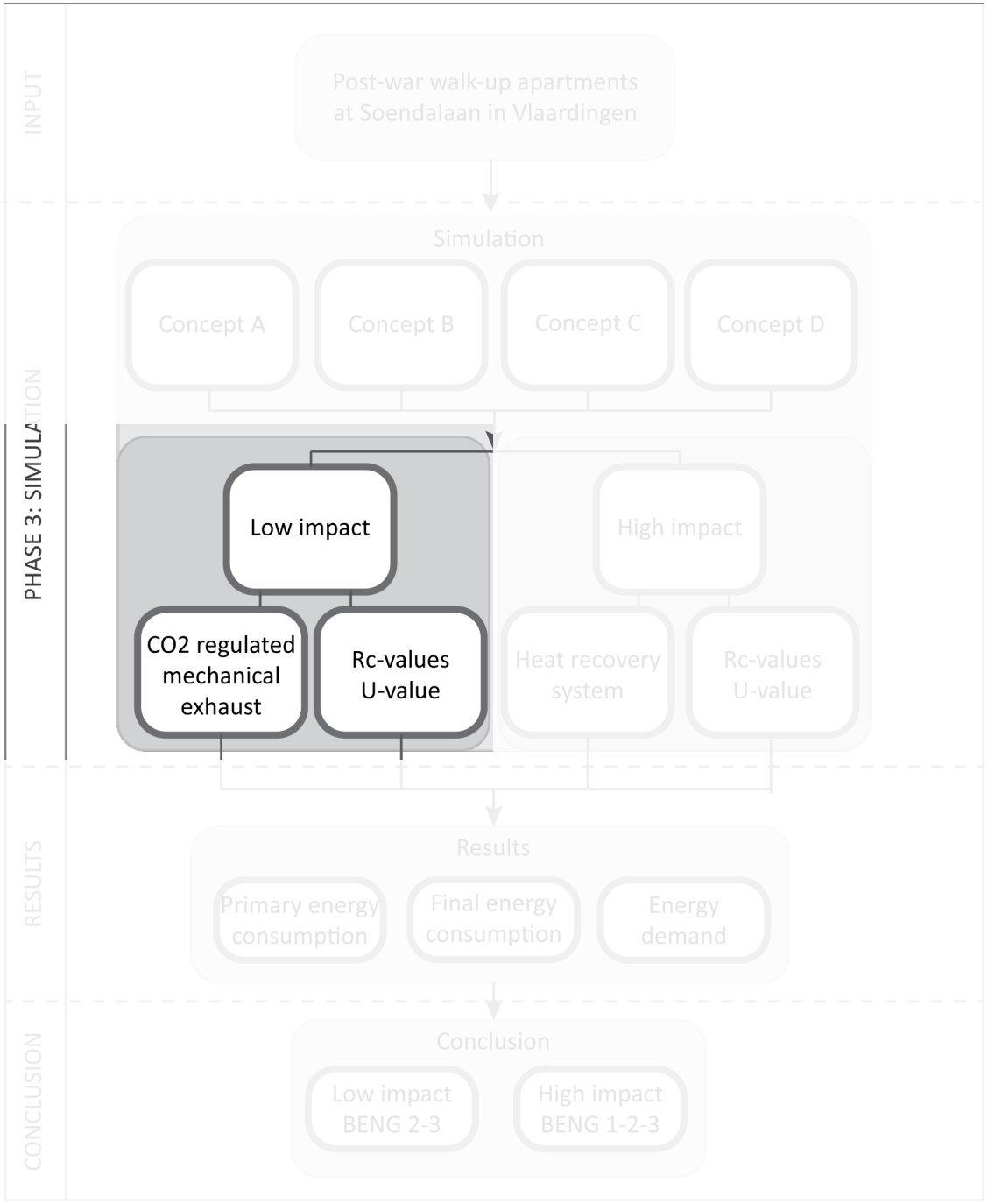
CONCEPT D
PVT PANELS

PVT



STRATEGY


INPUT
Post-war walk-up apartments at Soendalaan in Vlaardingen
PHASE 3: SIMULATION
Simulation
Concept A
Concept B
Concept C
Concept D
Low impact
CO2 regulated mechanical exhaust
Rc-values U-value
High impact
Heat recovery system
Rc-values U-value
RESULTS
Results
Primary energy consumption
Final energy consumption
Energy demand
CONCLUSION
Conclusion
Low impact BENG 2-3
High impact BENG 1-2-3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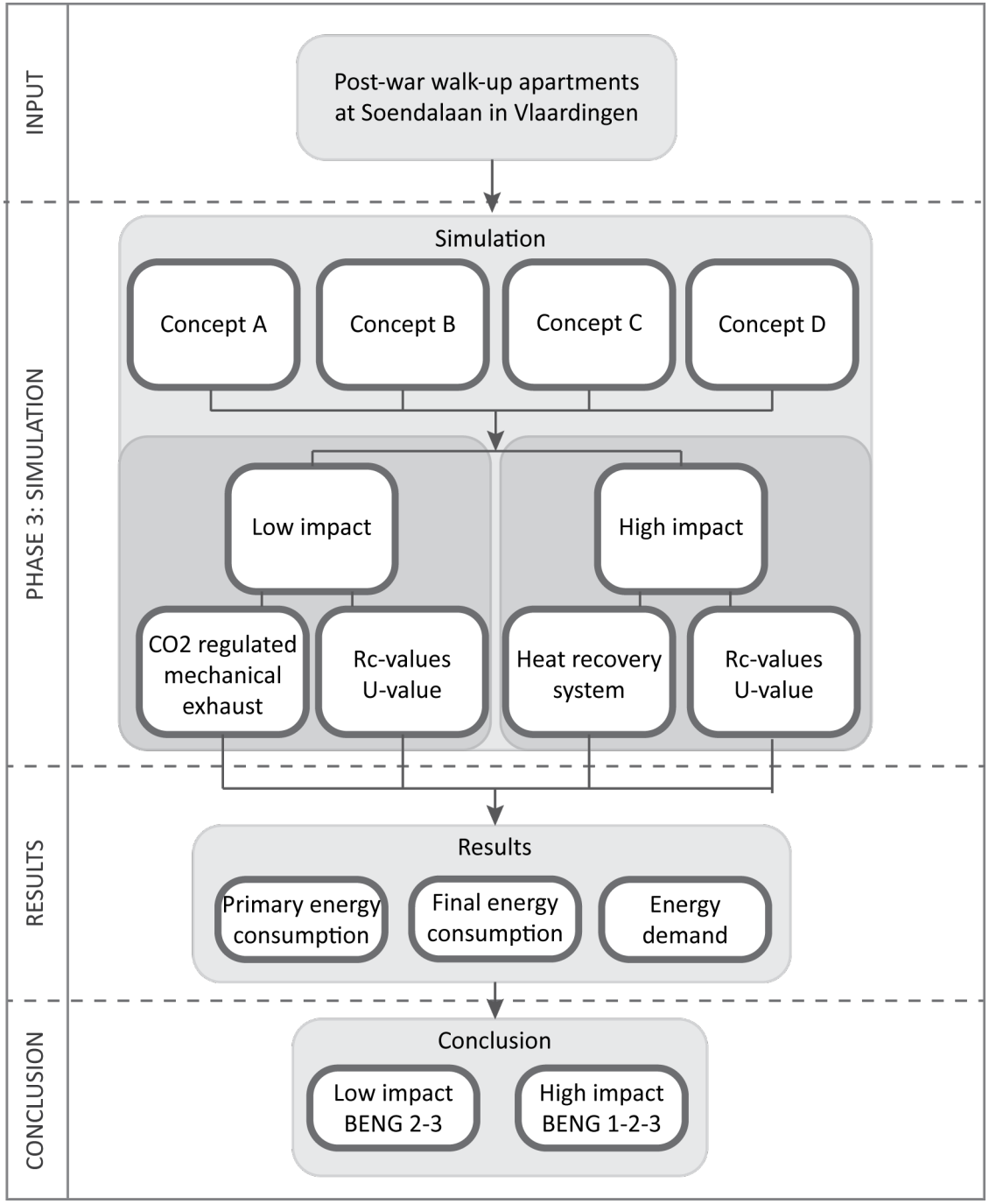
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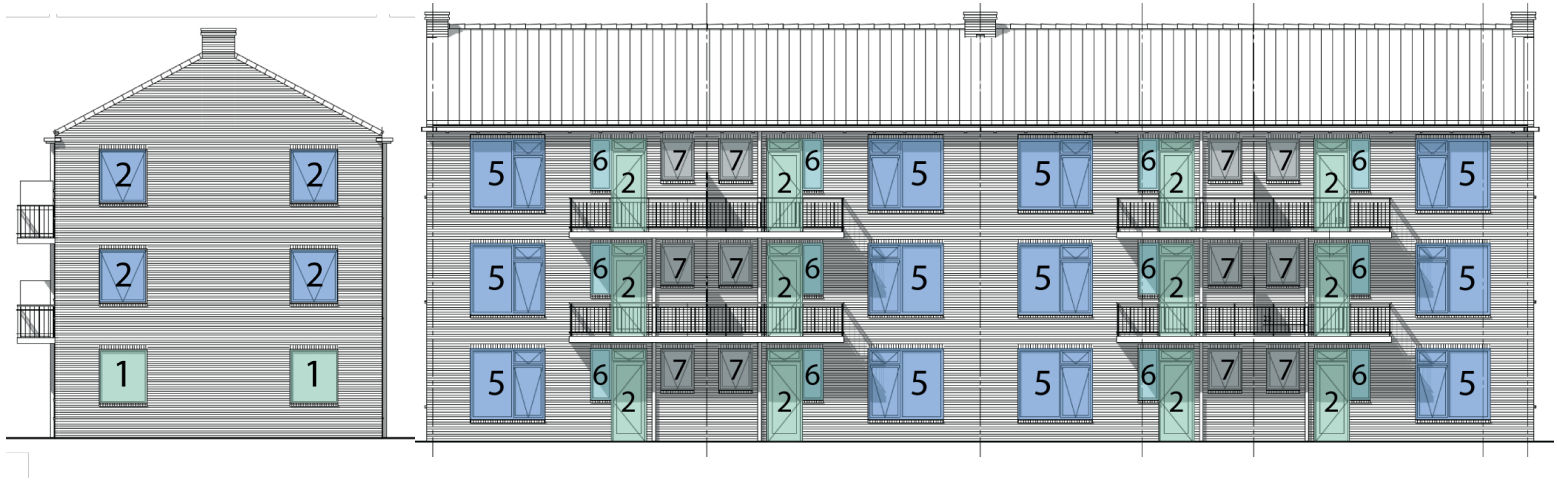
SOFTWARE UNIEC[2.2]

EAST FACADE Openings	Facade openings [m2]	Glazing [m2]	Window frames [m2]	Pieces [#]	All facade openings [m2]	All glazing [m2]	All window frames [m2]
Window 1	2,0	1,7	0,3	2	4,0	3,4	0,6
Window 2	2,0	1,5	0,5	4	8,0	6,0	2,0
TOTAL OPENINGS AREA [m2]					**12,0**	**9,4**	**2,6**
TOTAL FACADE AREA					85,8		
TOTAL OPENINGS AREA [m2]					12,0	-	
TOTAL CLOSED AREA					73,8		

WEST FACADE Openings	Facade openings [m2]	Glazing [m2]	Window frames [m2]	Pieces [#]	All facade openings [m2]	All glazing [m2]	All window frames [m2]
Window 1	2,0	1,7	0,3	2	4,0	3,4	0,6
Window 2	2,0	1,5	0,5	4	8,0	6,0	2,0
TOTAL OPENINGS AREA [m2]					**12,0**	**9,4**	**2,6**
TOTAL FACADE AREA					85,8		
TOTAL OPENINGS AREA [m2]					12,0	-	
TOTAL CLOSED AREA					73,8		



INPUT MEASURES

OVERVIEW Measures in Uniec		Concept A External heat supply >70˚C	
		A. Low	A. High
Building envelope			
	Rc-value Floor	2,6	3,7
	Rc-value Facade	2,1	4,6
	Rc-value Roof	6,1	6,1
	Rc-value internal wall	0,1	0,1
	U-value glazing	1,2	0,7
Heating systems			
	External heat supply	City grid Amsterdam Zuid-Oost - primary grid	
	Delivery temperature	>50˚C	
Ventilation			
	System	Inlet: Natural Exhaust: Mechanic	Inlet: Mechanic Exhaust: Mechanic
	Product	Itho Daalderop CO2 Optima NGG	Itho Daalderop HRU ECO 350 Optima 2 CO2
PV panels			
	Peak power	180 Wp/m2	
	RFpv	Z=1,00 N=0,70	
	Number/orientation	150m2 29˚	

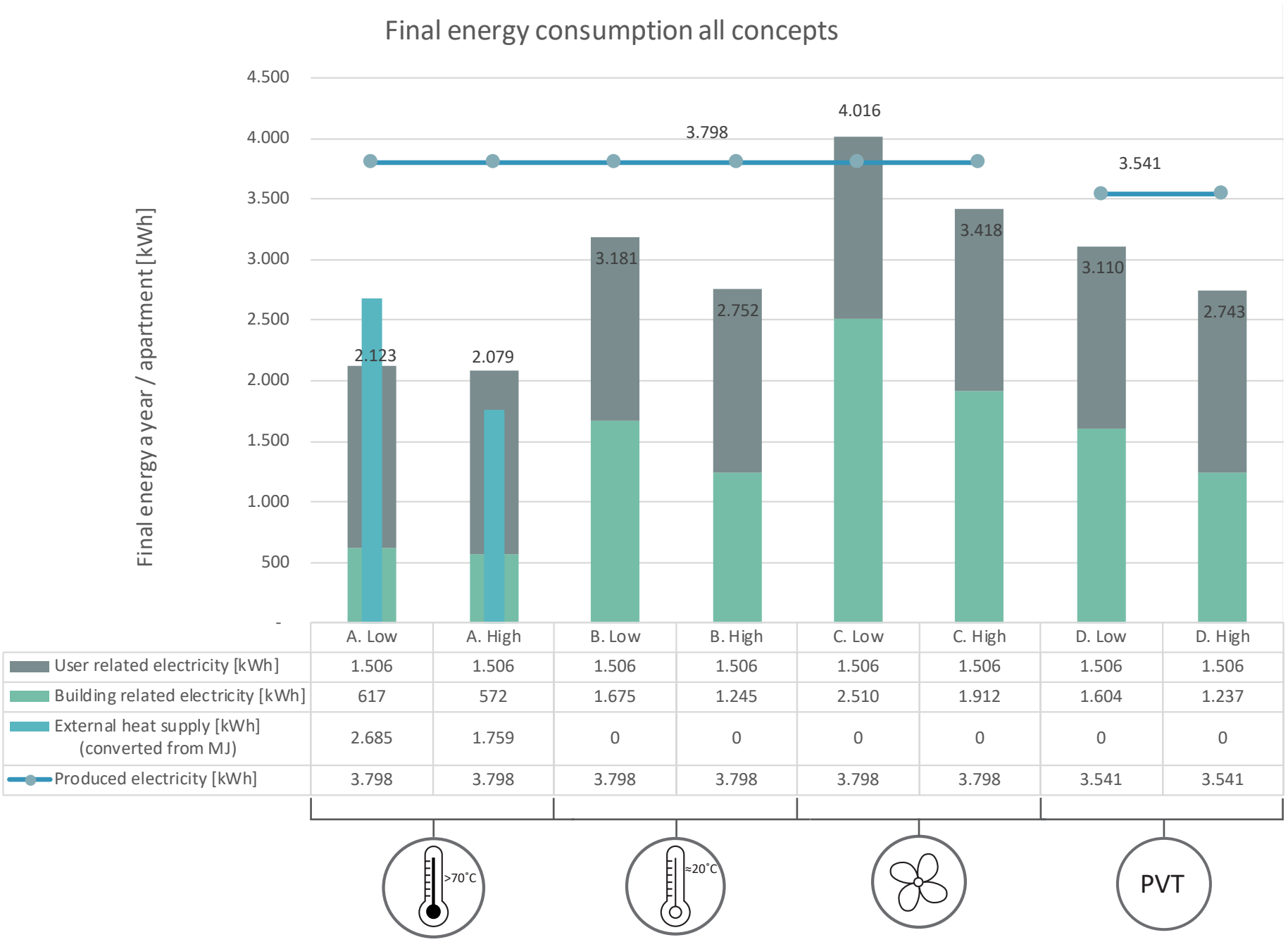
OVERVIEW Measures in Uniec		Concept B External heat supply ≈20˚C	
		B. Low	B. High
Building envelope			
	Rc-value Floor	2,6	3,7
	Rc-value Facade	2,1	4,6
	Rc-value Roof	6,1	6,1
	Rc-value internal wall	0,1	0,1
	U-value glazing	1,2	0,7
Heating systems			
	System	Combi-heat pump	
	Source	Groundwater	
	Product	Itho Daalderop WPU 25 5G + buffertank WPV150	
	COp heating	4,85	5,70
	COp DHW	3,45	3,70
	COp additional heating	1,00	1,00
	Supply temperature	50˚ < Θsup ≤ 55˚	35˚ < Θsup ≤ 40˚
	Delivery temperature	>50˚C	≤ 50˚C
Ventilation			
	System	Inlet: Natural Exhaust: Mechanic	Inlet: Mechanic Exhaust: Mechanic
	Product	Itho Daalderop CO2 Optima NGG	Itho Daalderop HRU ECO 350 Optima 2 CO2
PV panels			
	Peak power	180 Wp/m2	
	RFpv	Z=1,00 N=0,70	
	Number/orientation	150m2 29˚	

