SYNERGY BETWEEN DENSITY AND ENERGY FOR BUILDING RETROFITS IN

AMSTERDAM NIEUW-WEST

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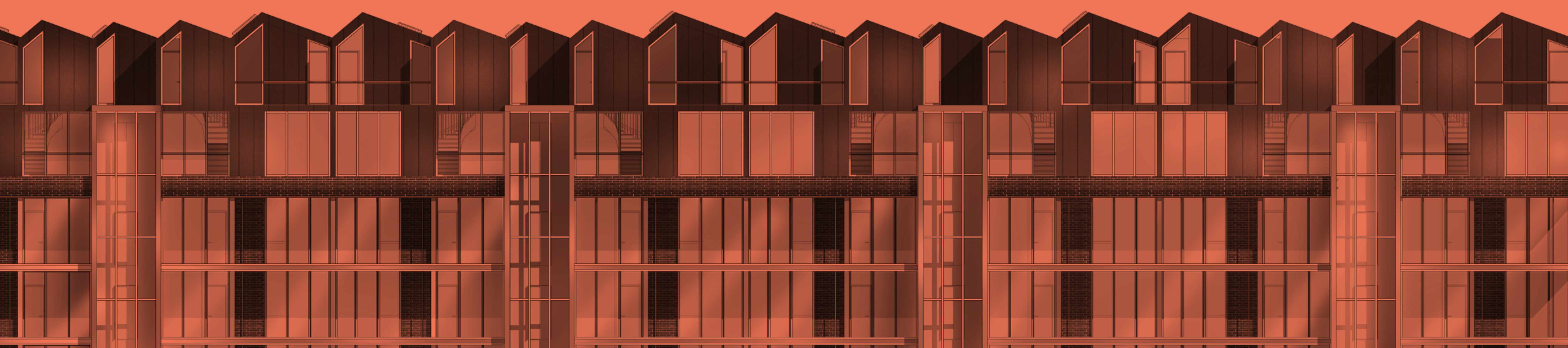
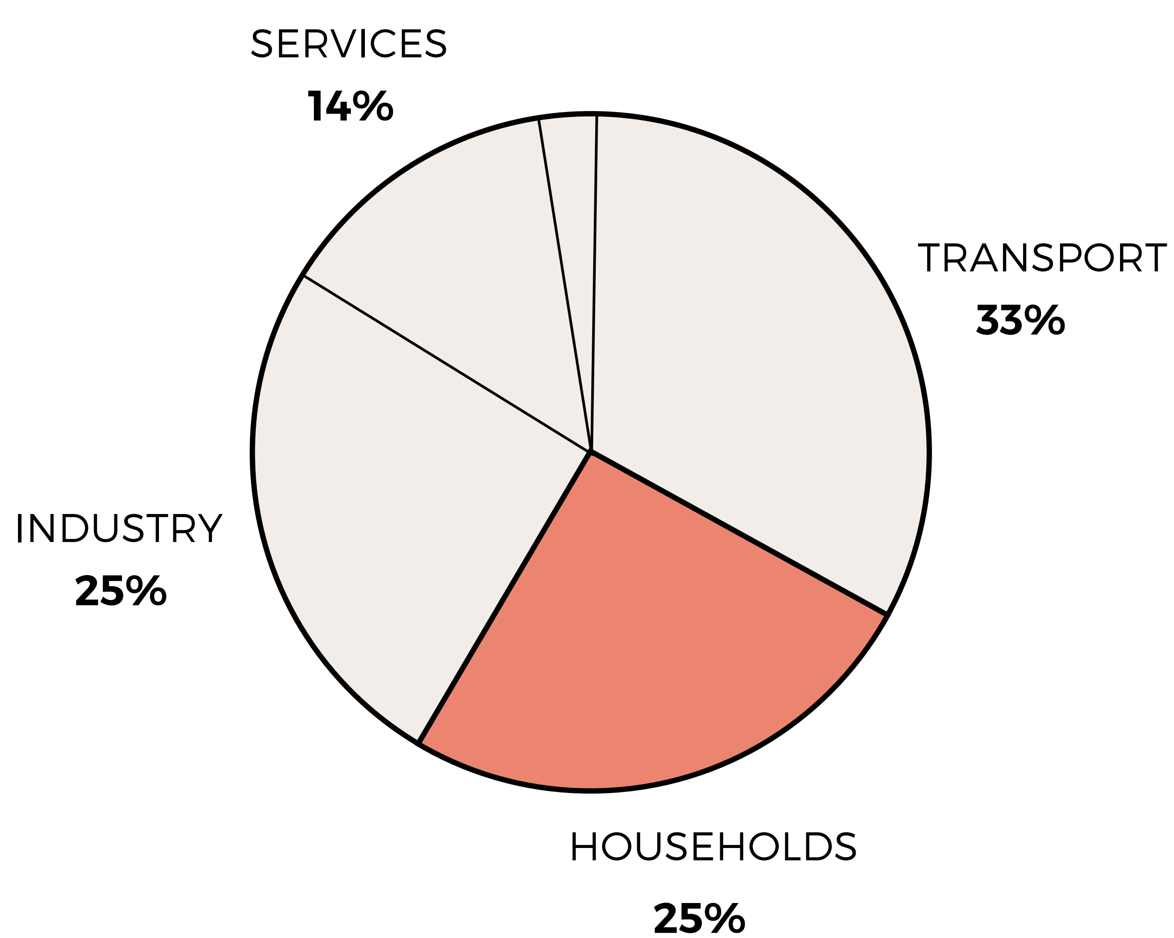