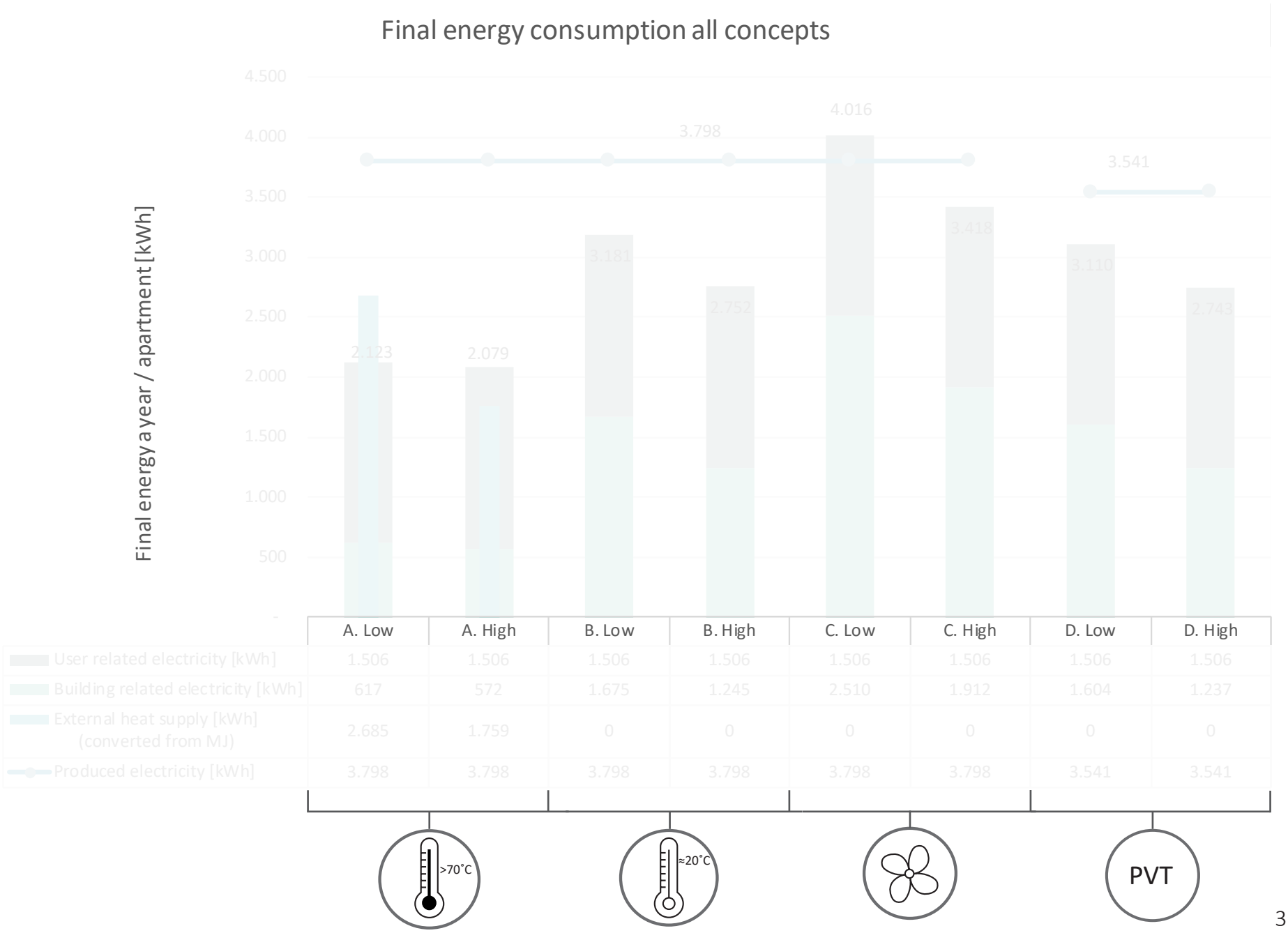
INPUT MEASURES

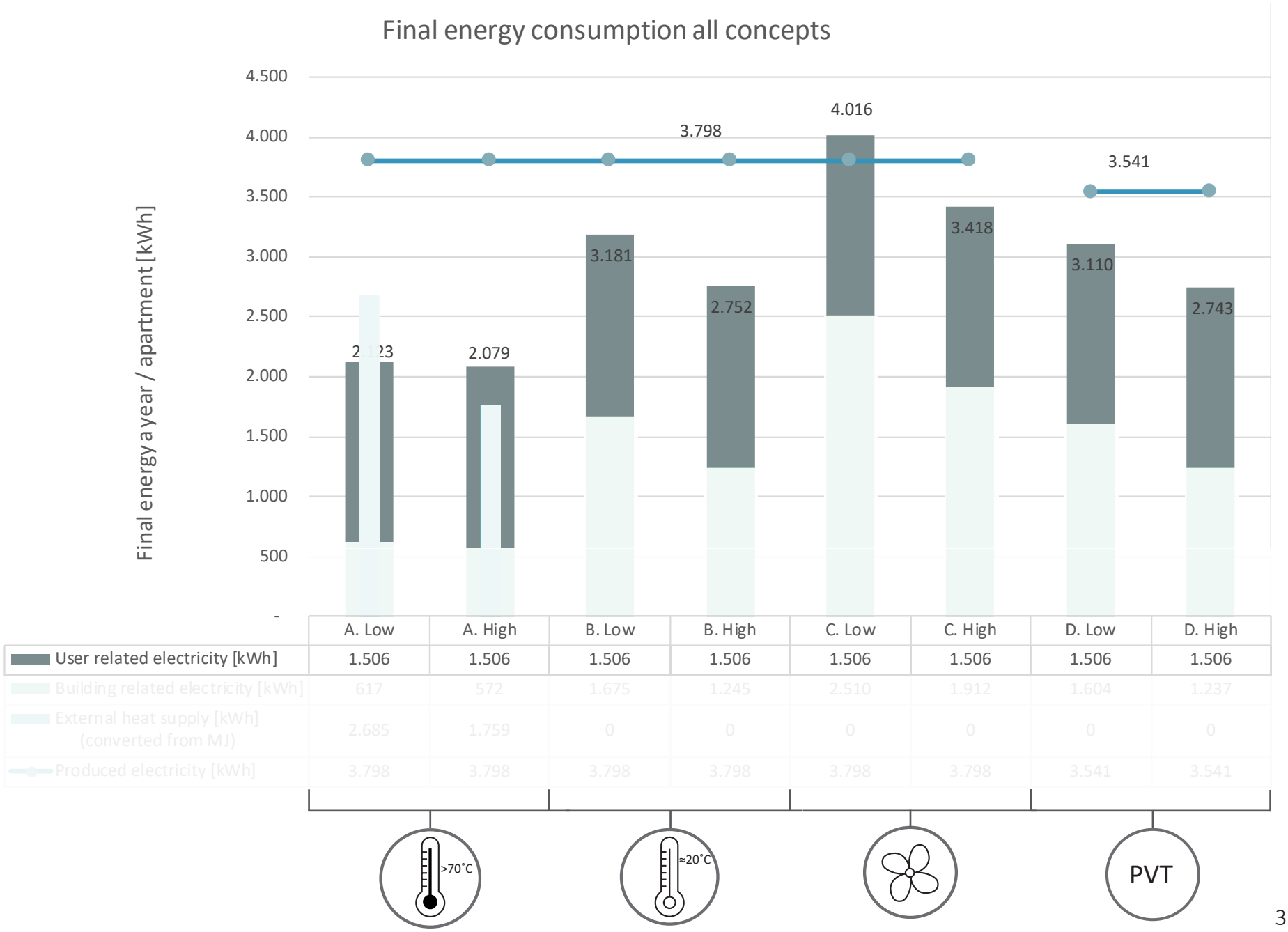
OVERVIEW Measures in Uniec		Concept A External heat supply >70˚C	
		A. Low	A. High
Building envelope			
	Rc-value Floor	2,6	3,7
	Rc-value Facade	2,1	4,6
	Rc-value Roof	6,1	6,1
	Rc-value internal wall	0,1	0,1
	U-value glazing	1,2	0,7
Heating systems			
	System	Combi-heat pump	
	Source	Outdoor air	
	Product	Itho Daalderop HP-S 55 + buffertank SVV 200l	
	COp heating	3,80	4,20
	COp DHW	1,75	1,75
	COp additional heating	1,00	1,00
	Supply temperature	50˚ < Θsup ≤ 55˚	35˚ < Θsup ≤ 40˚
	Delivery temperature	>50˚C	≤ 50˚C
Cooling			
	System	Compression cooling machine	
	Specification	HT-delivery system	
Ventilation			
	System	Inlet: Natural Exhaust: Mechanic	Inlet: Mechanic Exhaust: Mechanic
	Product	Itho Daalderop CO2 Optima NGG	Itho Daalderop HRU ECO 350 Optima 2 CO2
PV panels			
	Peak power	180 Wp/m2	
	RFpv	Z=1,00 N=0,70	
	Number/orientation	150m2 29˚	

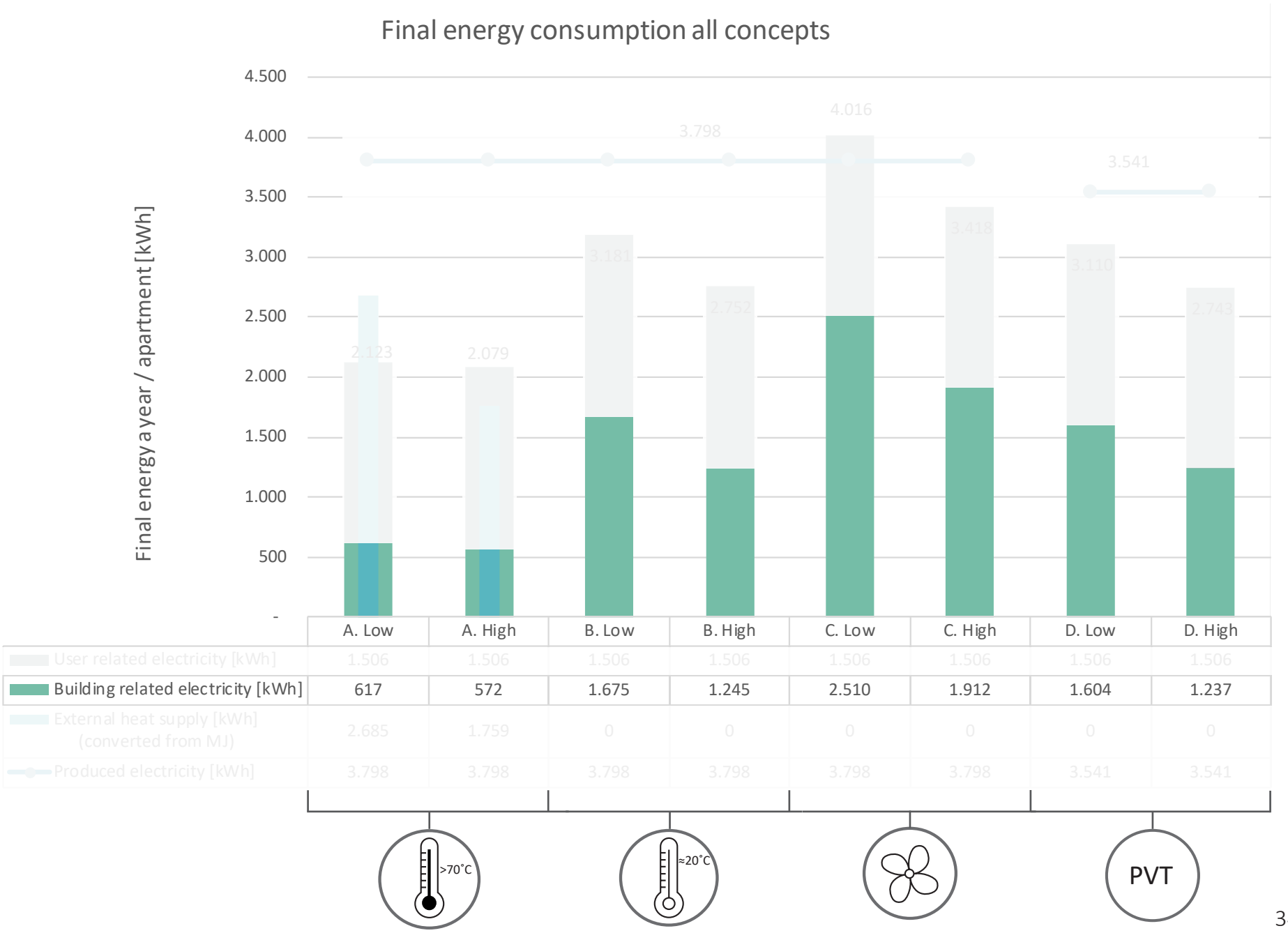
OVERVIEW Measures in Uniec		Concept B External heat supply ≈20˚C	
		Concept C Outdoor air	
		C. Low	C. High
Building envelope			
	Rc-value Floor	2,6	3,7
	Rc-value Facade	2,1	4,6
	Rc-value Roof	6,1	6,1
	Rc-value internal wall	0,1	0,1
	U-value glazing	1,2	0,7
Heating systems			
	System	Combi-heat pump	
	Source	Outdoor air	
	Product	Itho Daalderop HP-S 55 + buffertank SVV 200l	
	COp heating	3,80	4,20
	COp DHW	1,75	1,75
	COp additional heating	1,00	1,00
	Supply temperature	50˚ < Θsup ≤ 55˚	35˚ < Θsup ≤ 40˚
	Delivery temperature	>50˚C	≤ 50˚C
Cooling			
	System	Compression cooling machine	
	Specification	HT-delivery system	
Ventilation			
	System	Inlet: Natural Exhaust: Mechanic	Inlet: Mechanic Exhaust: Mechanic
	Product	Itho Daalderop CO2 Optima NGG	Itho Daalderop HRU ECO 350 Optima 2 CO2
PV panels			
	Peak power	180 Wp/m2	
	RFpv	Z=1,00 N=0,70	
	Number/orientation	150m2 29˚	

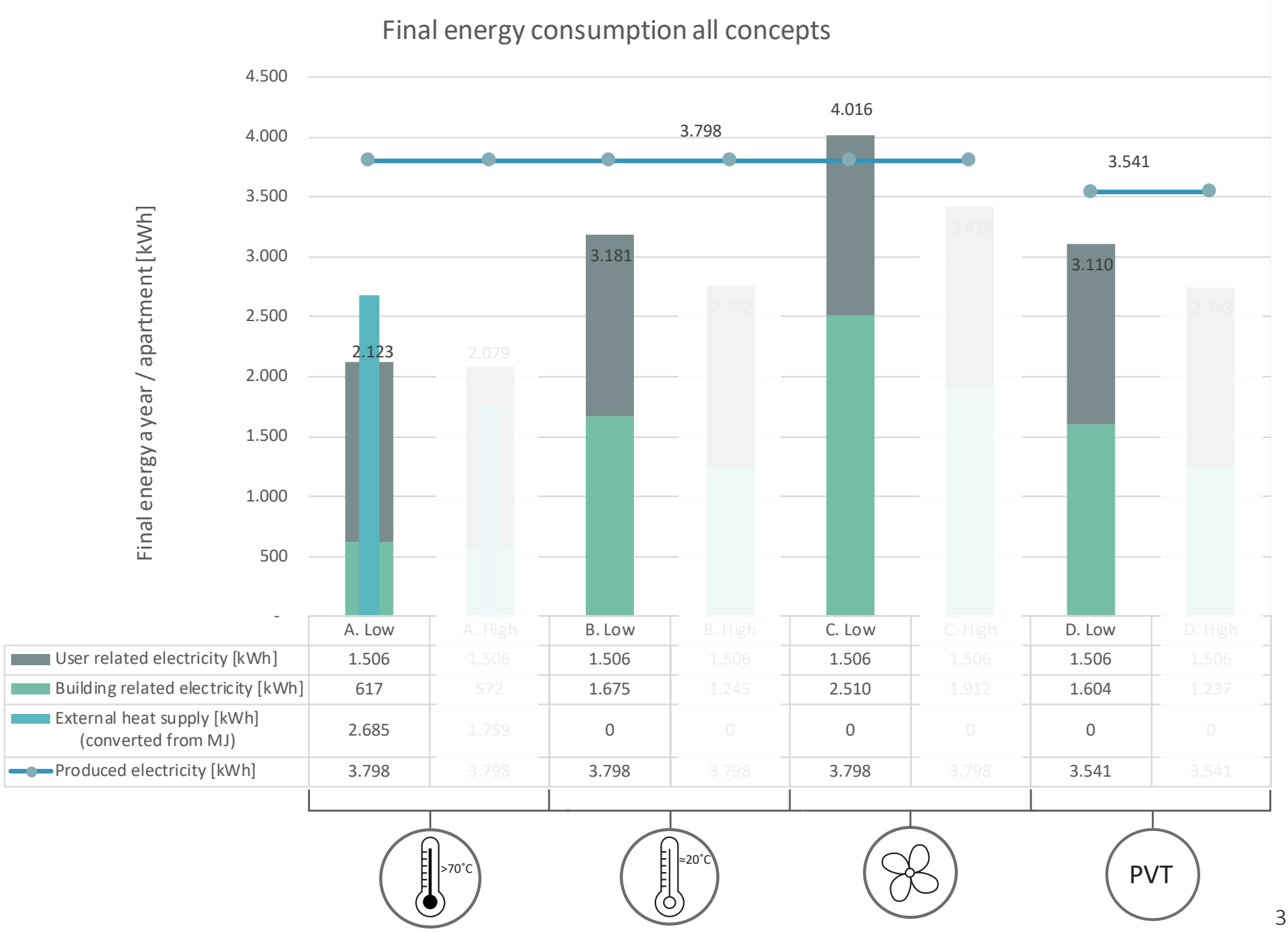
OVERVIEW Measures in Uniec		Concept D PVT panels	
		D. Low	D. High
Building envelope			
	Rc-value Floor	2,6	3,7
	Rc-value Facade	2,1	4,6
	Rc-value Roof	6,1	6,1
	Rc-value internal wall	0,1	0,1
	U-value glazing	1,2	0,7
Heating systems			
	System	Combi-heat pump	
	Source	Ground	
	Product	Nibe F1255-6 (PC) with Triple Solar source	
	COp heating	5,05	
	COp DHW	3,50	
	COp additional heating	1,00	
	Supply temperature	30˚ < Θsup ≤ 35˚	
	Delivery temperature	> 50˚C	≤ 50˚C
Ventilation			
	System	Inlet: Natural Exhaust: Mechanic	Inlet: Mechanic Exhaust: Mechanic
	Product	Itho Daalderop CO2 Optima NGG	Itho Daalderop HRU ECO 350 Optima 2 CO2
PV panels			
	Peak power	180 Wp/m2	
	RFpv	S=1,00 N=0,70	
	Number/orientation	75 m2 (S) 150m2(N) 29˚	
PVT panels			
	Peak power	165 Wp/m2	
	RFpv	S = 1,00	
	Number/orientation	75m2 29˚	

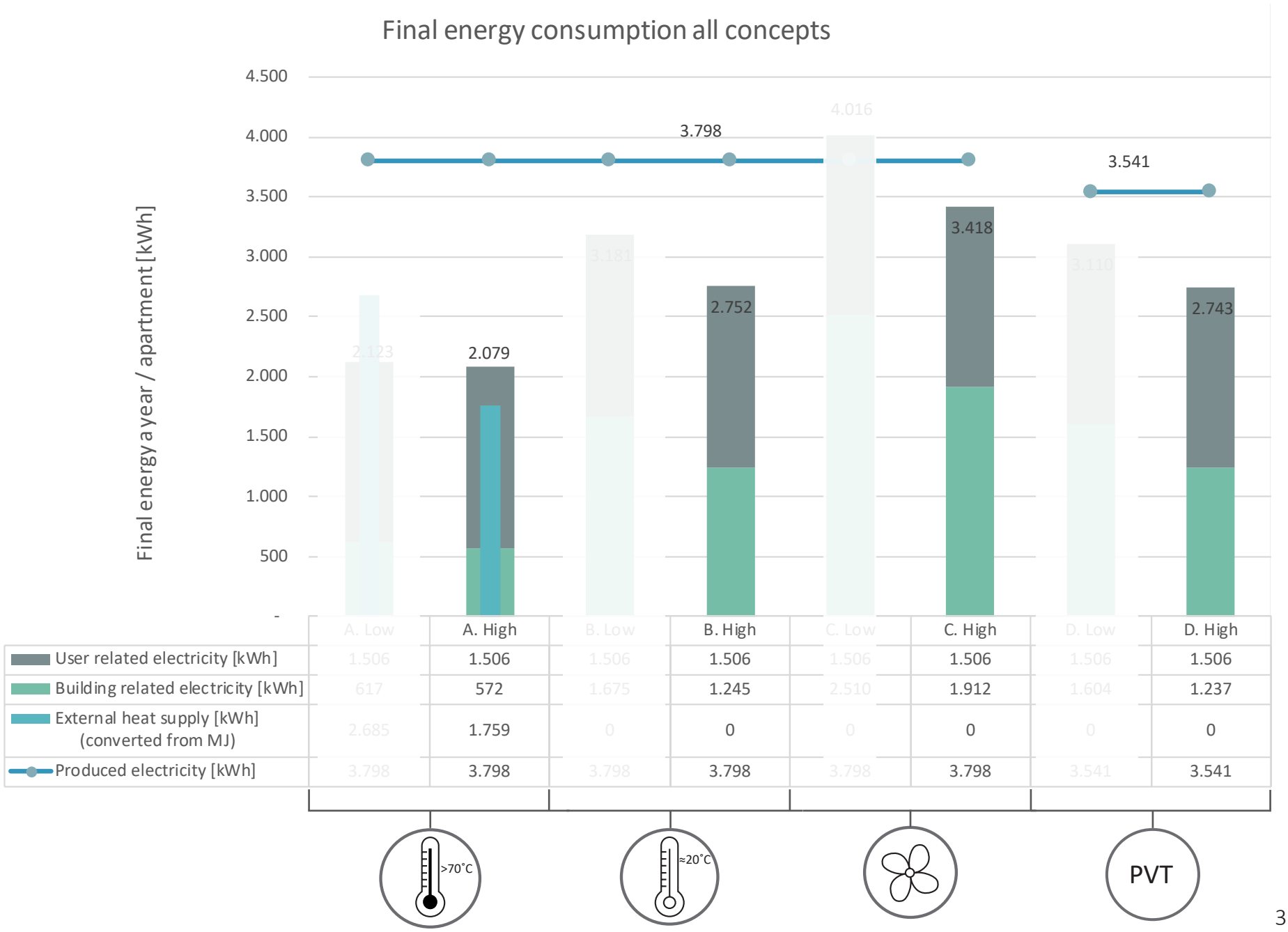

Final energy consumption all concepts
Final energy a year / apartment [kWh]
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
500
-
2.123
2.079
3.181
2.752
4.016
3.418
3.110
2.743
3.798
3.541
A. Low
A. High
B. Low
B. High
C. Low
C. High
D. Low
D. High
User related electricity [kWh]
1.506
1.506
1.506
1.506
1.506
1.506
1.506
1.506
Building related electricity [kWh]
617
572
1.675
1.245
2.510
1.912
1.604
1.237
External heat supply [kWh] (converted from MJ)
2.685
1.759
0
0
0
0
0
0
Produced electricity [kWh]
3.798
3.798
3.798
3.798
3.798
3.798
3.541
3.541
>70°C
≈20°C
PVT

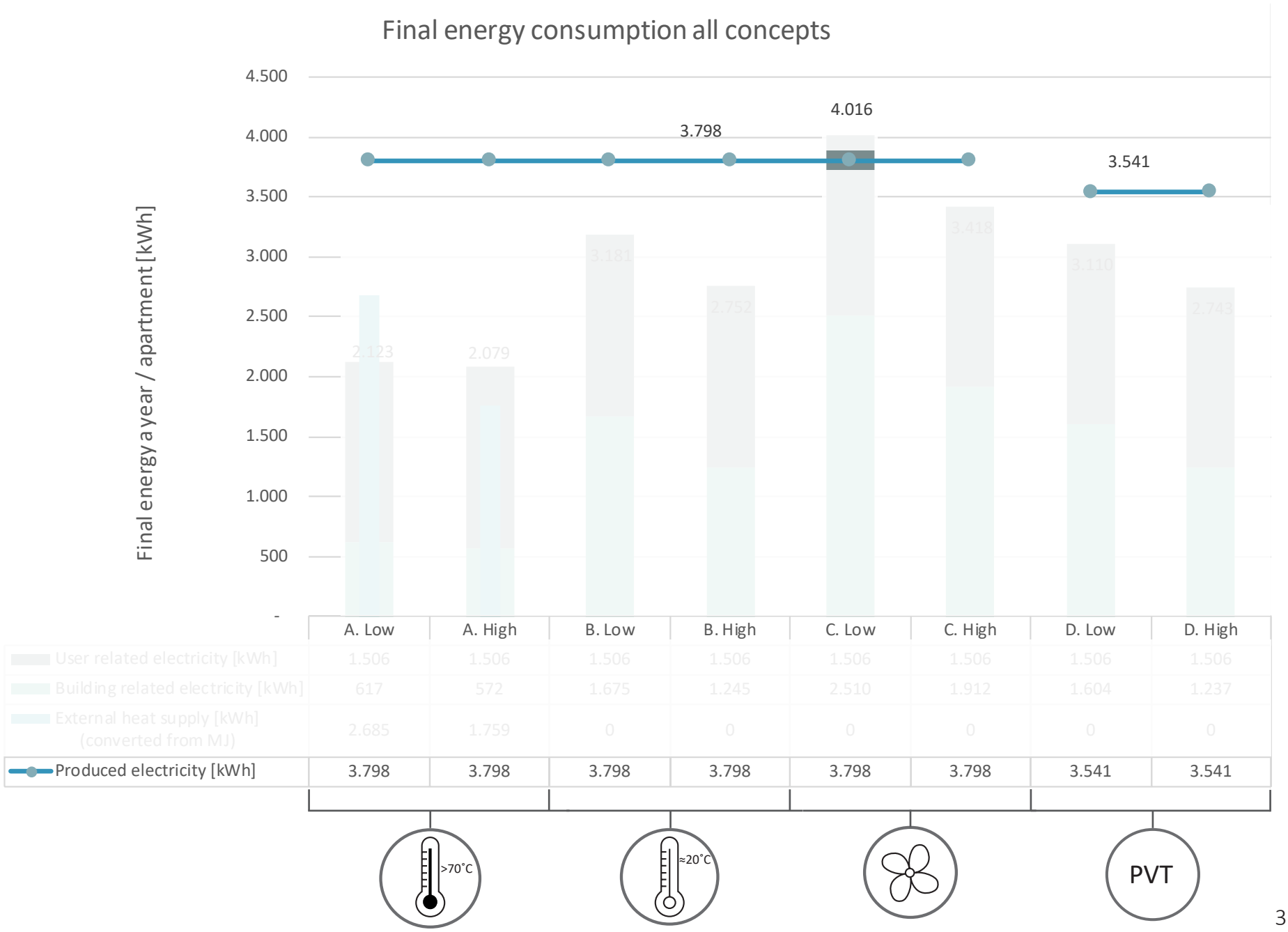

Final energy consumption all concepts
Final energy a year / apartment [kWh]
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
500
-
2.123
2.079
3.181
2.752
4.016
3.418
3.110
2.743
3.798
3.541
A. Low
A. High
B. Low
B. High
C. Low
C. High
D. Low
D. High
User related electricity [kWh] 1.506 1.506 1.506 1.506 1.506 1.506 1.506 1.506
Building related electricity [kWh] 617 572 1.675 1.245 2.510 1.912 1.604 1.237
External heat supply [kWh] (converted from MJ) 2.685 1.759 0 0 0 0 0 0
Produced electricity [kWh] 3.798 3.798 3.798 3.798 3.798 3.798 3.541 3.541
>70°C
≈20°C
PVT

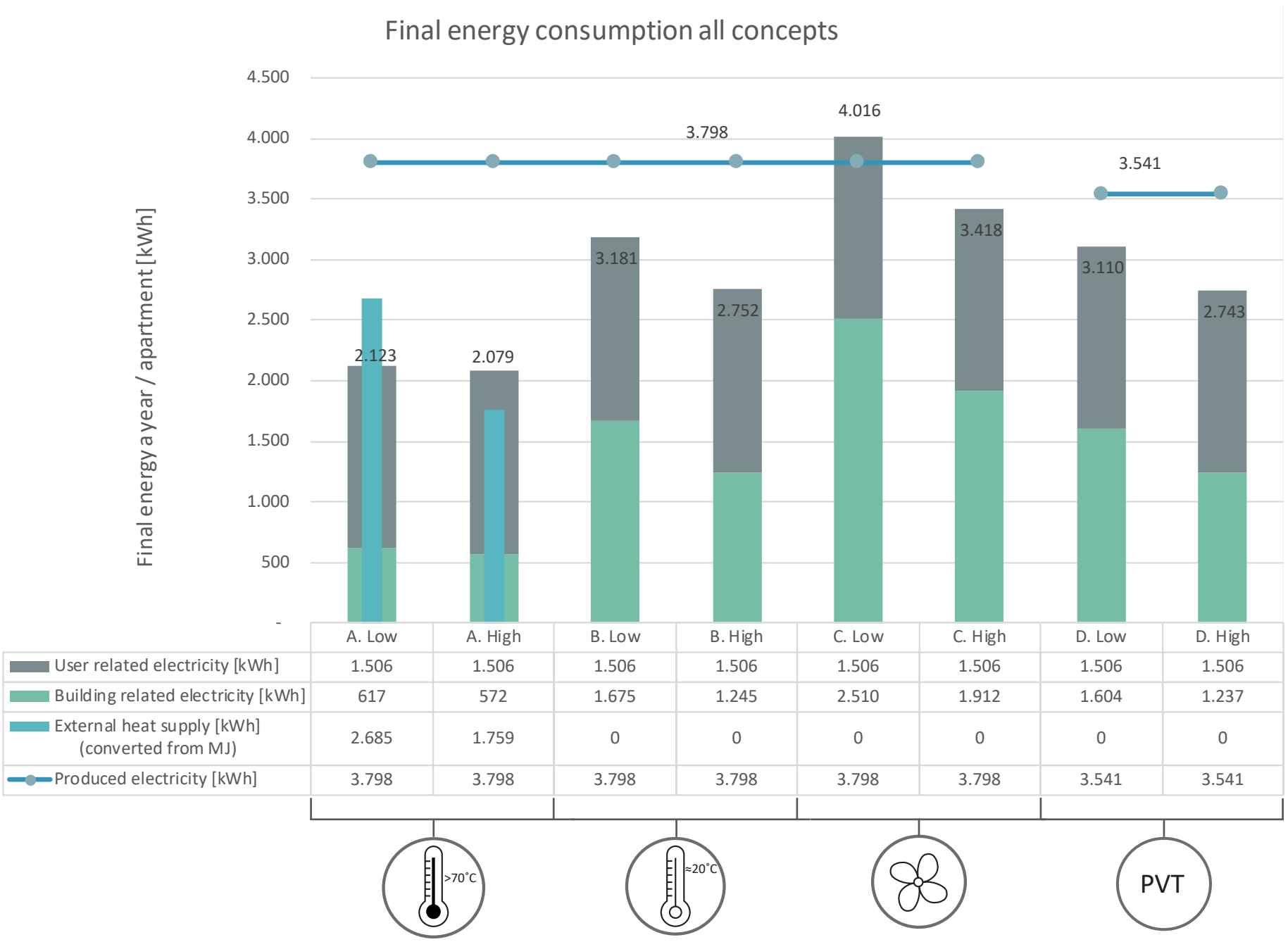

Final energy consumption all concepts
Final energy a year / apartment [kWh]
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
500
-
3.798
4.016
3.541
3.181
2.752
3.418
3.110
2.743
2.123
2.079
A. Low
A. High
B. Low
B. High
C. Low
C. High
D. Low
D. High
User related electricity [kWh]
1.506
1.506
1.506
1.506
1.506
1.506
1.506
1.506
Building related electricity [kWh]
617
572
1.675
1.245
2.510
1.912
1.604
1.237
External heat supply [kWh] (converted from MJ)
2.685
1.759
0
0
0
0
0
0
Produced electricity [kWh]
3.798
3.798
3.798
3.798
3.798
3.798
3.541
3.541
>70°C
≈20°C
PVT


Final energy consumption all concepts
Final energy a year / apartment [kWh]
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
500
-
2.123
2.079
3.181
2.752
4.016
3.418
3.110
2.743
3.798
3.541
A. Low
A. High
B. Low
B. High
C. Low
C. High
D. Low
D. High
User related electricity [kWh] 1.506 1.506 1.506 1.506 1.506 1.506 1.506 1.506
Building related electricity [kWh] 617 572 1.675 1.245 2.510 1.912 1.604 1.237
External heat supply [kWh] (converted from MJ) 2.685 1.759 0 0 0 0 0 0
Produced electricity [kWh] 3.798 3.798 3.798 3.798 3.798 3.798 3.541 3.541
>70°C
≈20°C
PVT


Final energy consumption all concepts
Final energy a year / apartment [kWh]
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
500
-
4.016
3.798
3.541
3.181
3.110
3.418
2.752
2.743
2.123
2.079
A. Low
A. High
B. Low
B. High
C. Low
C. High
D. Low
D. High
User related electricity [kWh]
1.506 1.506 1.506 1.506 1.506 1.506 1.506 1.506
Building related electricity [kWh]
617 572 1.675 1.245 2.510 1.912 1.604 1.237
External heat supply [kWh] (converted from MJ)
2.685 1.759 0 0 0 0 0 0
Produced electricity [kWh]
3.798 3.798 3.798 3.798 3.798 3.798 3.541 3.541
>70°C
≈20°C
PVT


Final energy consumption all concepts
Final energy a year / apartment [kWh]
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
500
-
3.798
3.541
4.016
3.418
3.181
3.110
2.752
2.743
2.123
2.079
A. Low
A. High
B. Low
B. High
C. Low
C. High
D. Low
D. High
User related electricity [kWh]
1.506 1.506 1.506 1.506 1.506 1.506 1.506 1.506
Building related electricity [kWh]
617 572 1.675 1.245 2.510 1.912 1.604 1.237
External heat supply [kWh] (converted from MJ)
2.685 1.759 0 0 0 0 0 0
Produced electricity [kWh]
3.798 3.798 3.798 3.798 3.798 3.798 3.541 3.541
>70°C
≈20°C
PVT


Final energy consumption all concepts
Final energy a year / apartment [kWh]
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
500
-
3.798
4.016
3.541
2.123
2.079
3.181
2.752
3.418
3.110
2.743
A. Low
A. High
B. Low
B. High
C. Low
C. High
D. Low
D. High
User related electricity [kWh] 1.506 1.506 1.506 1.506 1.506 1.506 1.506 1.506
Building related electricity [kWh] 617 572 1.675 1.245 2.510 1.912 1.604 1.237
External heat supply [kWh] (converted from MJ) 2.685 1.759 0 0 0 0 0 0
Produced electricity [kWh] 3.798 3.798 3.798 3.798 3.798 3.798 3.541 3.541
>70°C
≈20°C
PVT

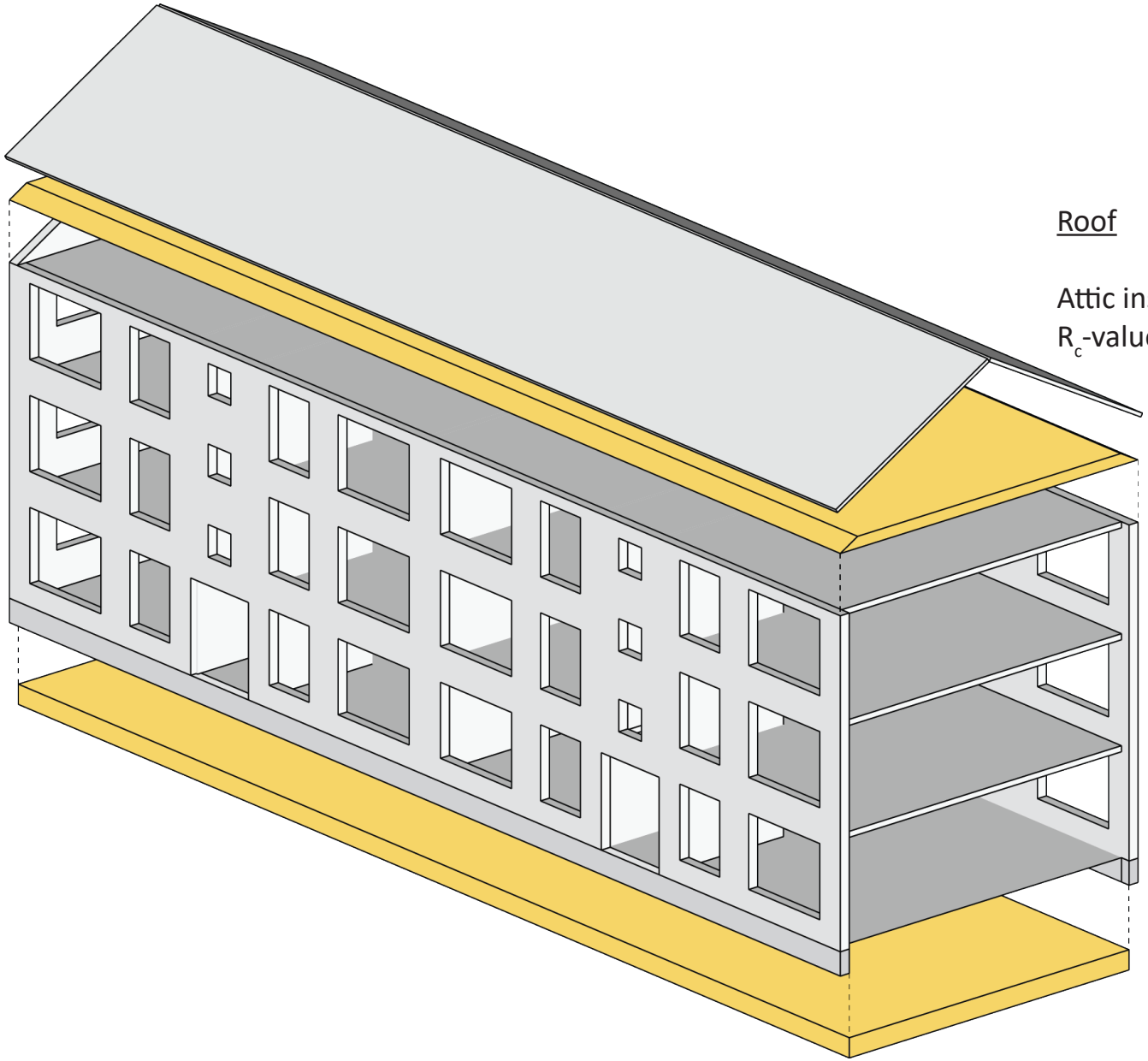


	A. Low	A. High	B. Low	B. High	C. Low	C. High	D. Low	D. High
User related electricity [kWh]	1.506	1.506	1.506	1.506	1.506	1.506	1.506	1.506
Building related electricity [kWh]	617	572	1.675	1.245	2.510	1.912	1.604	1.237
External heat supply [kWh] (converted from MJ)	2.685	1.759	0	0	0	0	0	0
Produced electricity [kWh]	3.798	3.798	3.798	3.798	3.798	3.798	3.541	3.541

DESIGN CRITERIA

<u>Façade</u>

Cavity insulation
R_c-value = 2,1 $m^2 \cdot K/W$



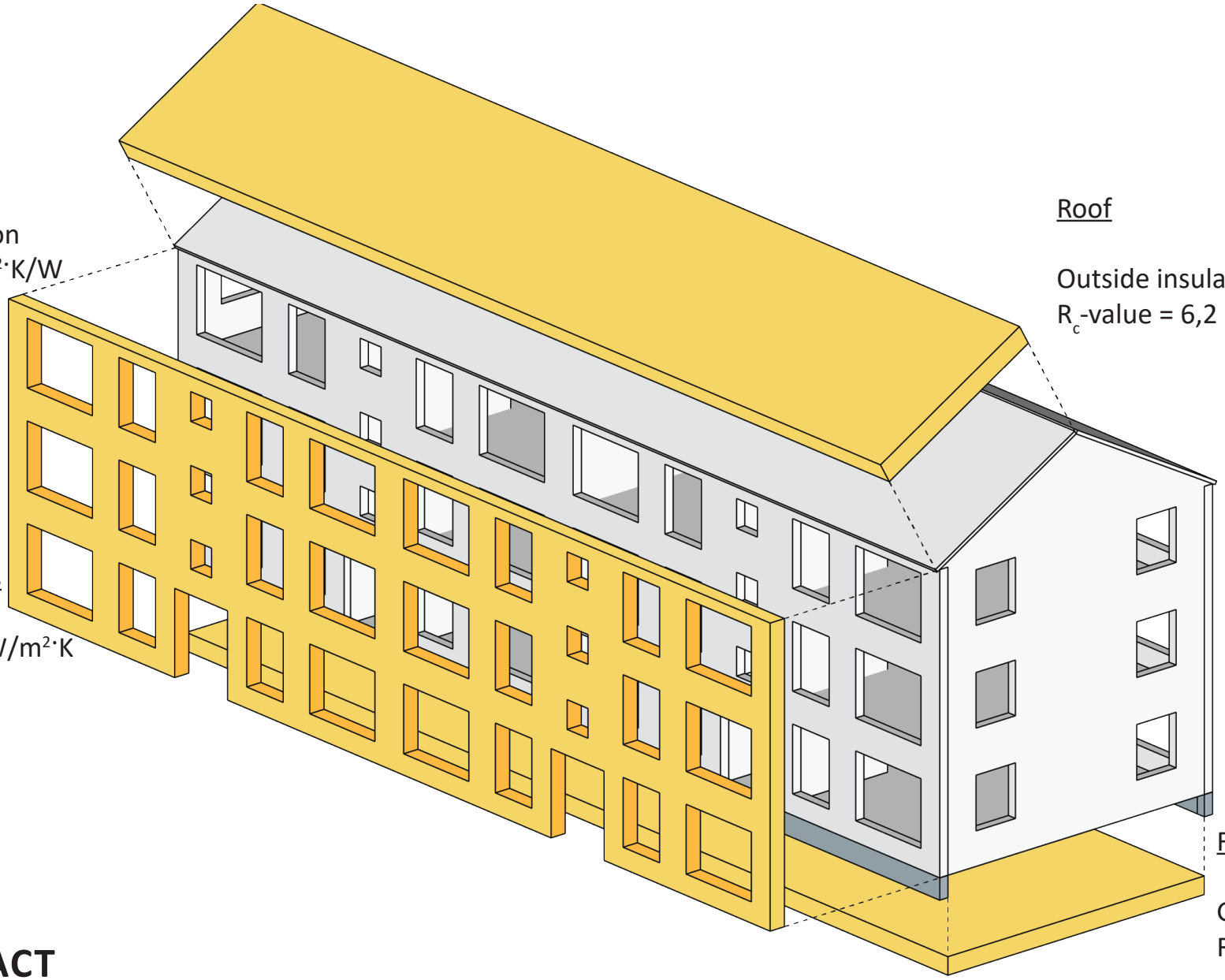
<u>Roof</u>

Attic insulation
R_c-value = 3,4 $m^2 \cdot K/W$

<u>Floor</u>

Ground insulation
R_c-value = 4,0 $m^2 \cdot K/W$

LOW IMPACT



Façade

Outside insulation
R_c-value = 3,4 m²·K/W

Façade openings

U-value = 0,93 W/m²·K

Roof

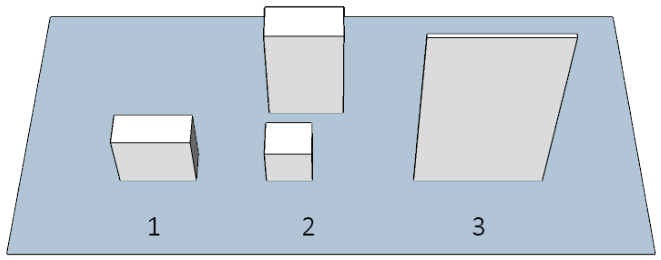
Outside insulation
R_c-value = 6,2 m²·K/W

Floor

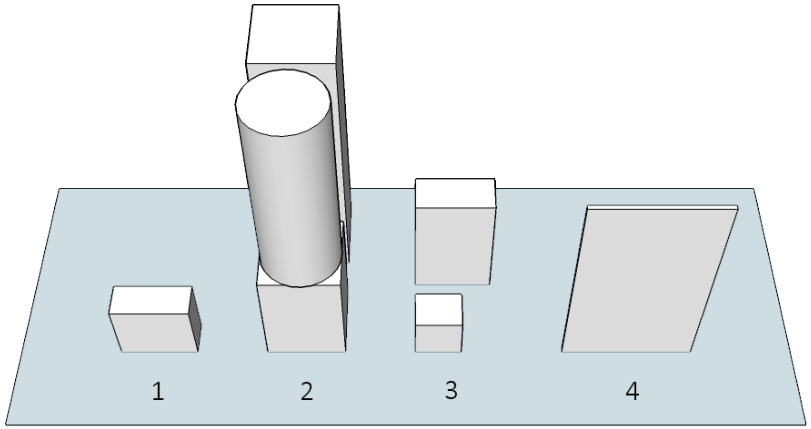
Ground insulation
R_c-value = 5,6 m²·K/W

HIGH IMPACT

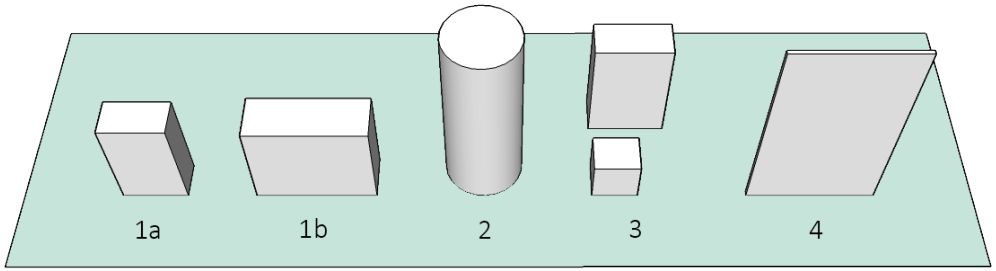
Concept A: External heat supply >70˚C		**Dimensions [mm] L x W x H**	**Weight [kg]**	**Requirements estimation**
1. Sub-station EcoMechanic		588 x 258 x 493	9	Inlet – outlet city grid
2. Ventilation	2a. CO2 regulated Itho Daalderop Optima Flow system	355 x 294 x 350	3,5	Electricity, air outlet
	2b. WTW Itho Daalderop HRU ECO 200 E	597 x 290 x 916	12	Electricity, air outlet, air inlet, condensation drain
3. PV CSUN 255-60P	1 panel	990 x 35 x 1640	18,3	Electricity



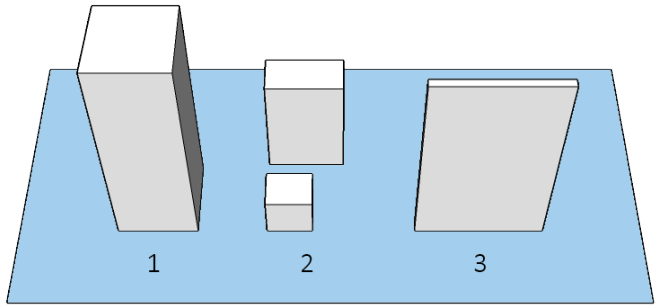
Concept B: External heat supply ≈20˚C		**Dimensions [mm] L x W x H**	**Weight [kg]**	**Requirements estimation**
1. Sub-station EcoMechanic		588 x 258 x 493	9	Inlet – outlet city grid
2. Heat pump Itho Daalderop WPU 5G	2a. Heat pump only	600 x 600 x 830	85	Electricity, water inlet, water outlet
	2b. Optional: Buffer tank Itho Daalderop I-SVV 200l	*1486,5 x Ø595*	*56 (empty*	*Electricity, water inlet, CV supply, CV outlet*
	2c. In combination with buffer tank 200l	600 x 600 x 2103		Electricity, water inlet, CV supply, CV outlet
3. Ventilation	3a. CO2 regulated Itho Daalderop Optima Flow system	355 x 294 x 350	3,5	Electricity, air outlet
	3b. WTW Itho Daalderop HRU ECO 200 E	597 x 290 x 916	12	Electricity, air outlet, air inlet, condensation drain
3. PV CSUN 255-60P	1 panel	990 x 35 x 1640	18,3	Electricity



Concept C: Outdoor air		**Dimensions [mm] L x W x H**	**Weight [kg]**	**Requirements estimation**
1. Heat pump Itho Daalderop HP-s 55	1a. Indoor unit	505 x 288 x 790	45	Electricity, outdoor air, CV supply, CV outlet
	1b. Outdoor unit	934 x 354 x 753	62,5	Electricity, outdoor air, air outlet
2. Buffer tank Itho Daalderop I-SVV 200l		1486,5 x Ø595	56 (empty)	Electricity, water inlet, CV supply, CV outlet
3. Ventilation	3a. CO2 regulated Itho Daalderop Optima Flow system	355 x 294 x 350	3,5	Electricity, air outlet
	3b. WTW Itho Daalderop HRU ECO 200 E	597 x 290 x 916	12	Electricity, air outlet, air inlet, condensation drain
4. PV CSUN 255-60P	1 panel	990 x 35 x 1640	18,3	Electricity

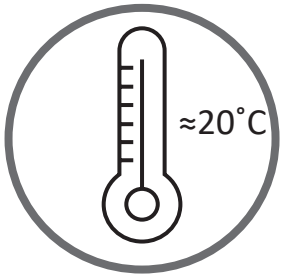


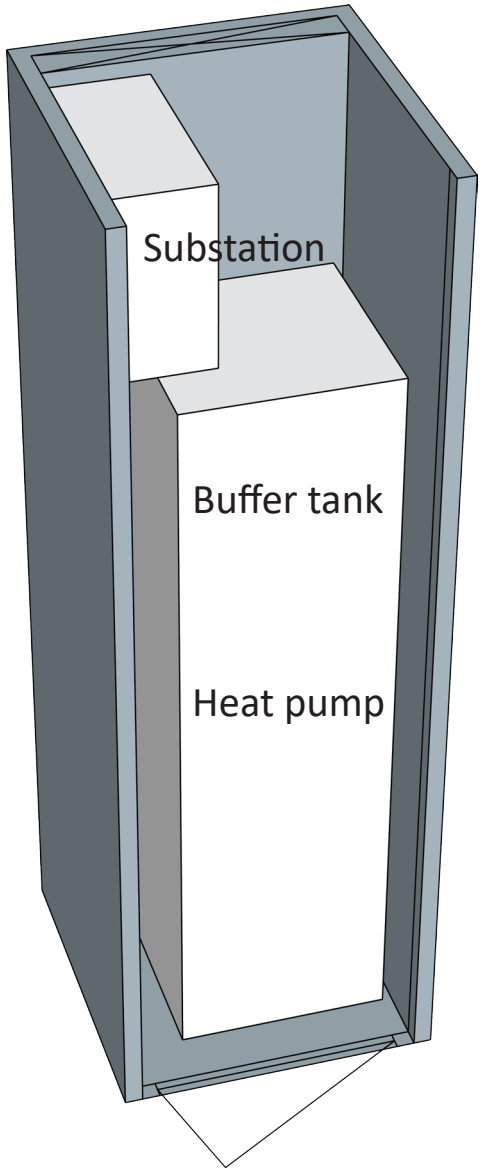
Concept D: PVT		**Dimensions [mm] L x W x H**	**Weight [kg]**	**Requirements estimation**
1. Heat pump NIBE-F1255-6	In combination with buffer tank 180l	600 x 620 x 1800	240	Electricity, water inlet, water outlet, CV supply, CV outlet
2. Ventilation	2a. CO2 regulated Itho Daalderop Optima Flow system	355 x 294 x 350	3,5	Electricity, air outlet
	2b. WTW Itho Daalderop HRU ECO 200 E	597 x 290 x 916	12	Electricity, air outlet, air inlet, condensation drain
3. PVT Triple Solar M2 285 165	1 panel	995 x 65 x 1668	27	Electricity, water inlet, water outlet

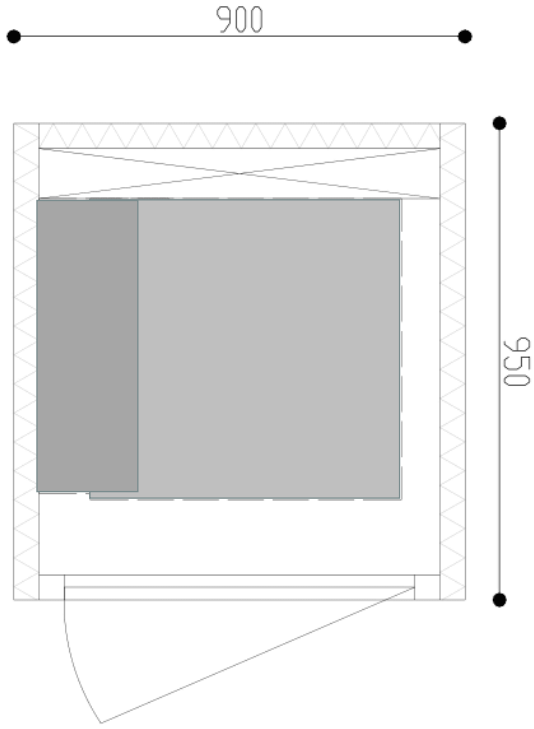


PHASE 4: DESIGN

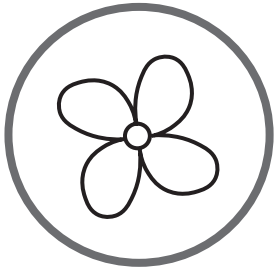
CONCEPT B

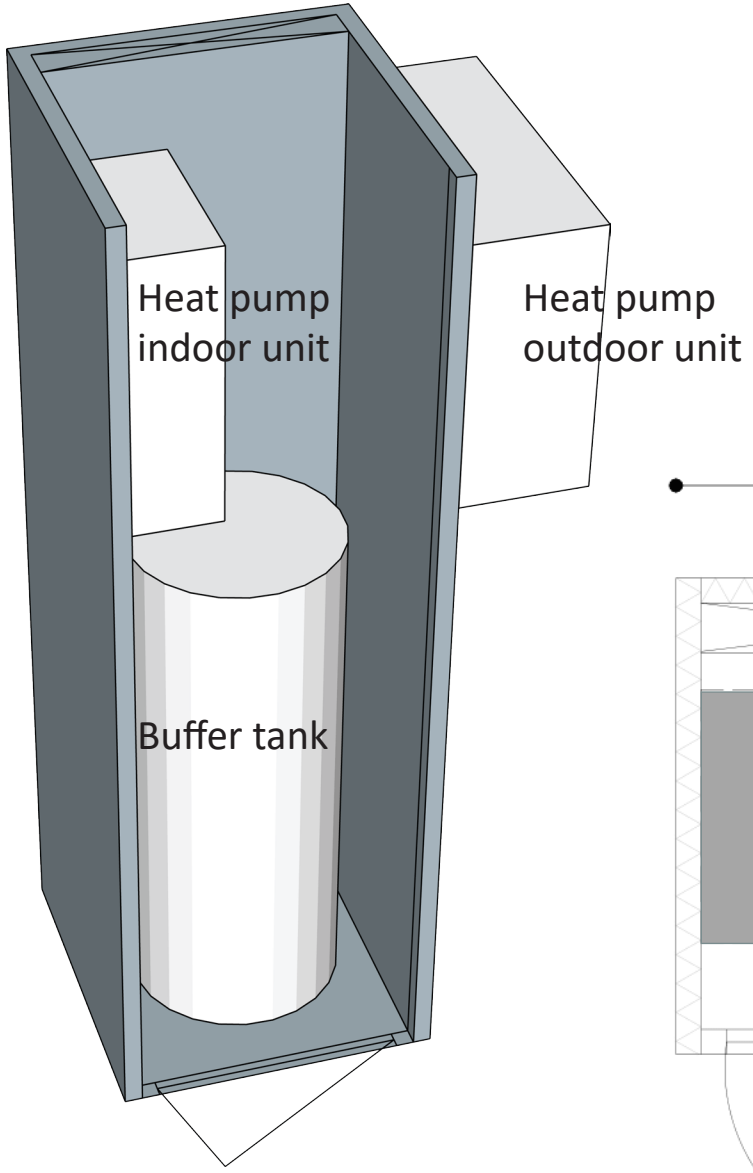


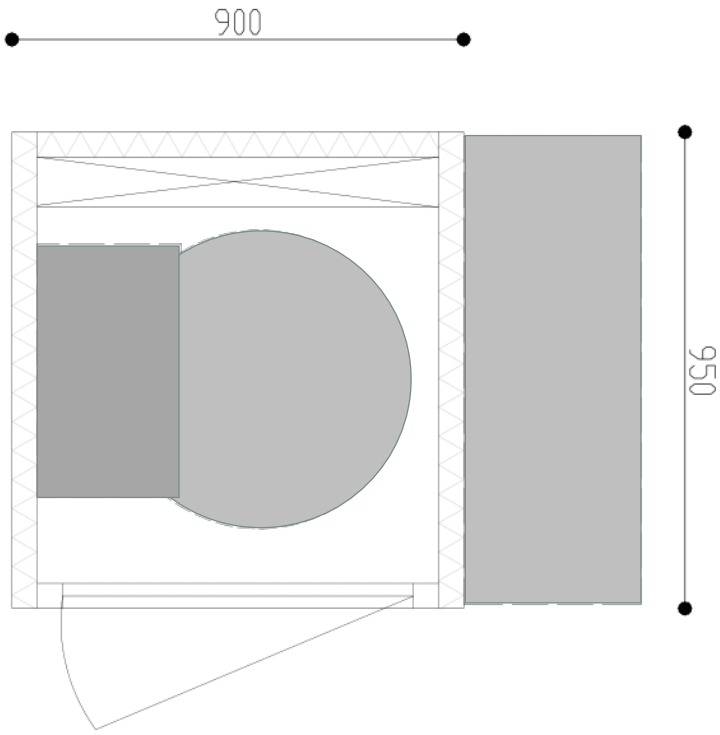




CONCEPT C

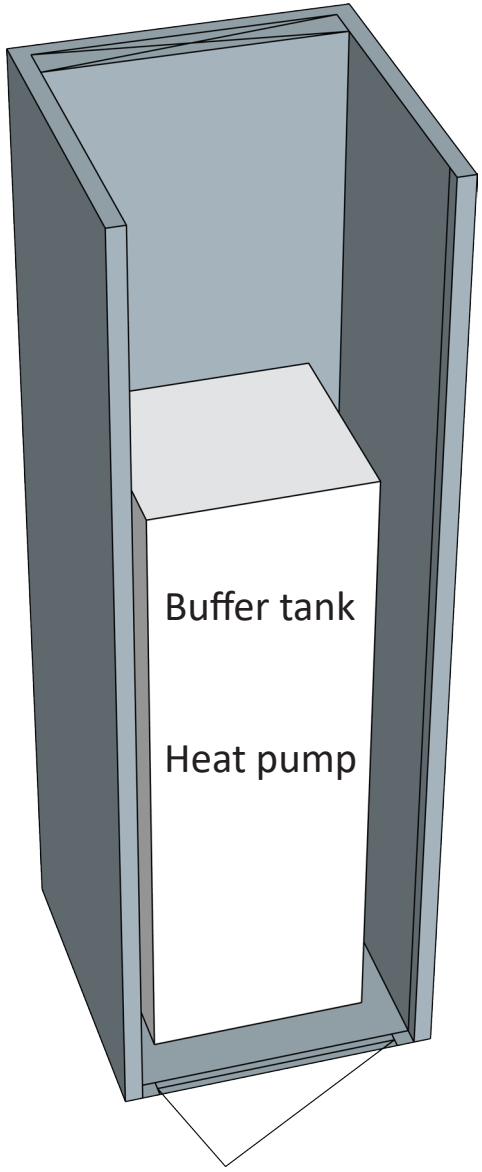


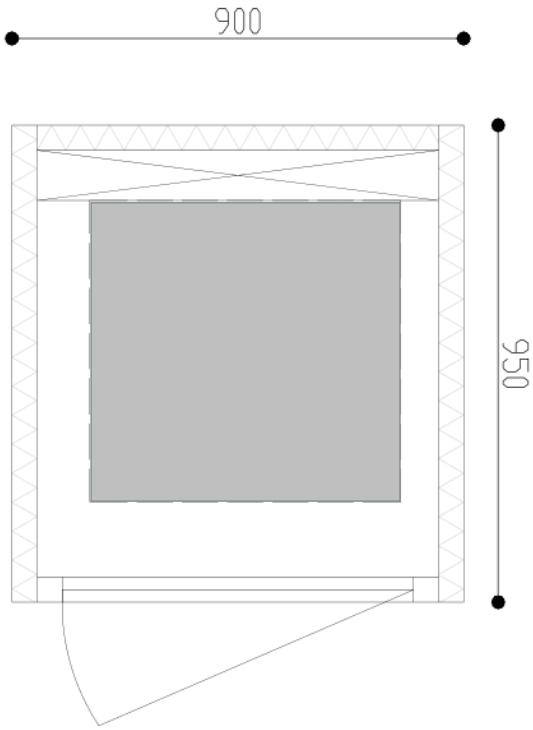

Heat pump
indoor unit
Heat pump
outdoor unit
Buffer tank


900
950

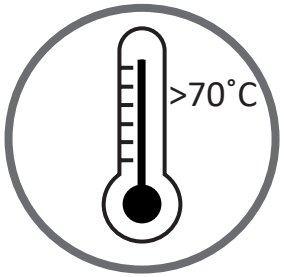
CONCEPT D

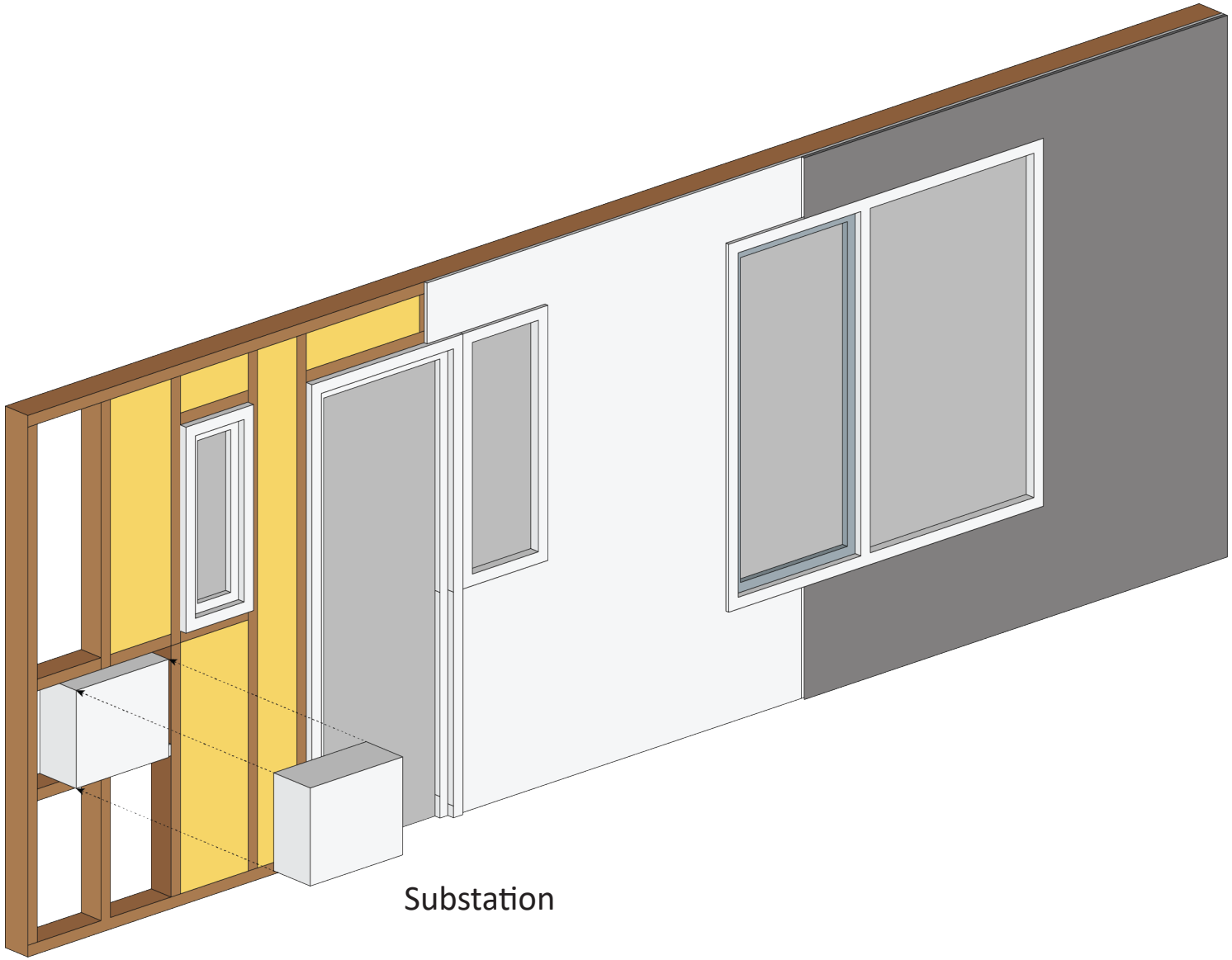
PVT





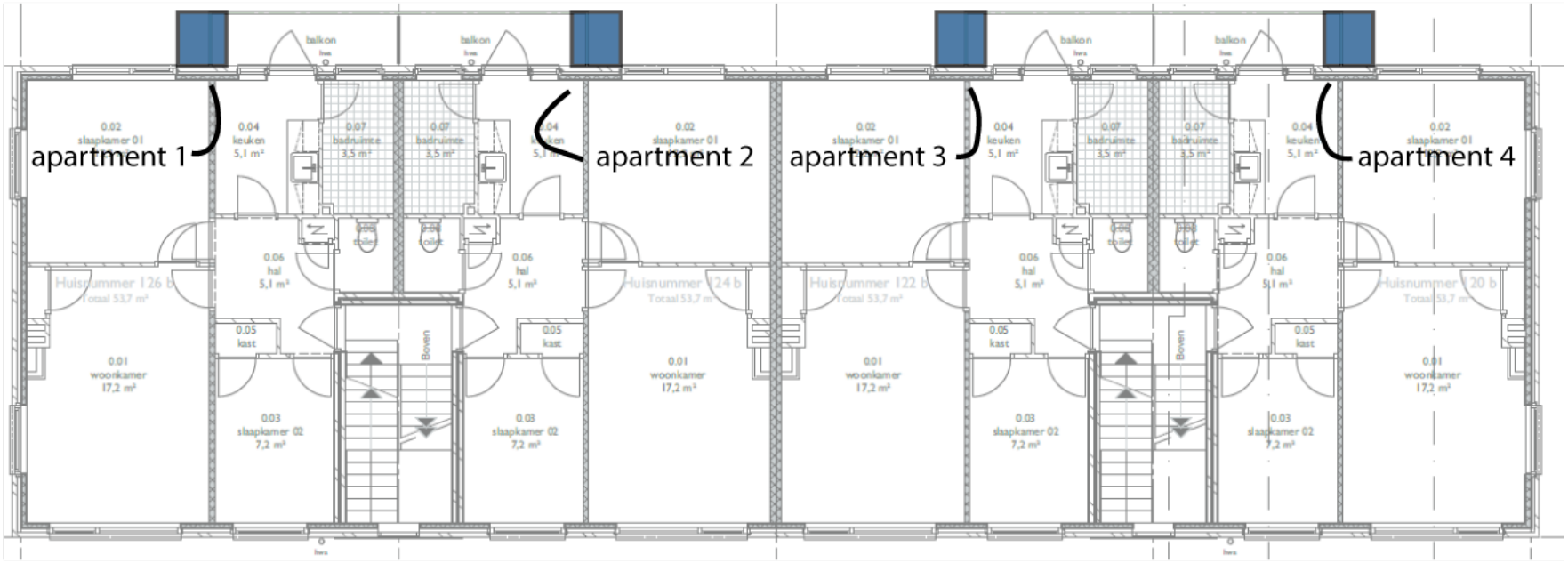
CONCEPT A



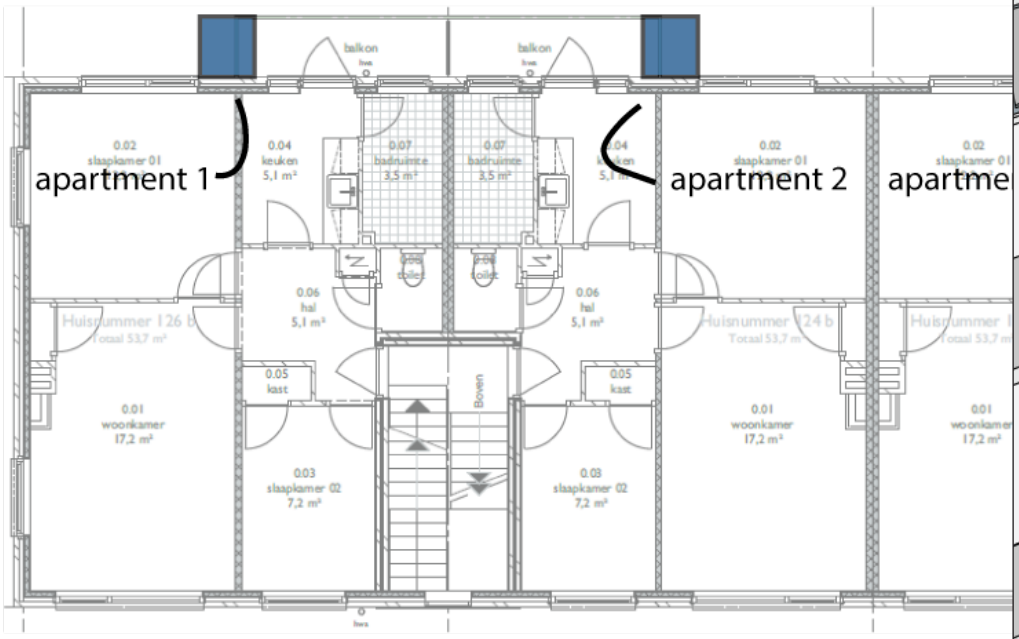


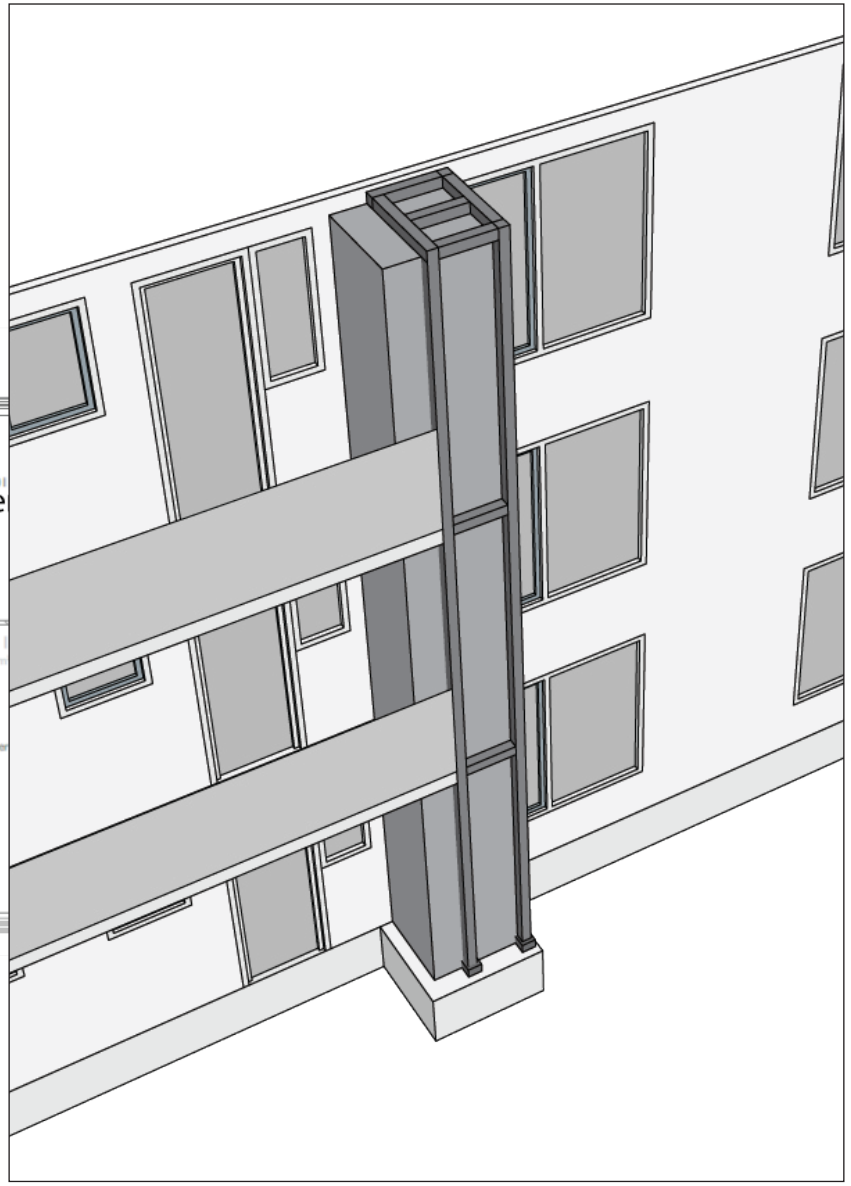
LOW IMPACT

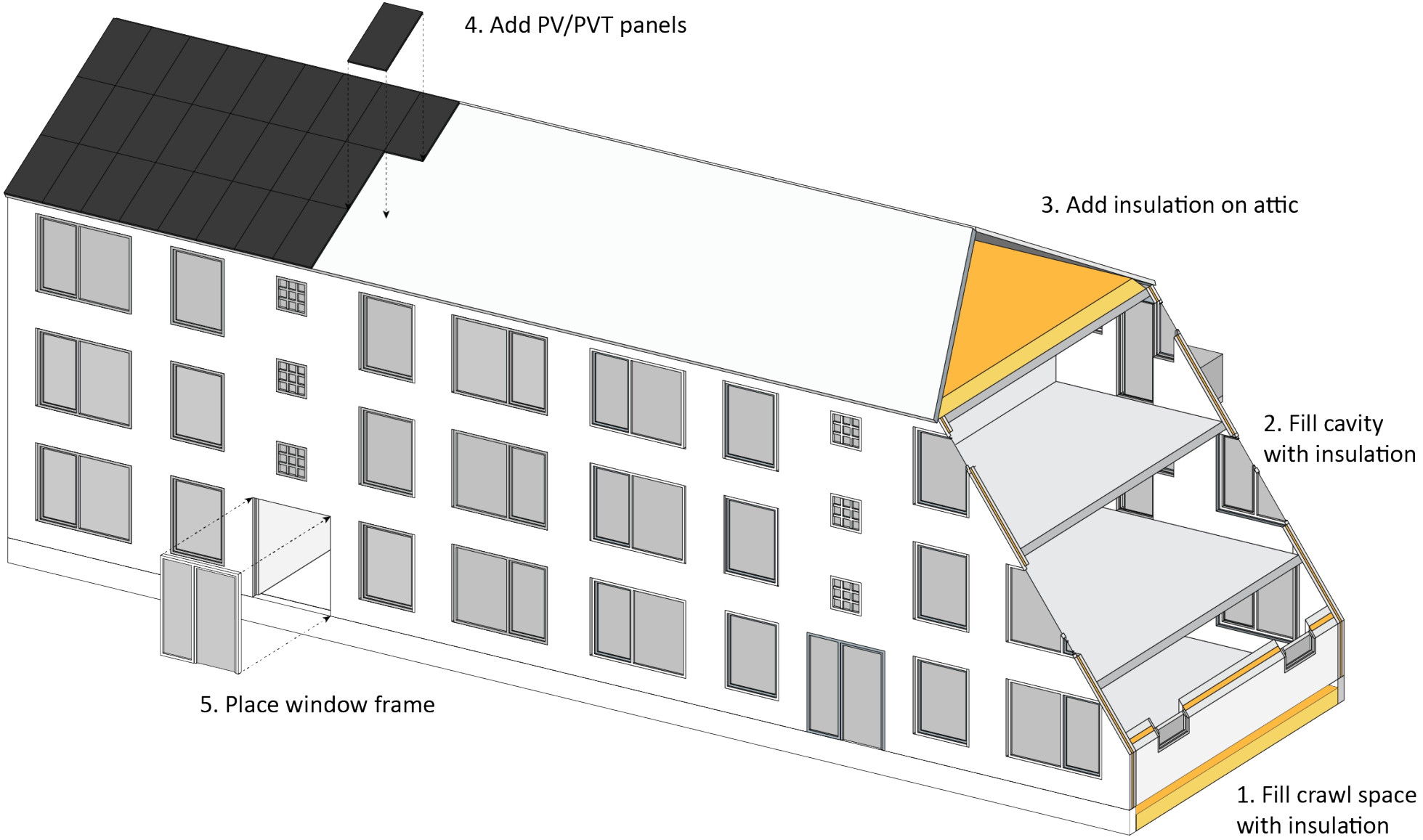
FLOOR PLAN

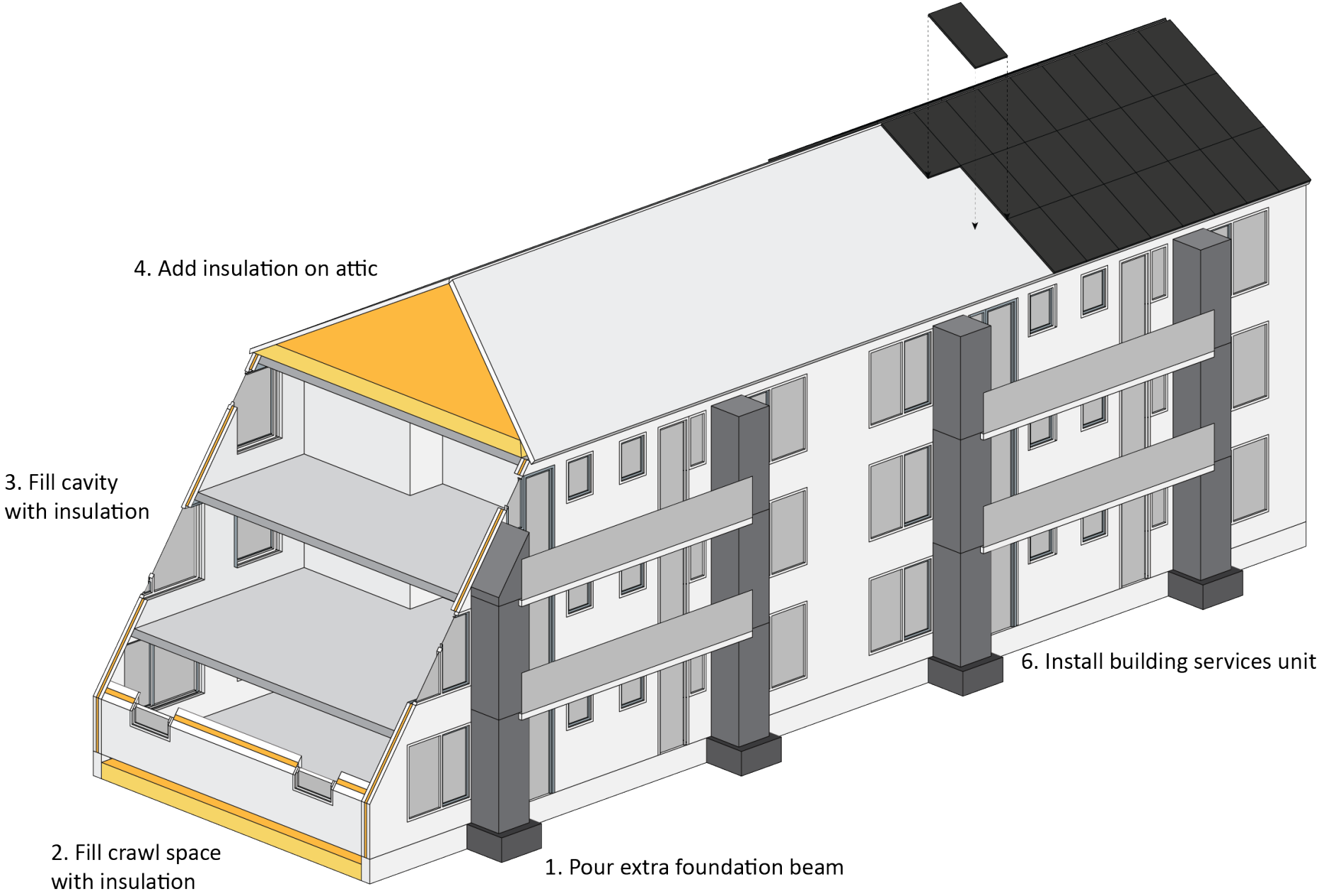

apartment 1
apartment 2
apartment 3
apartment 4
balkon
0.02 slaapkamer 01 17,2 m²
0.04 keuken 5,1 m²
0.07 badruimte 3,5 m²
0.06 hal 5,1 m²
0.05 kast
0.01 woonkamer 17,2 m²
0.03 slaapkamer 02 7,2 m²
Boven

SUBSTRUCTURE

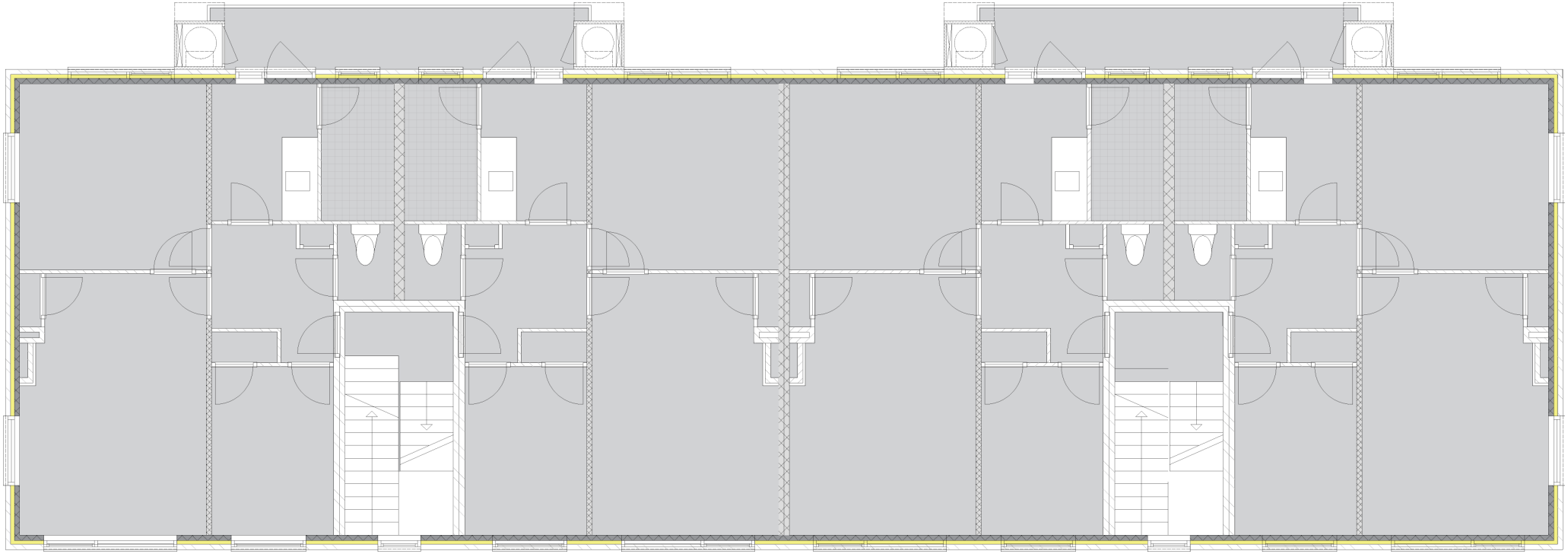





4. Add PV/PVT panels
3. Add insulation on attic
2. Fill cavity
with insulation
5. Place window frame
1. Fill crawl space
with insulation

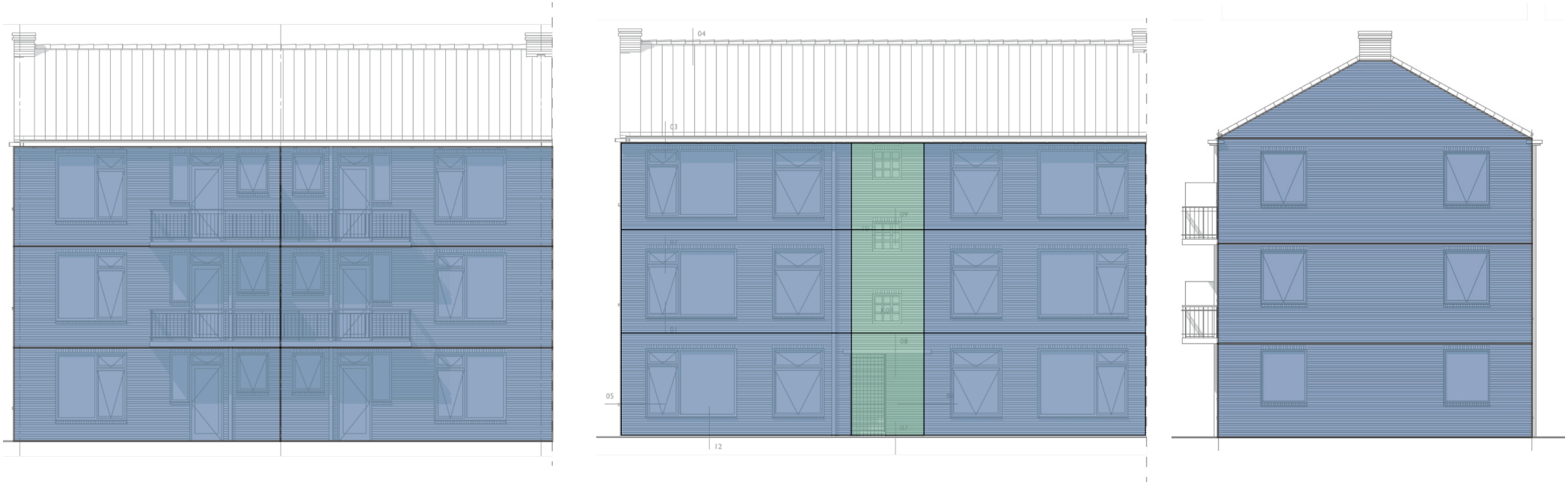

4. Add insulation on attic
3. Fill cavity with insulation
2. Fill crawl space with insulation
1. Pour extra foundation beam
6. Install building services unit

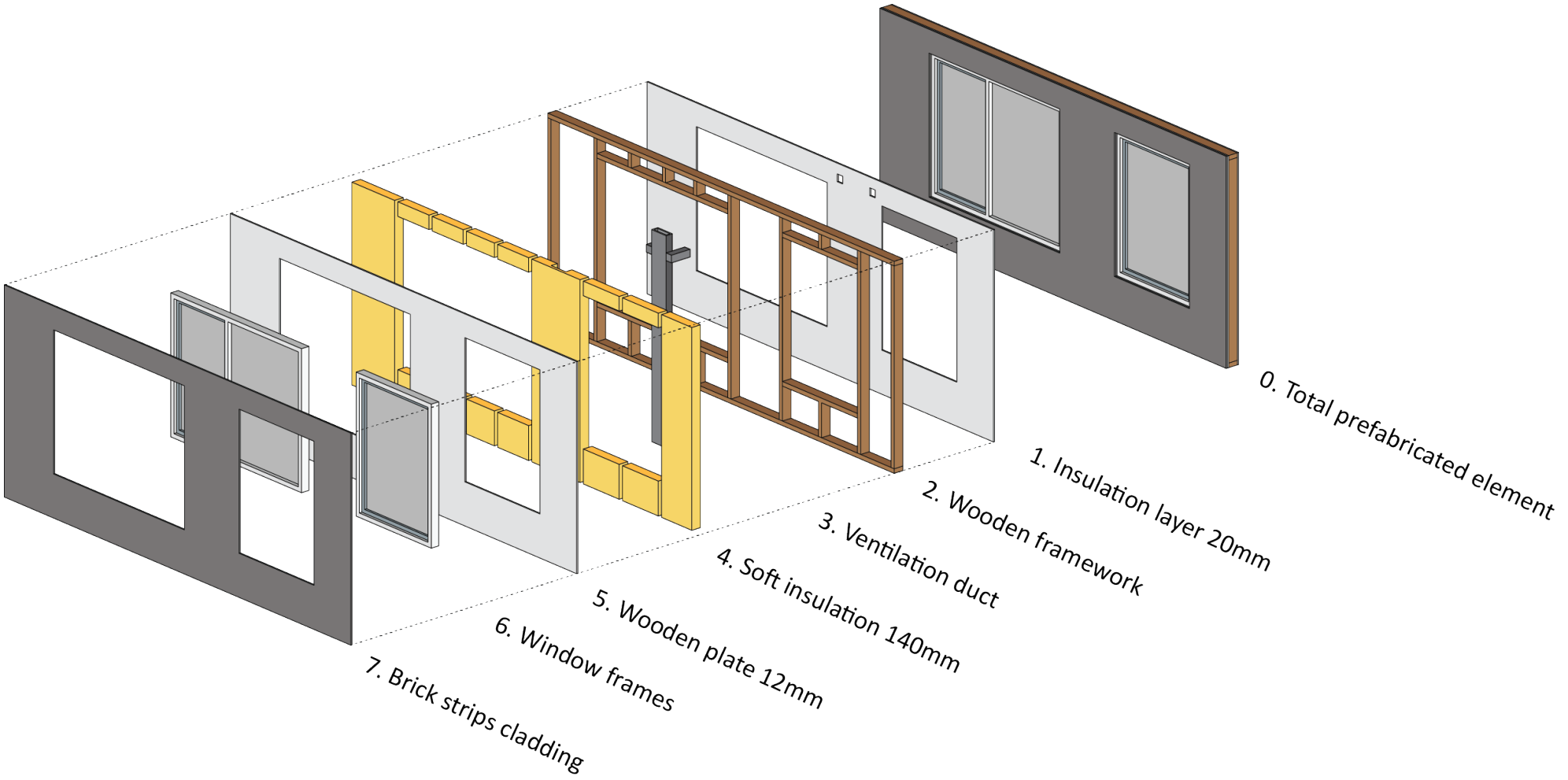
FLOOR PLAN

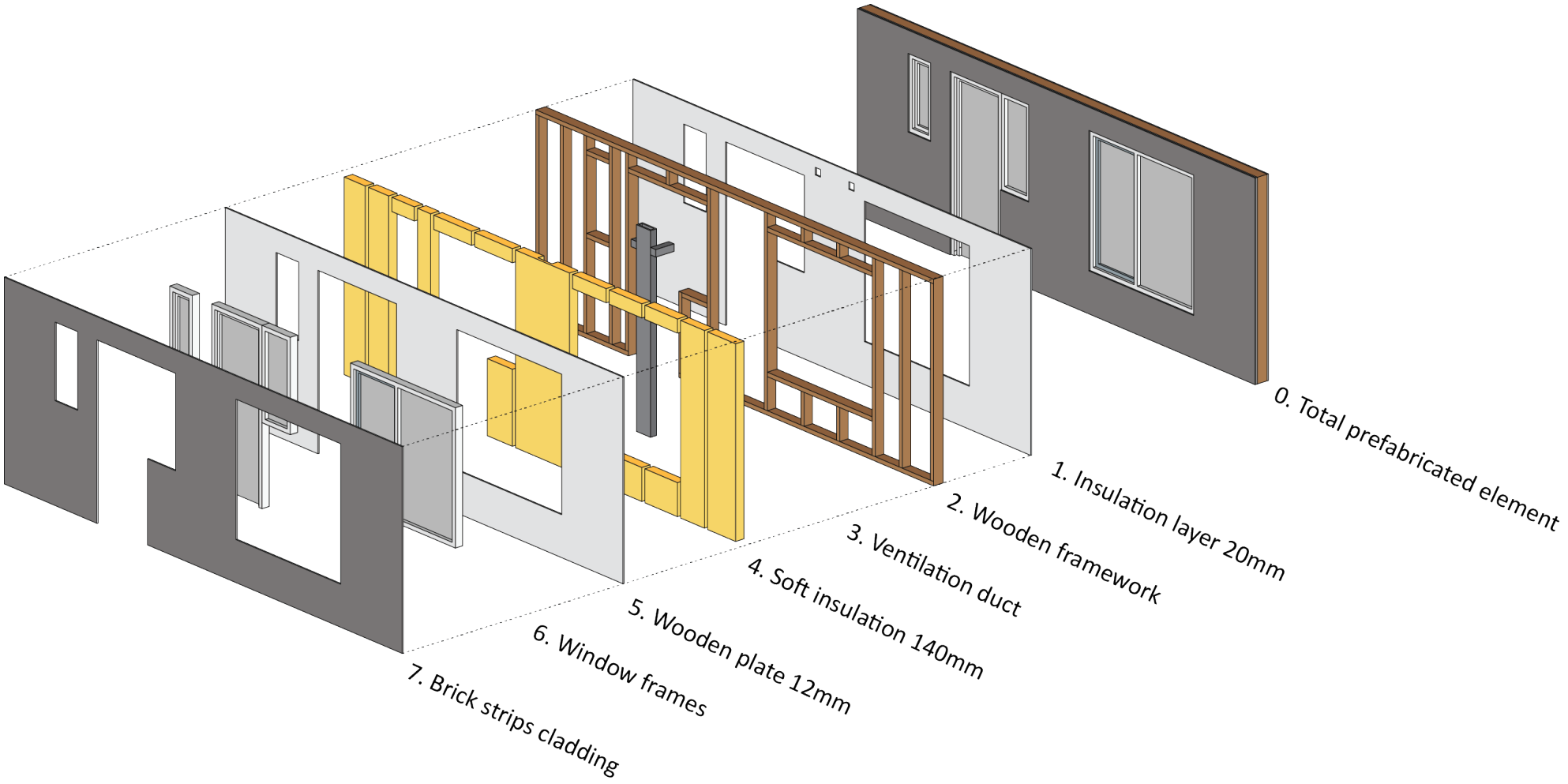


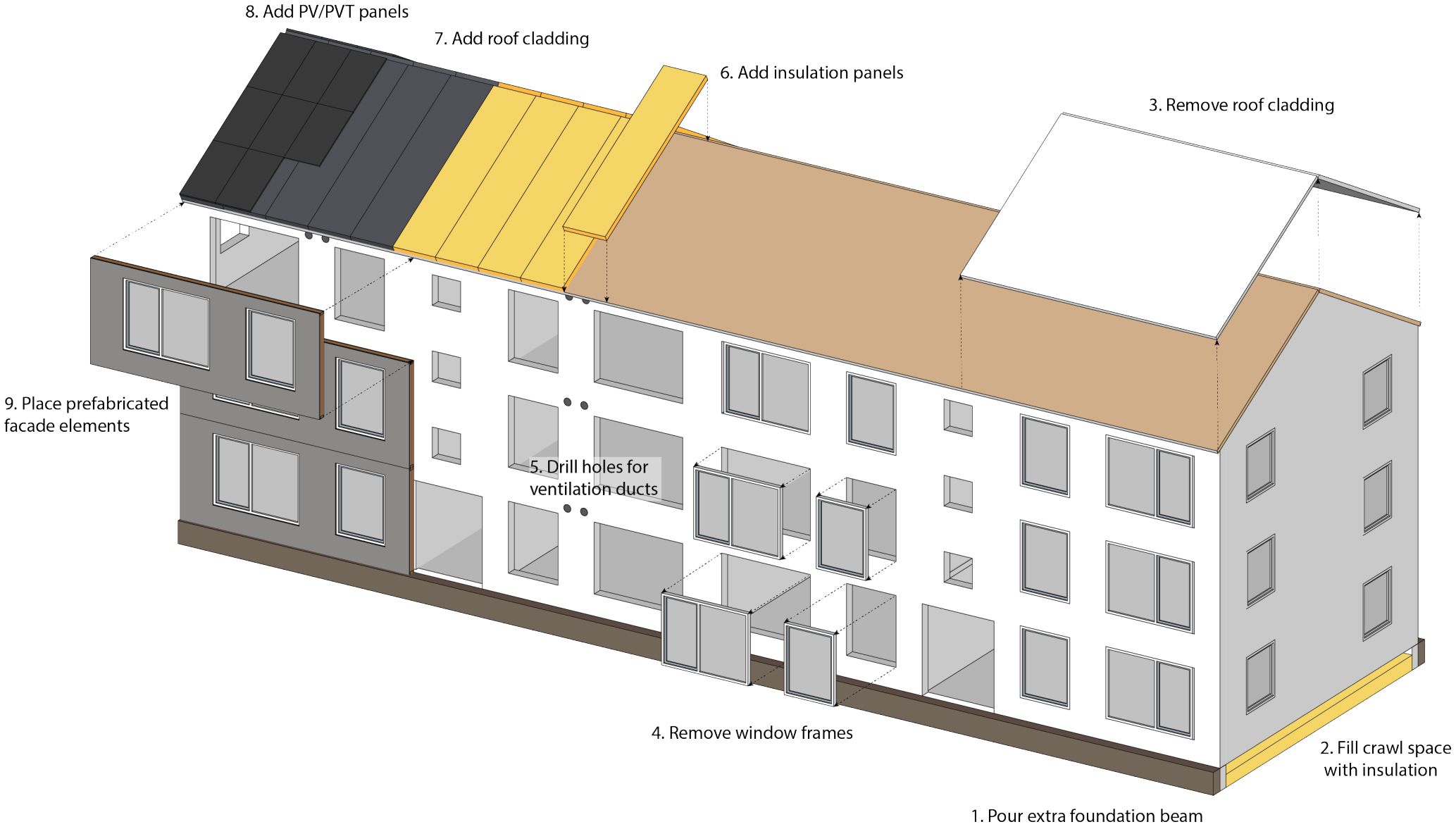
HIGH IMPACT

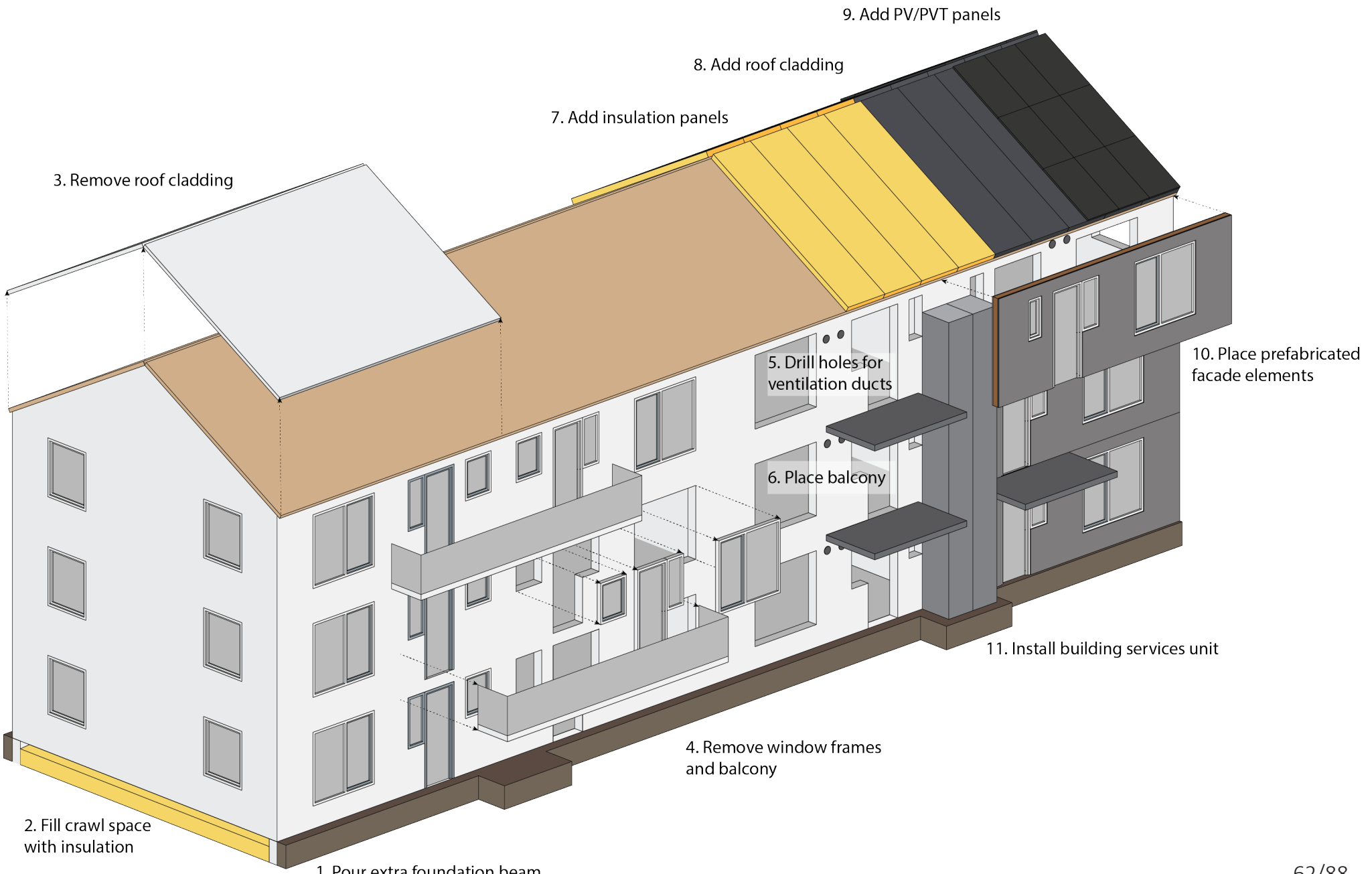
FULLY PREFABRICATED ELEMENTS



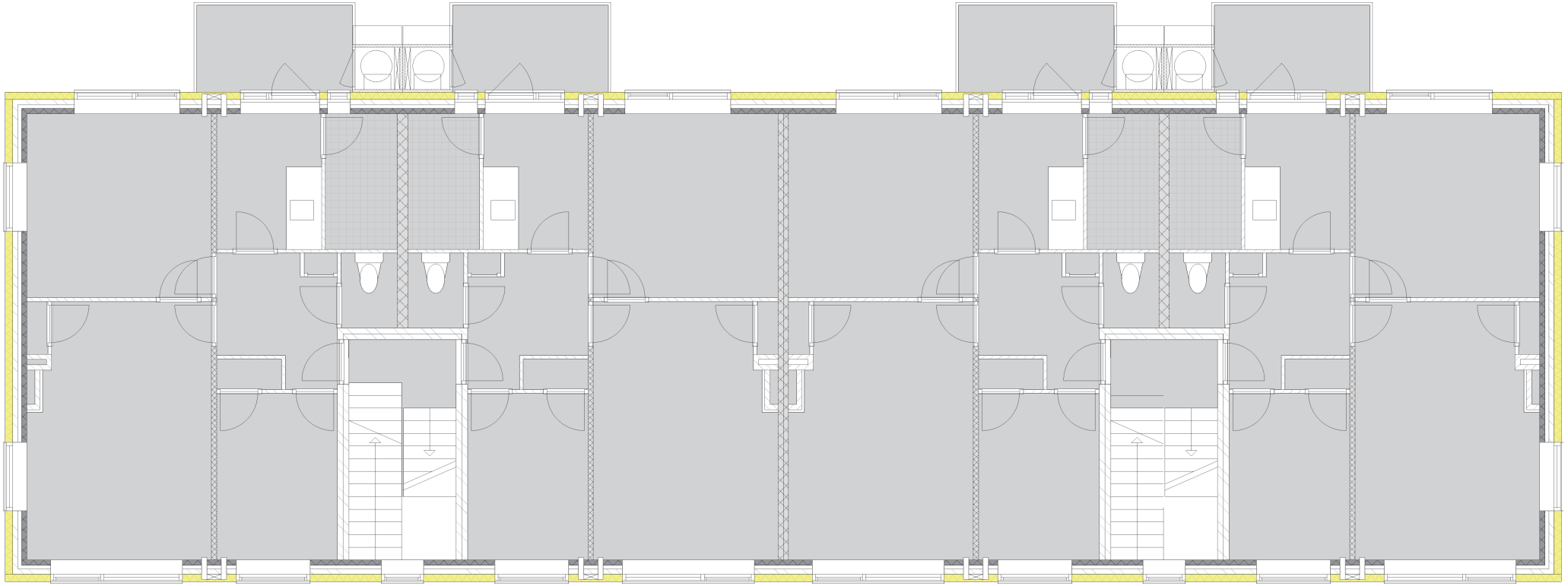

0. Total prefabricated element
1. Insulation layer 20mm
2. Wooden framework
3. Ventilation duct
4. Soft insulation 140mm
5. Wooden plate 12mm
6. Window frames
7. Brick strips cladding


0. Total prefabricated element
1. Insulation layer 20mm
2. Wooden framework
3. Ventilation duct
4. Soft insulation 140mm
5. Wooden plate 12mm
6. Window frames
7. Brick strips cladding


8. Add PV/PVT panels
7. Add roof cladding
6. Add insulation panels
3. Remove roof cladding
9. Place prefabricated facade elements
5. Drill holes for ventilation ducts
4. Remove window frames
2. Fill crawl space with insulation
1. Pour extra foundation beam


9. Add PV/PVT panels
8. Add roof cladding
7. Add insulation panels
3. Remove roof cladding
5. Drill holes for ventilation ducts
10. Place prefabricated facade elements
6. Place balcony
11. Install building services unit
4. Remove window frames and balcony
2. Fill crawl space with insulation
1. Pour extra foundation beam

FLOOR PLAN

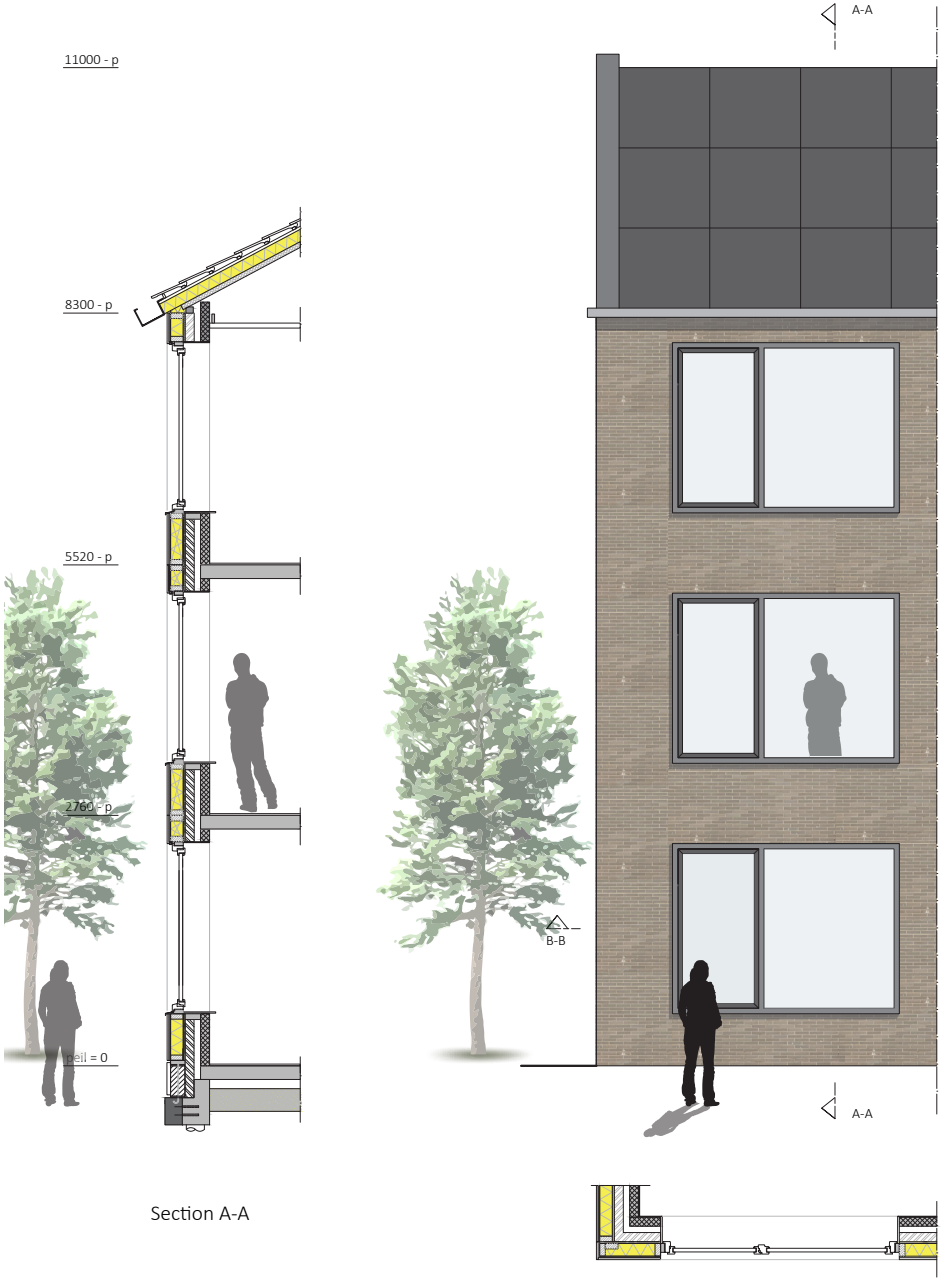


DIFFERENCES IN DETAIL

Section A-A

Section B-B

LOW IMPACT



Section A-A

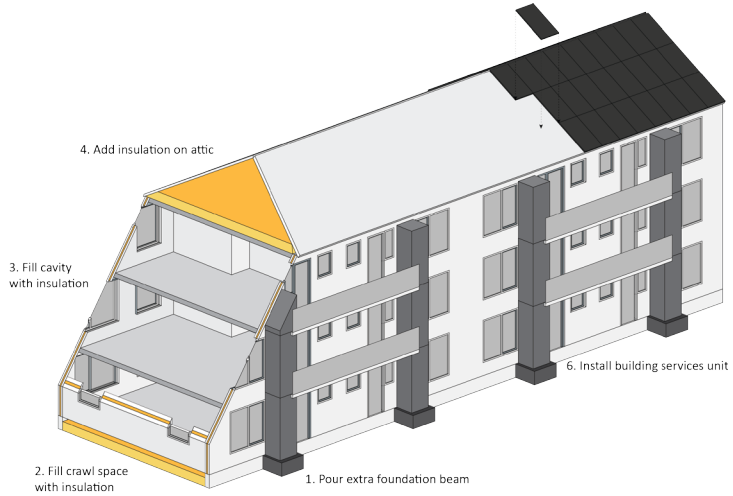
Section B-B

HIGH IMPACT

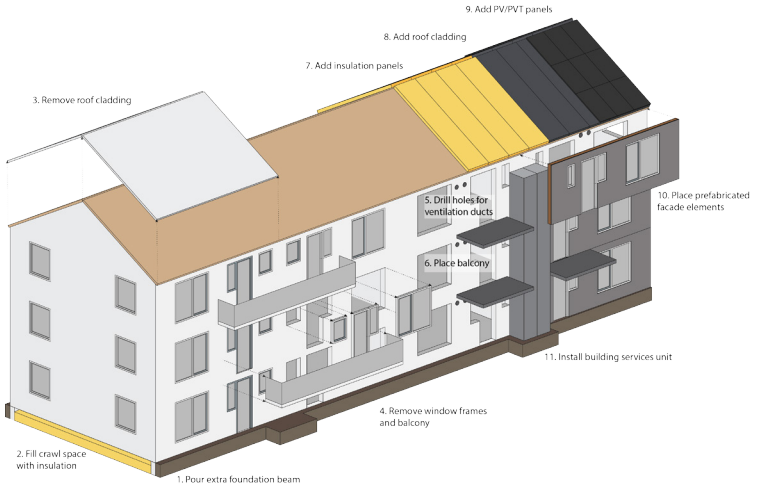
CONCLUSION

‘What prefabricated renovation approach for post-war walk-up apartments is applicable to accommodate energy saving measures, depending on different energy systems?’

TEMPLATE DESIGN

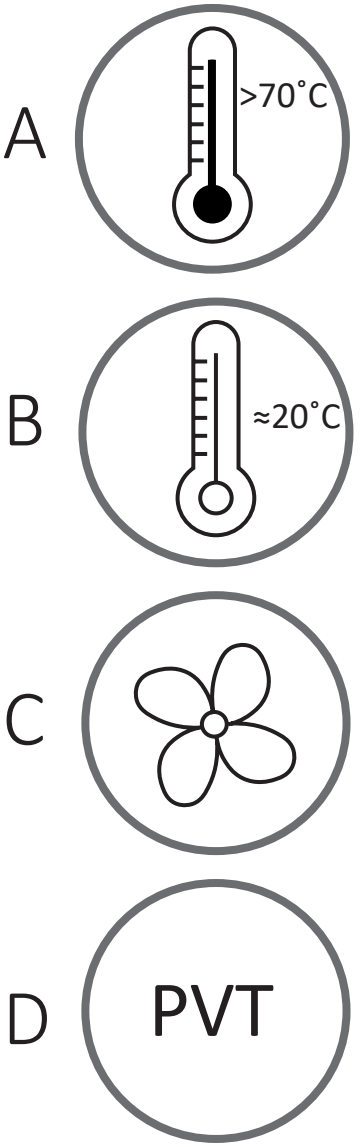


Low impact



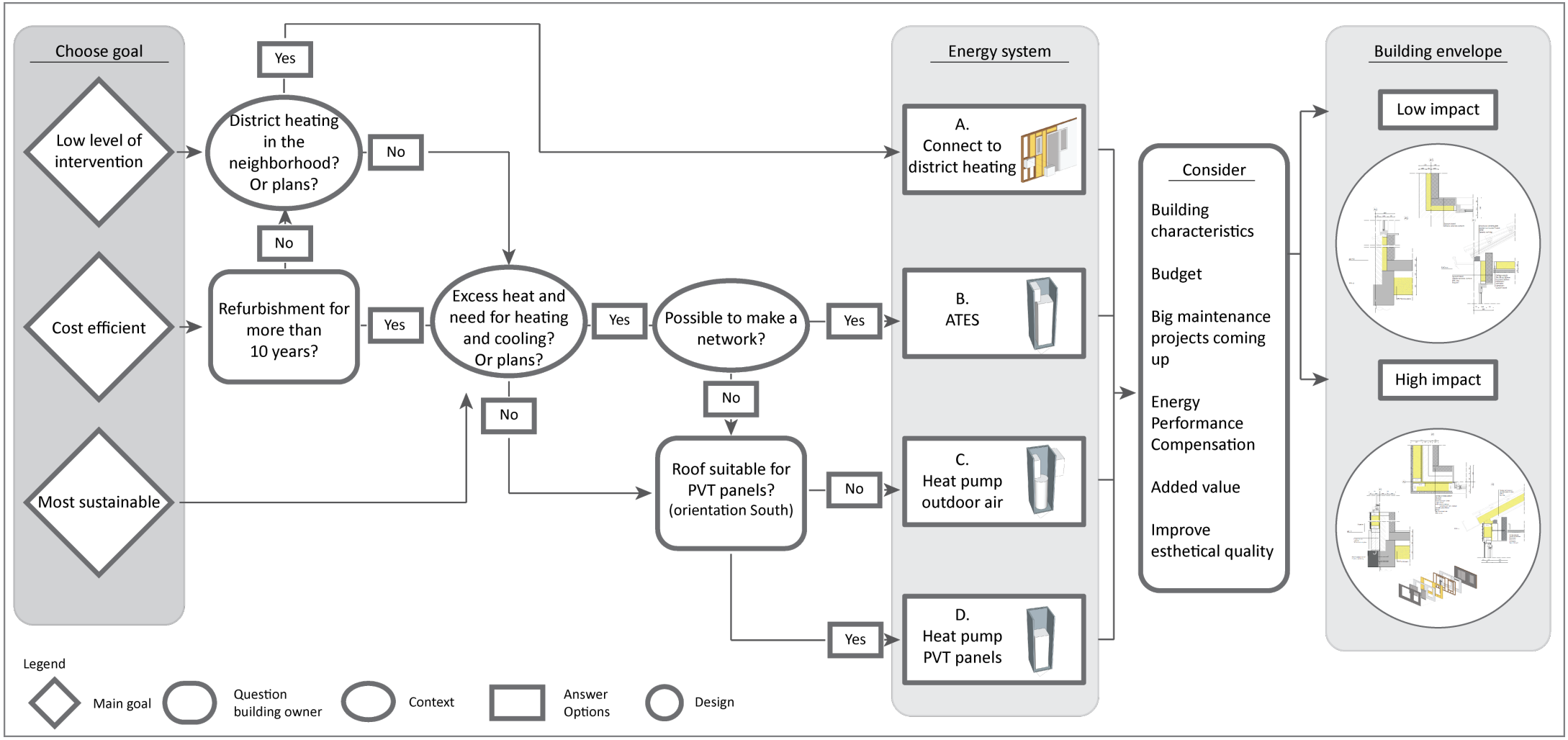
High impact

ENERGY SYSTEMS



DECISION-MAKING

HOUSING CORPORATION OR HOMEOWNER ASSOCIATION



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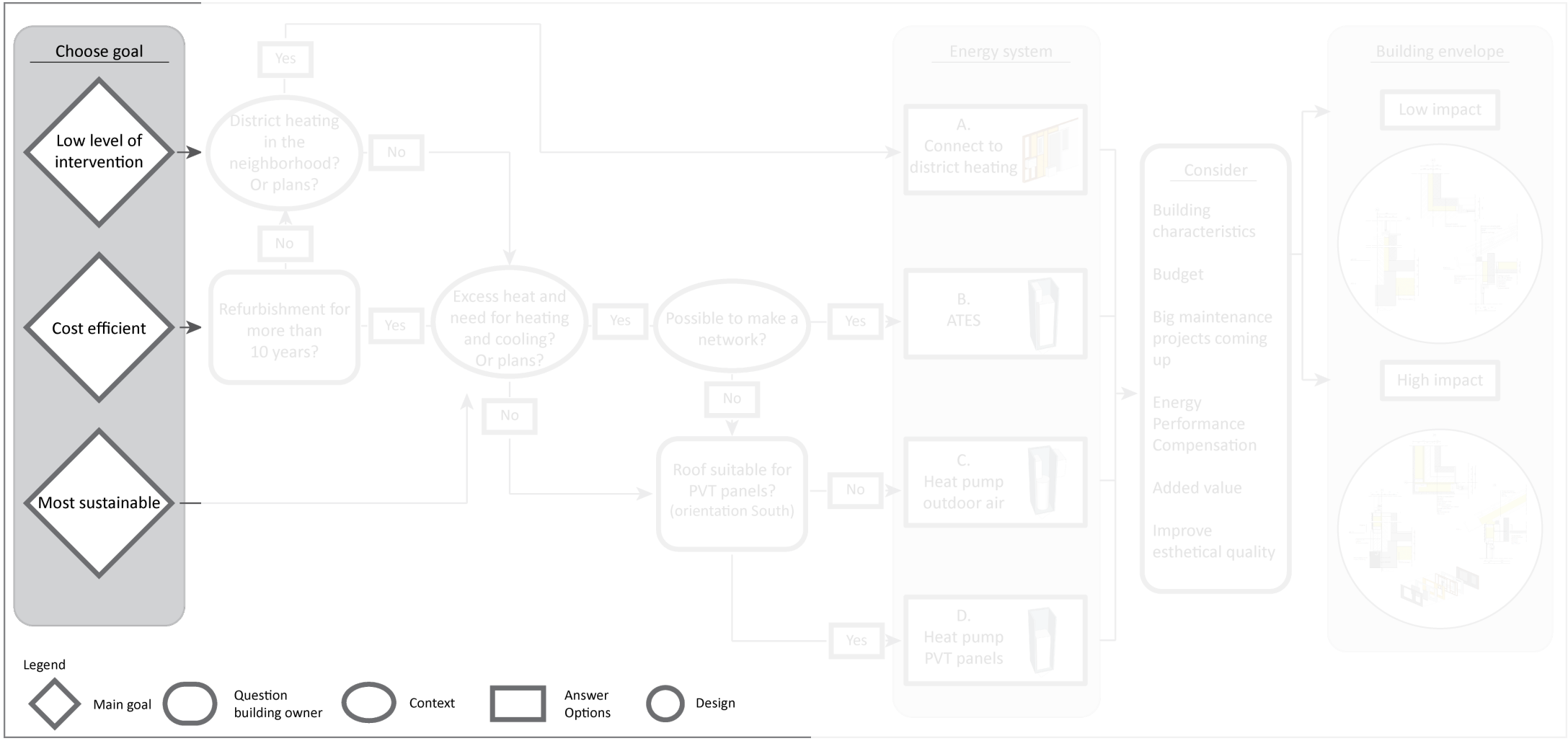

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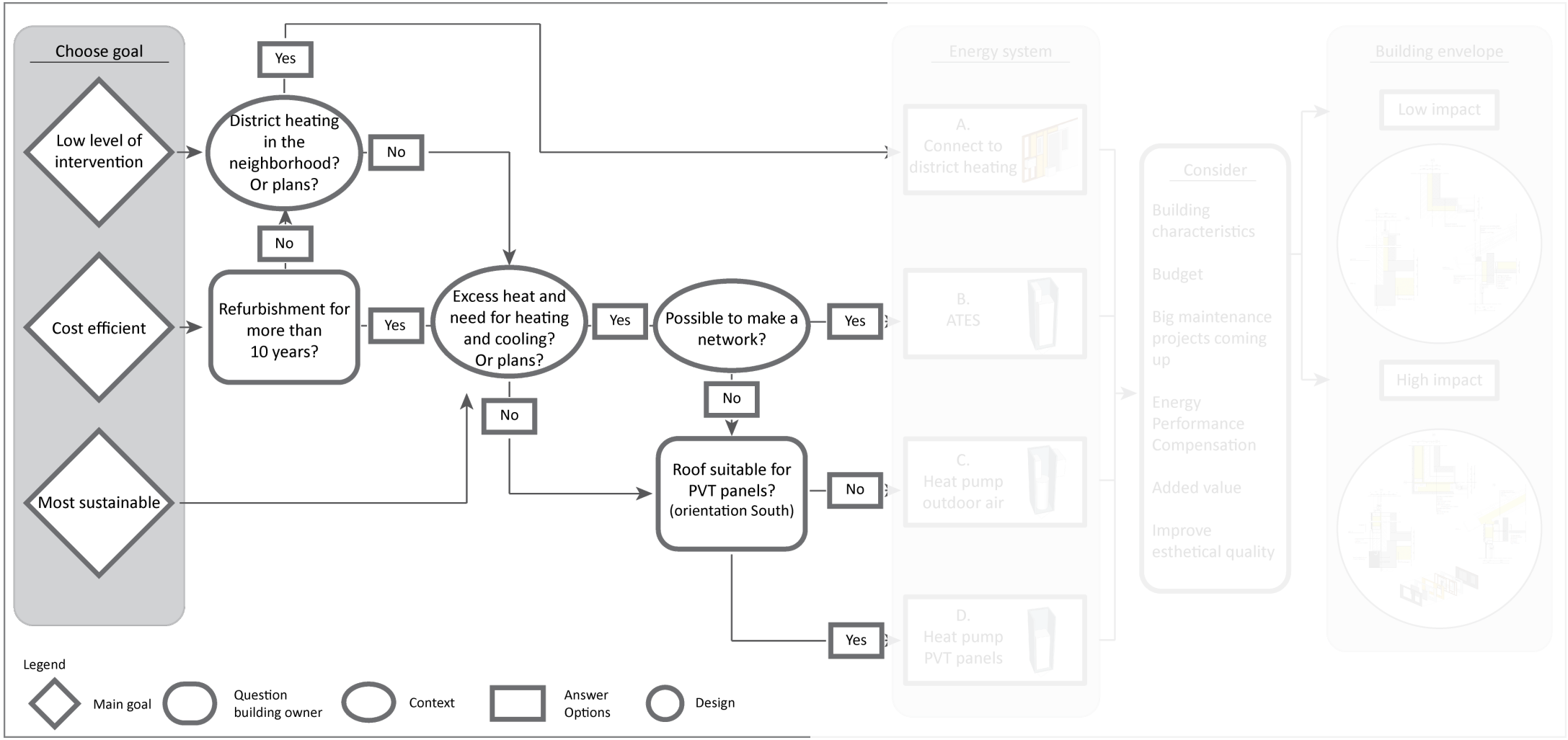

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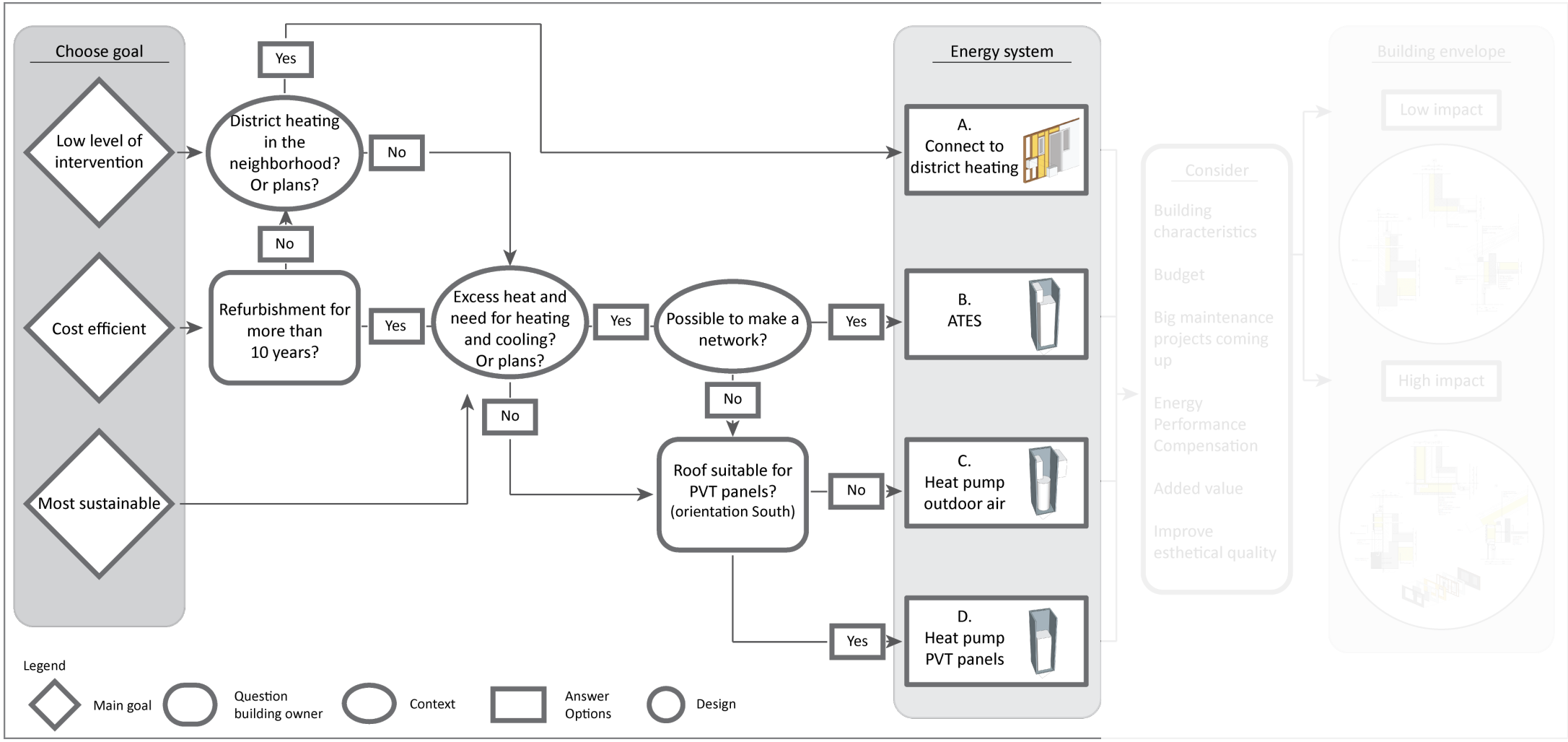

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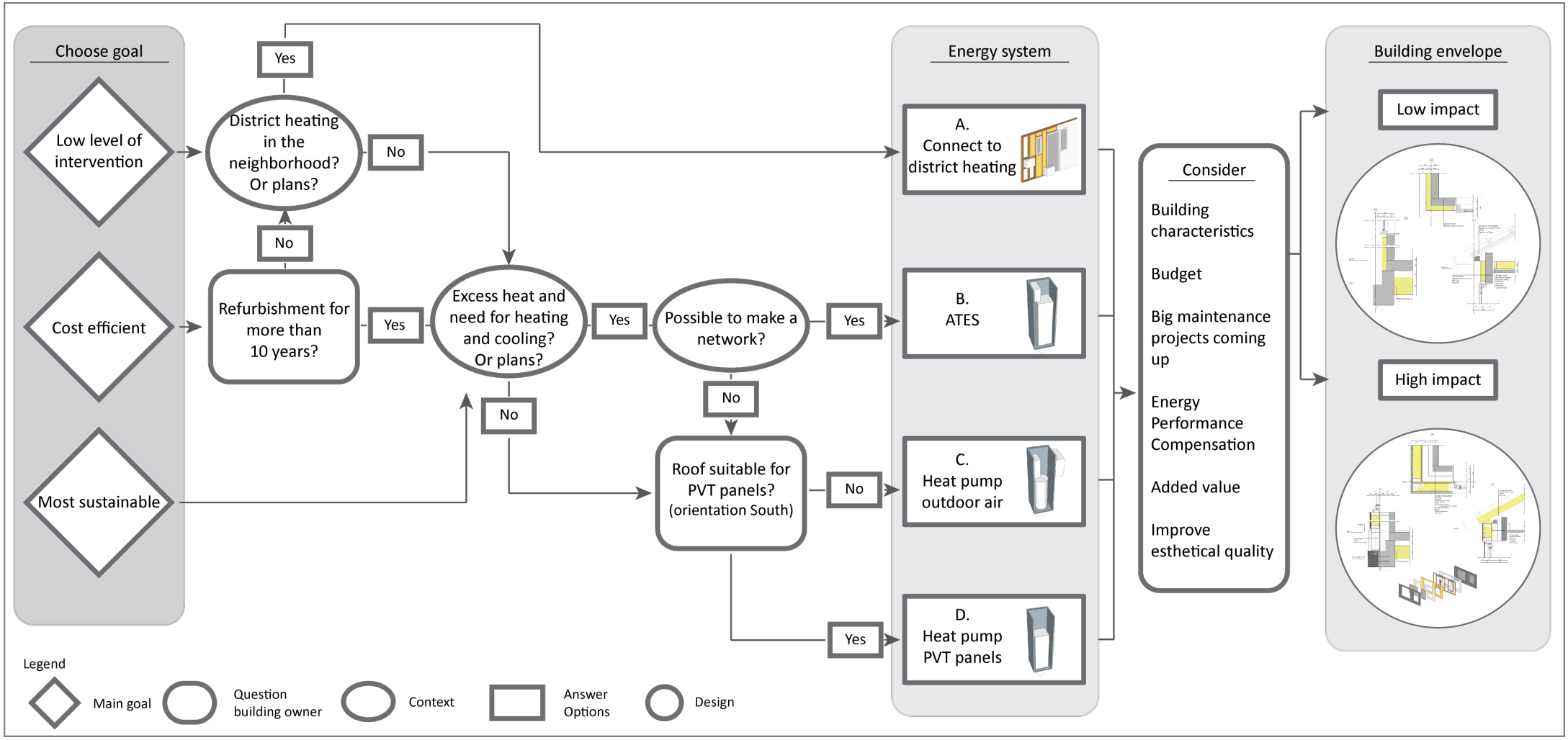
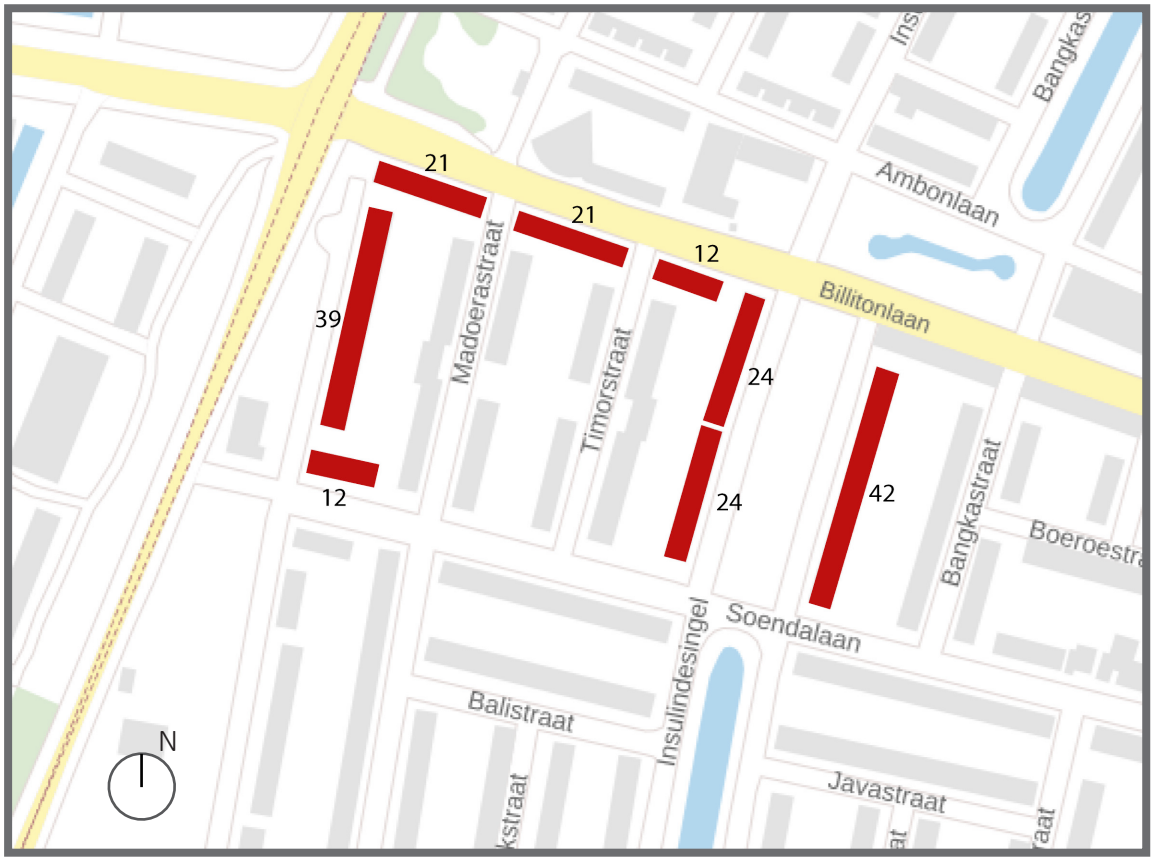


‘INDISCHE BUURT’ VLAARDINGEN

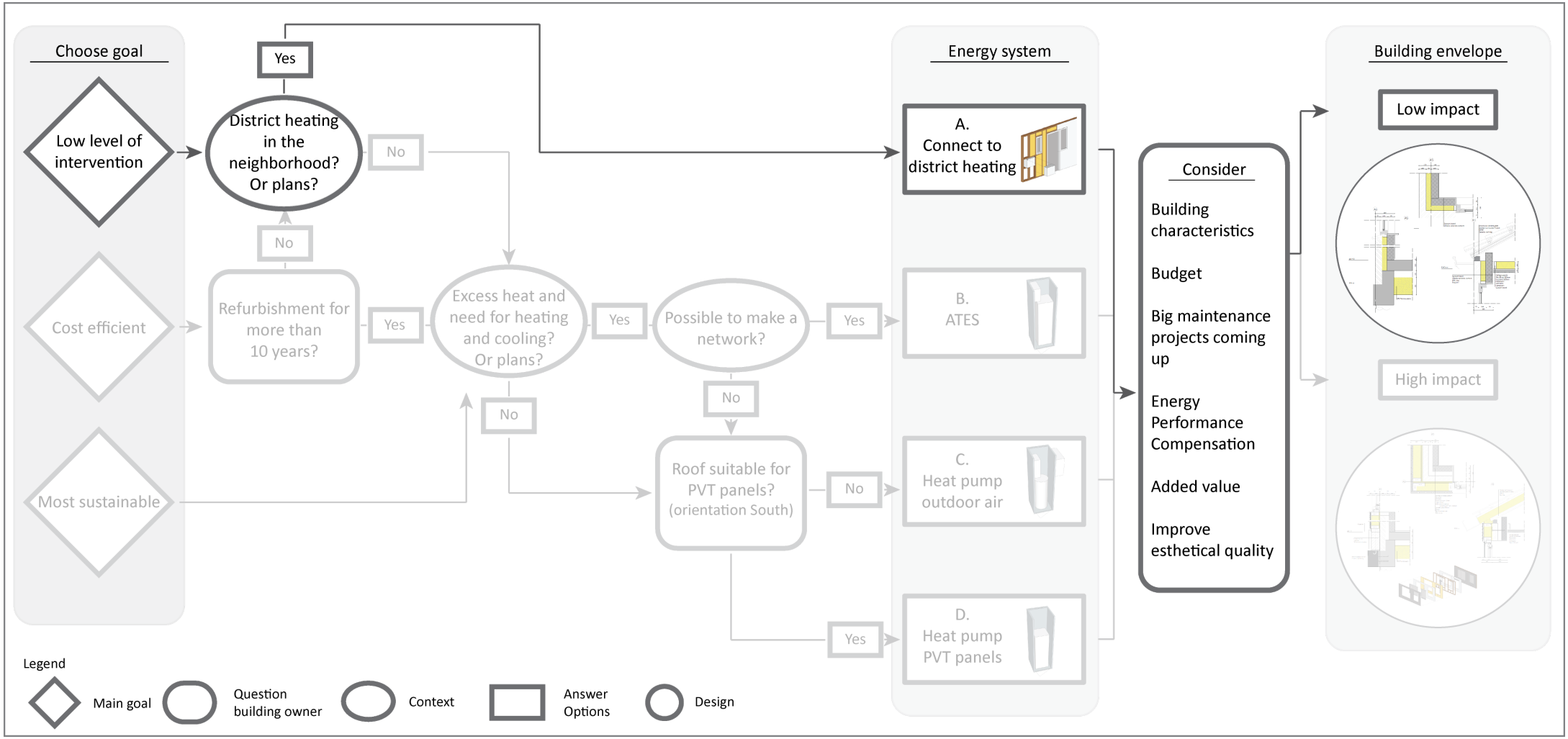
- 195 walk-up apartments

- 129 East-West orientation

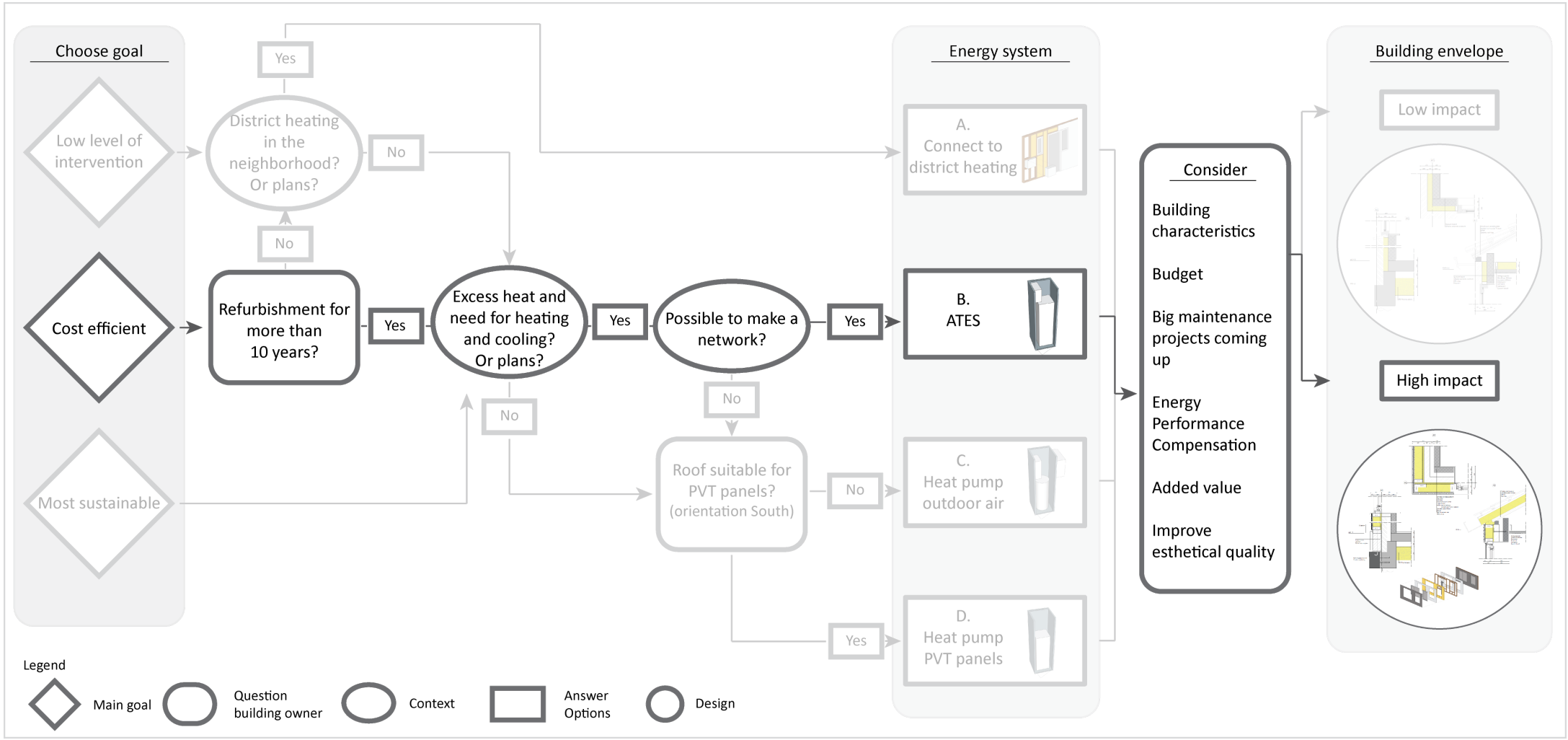
- 66 North-South orientation



SCENARIO 1


Choose goal
Low level of intervention
Cost efficient
Most sustainable
Yes
District heating in the neighborhood? Or plans?
No
No
Refurbishment for more than 10 years?
Yes
Excess heat and need for heating and cooling? Or plans?
Yes
No
Possible to make a network?
Yes
No
Roof suitable for PVT panels? (orientation South)
No
Yes
Energy system
A. Connect to district heating
B. ATES
C. Heat pump outdoor air
D. Heat pump PVT panels
Consider
Building characteristics
Budget
Big maintenance projects coming up
Energy Performance Compensation
Added value
Improve esthetical quality
Building envelope
Low impact
High impact
Legend
Main goal
Question building owner
Context
Answer Options
Design

SCENARIO 2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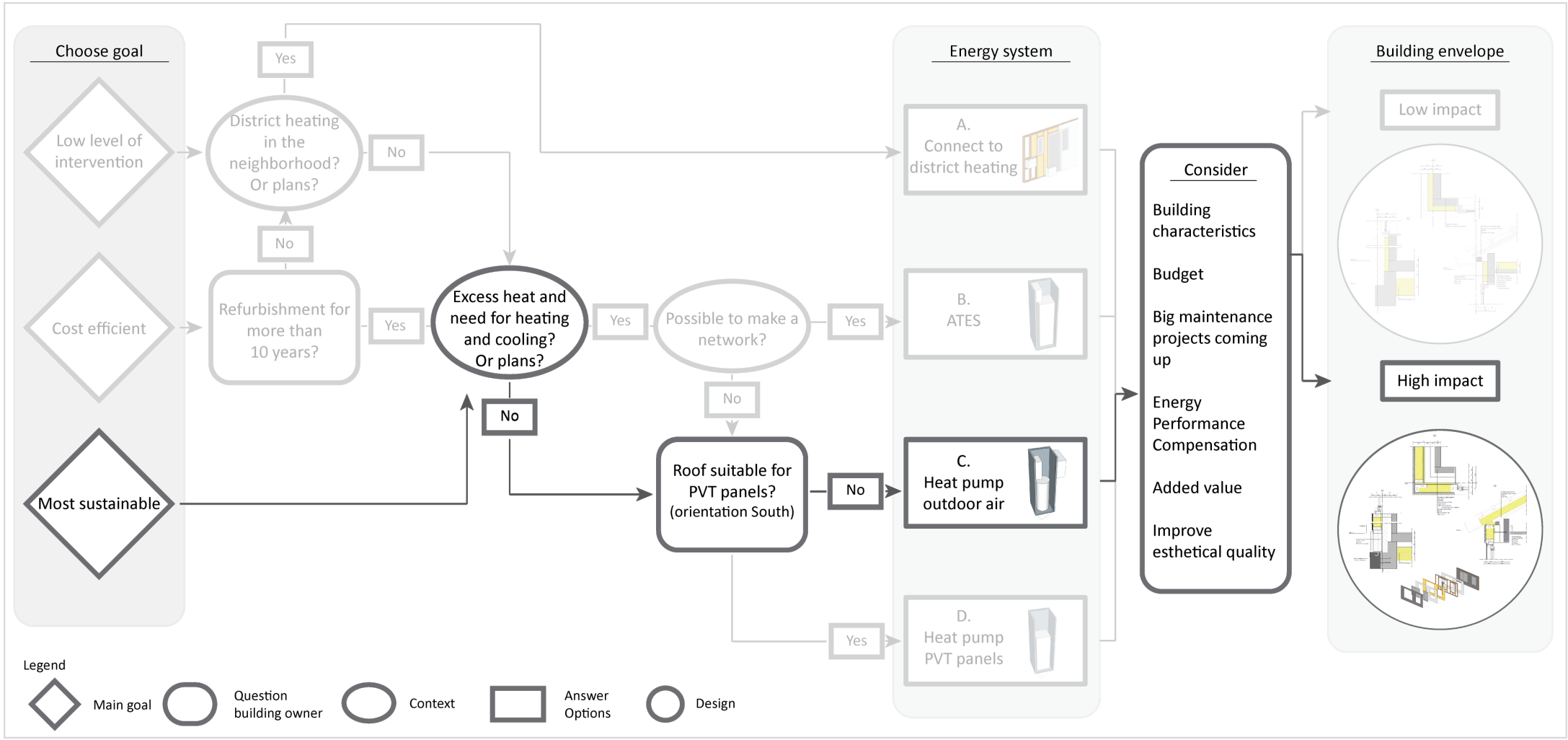
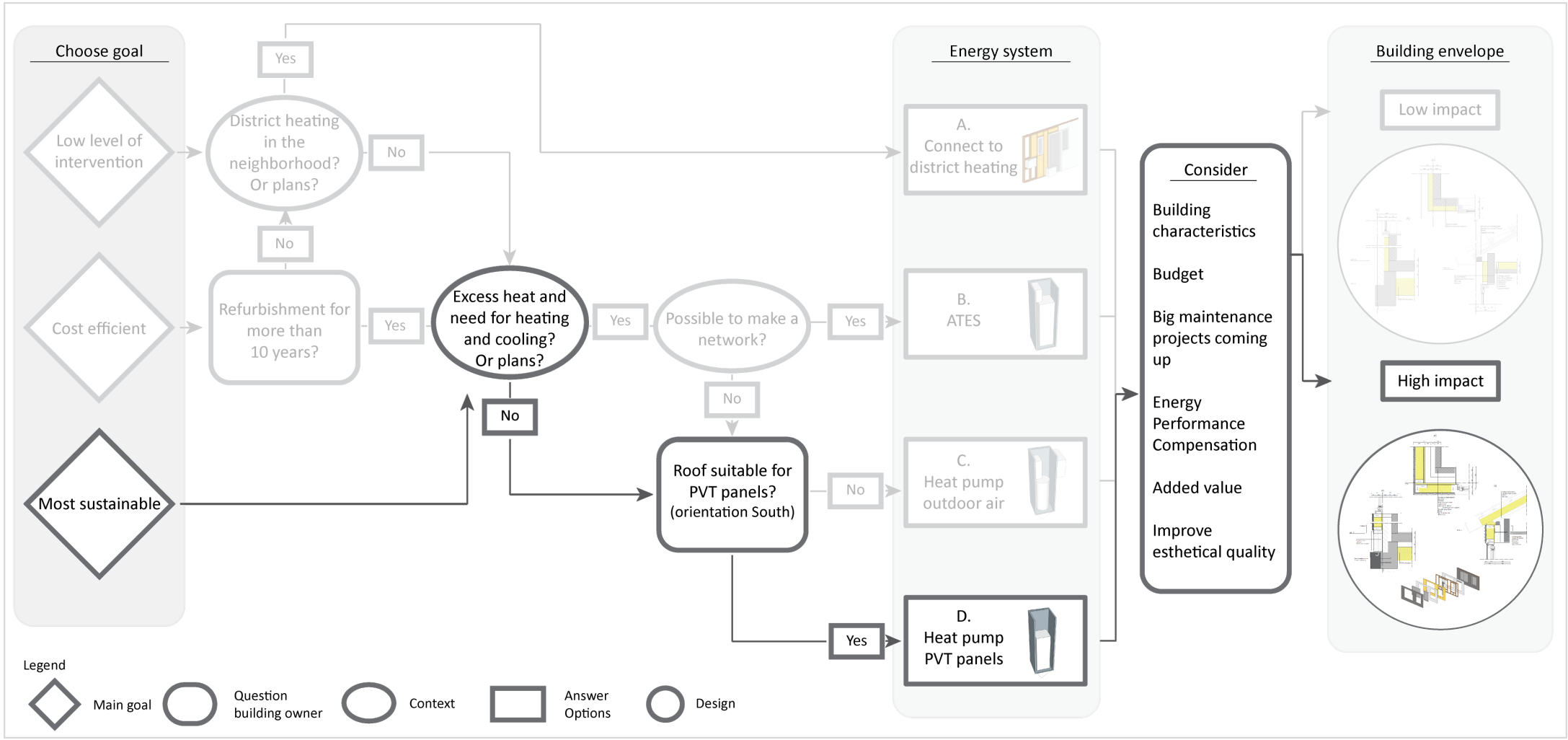
SCENARIO 3: EAST-WEST ORIENTATION

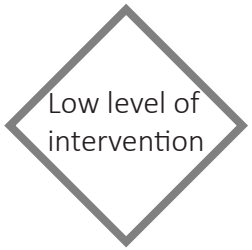


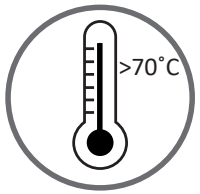
SCENARIO 3: NORTH-SOUTH ORIENTATION



COMPARISON WITH EXISTING SITUATION

SCENARIO 1





2,9
TIMES
Less Energy

SCENARIO 2

5,0
TIMES
Less Energy

SCENARIO 3

4,4
TIMES
Less Energy

COMPARISON WITH EXISTING SITUATION

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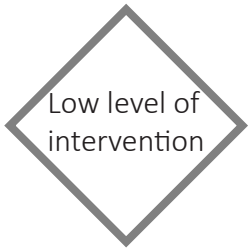

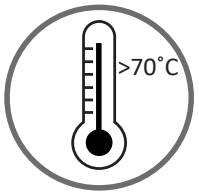

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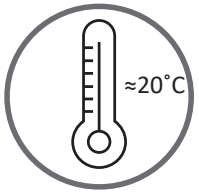

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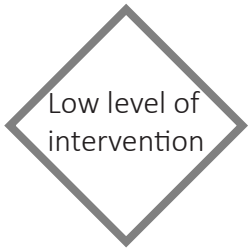

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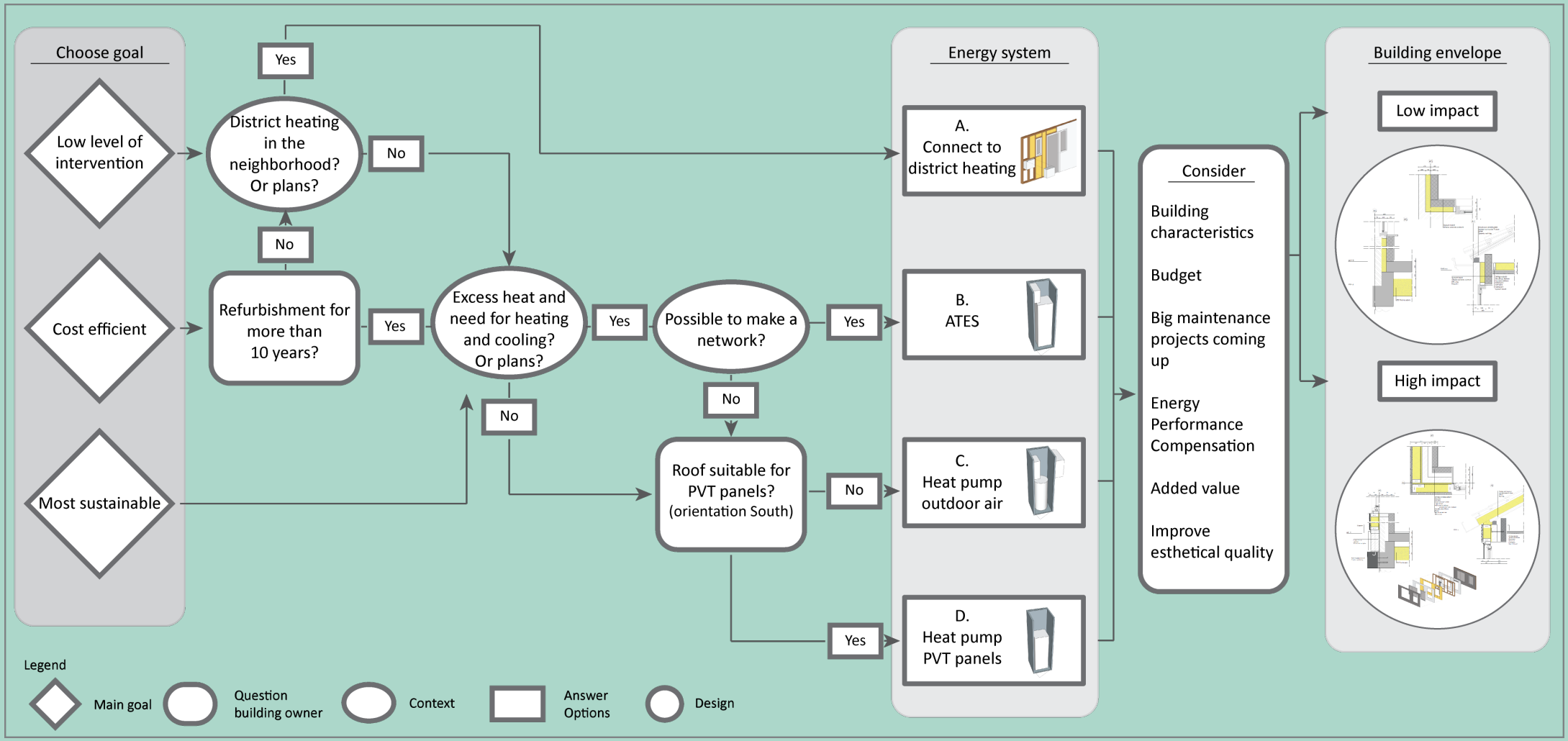
RECOMMENDATIONS

COST ASSESSMENT OF DIFFERENT ENERGY CONCEPTS

UPSCALING TO DIFFERENT BUILDING TYPES

CIRCULARITY OF THE APPROACH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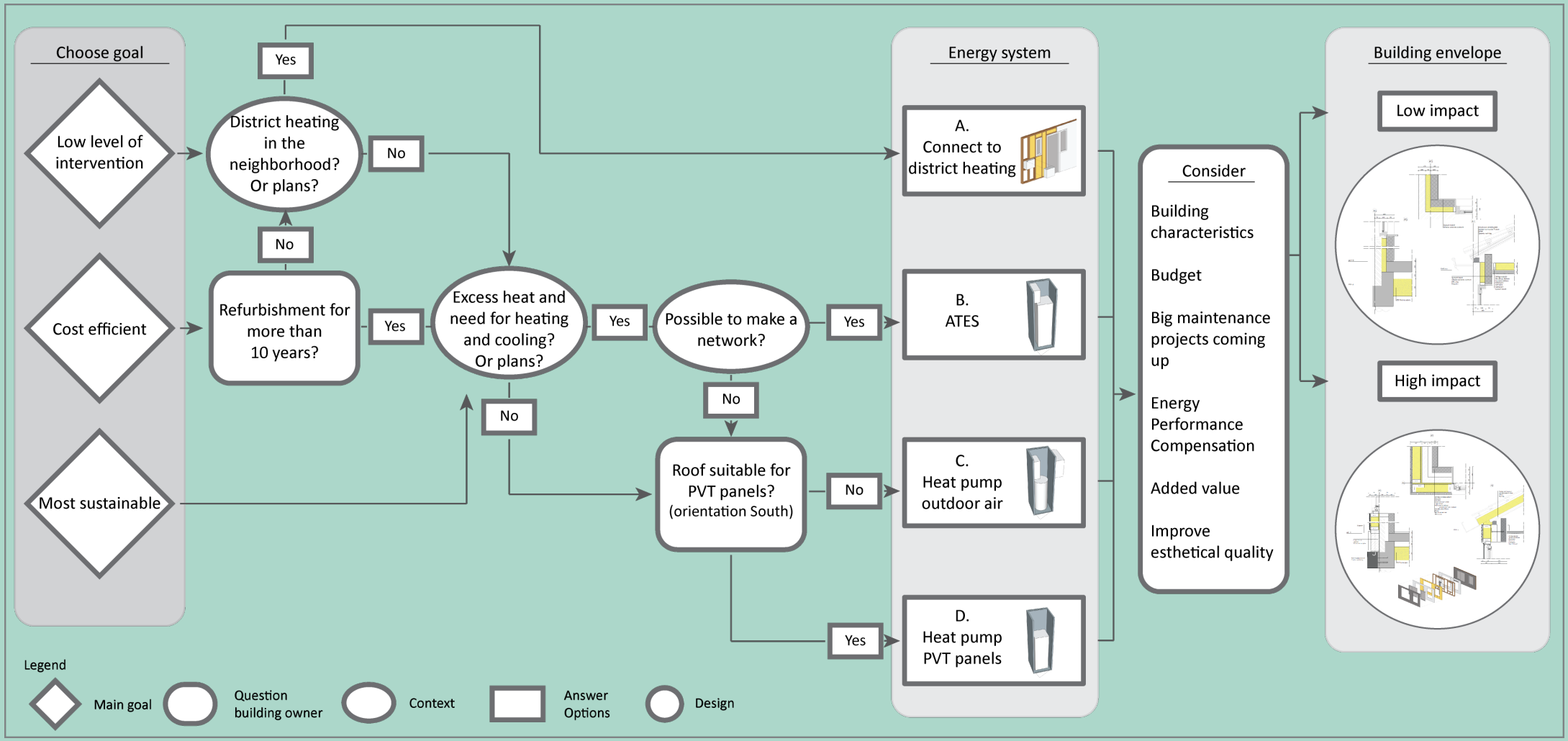
THANK YOU!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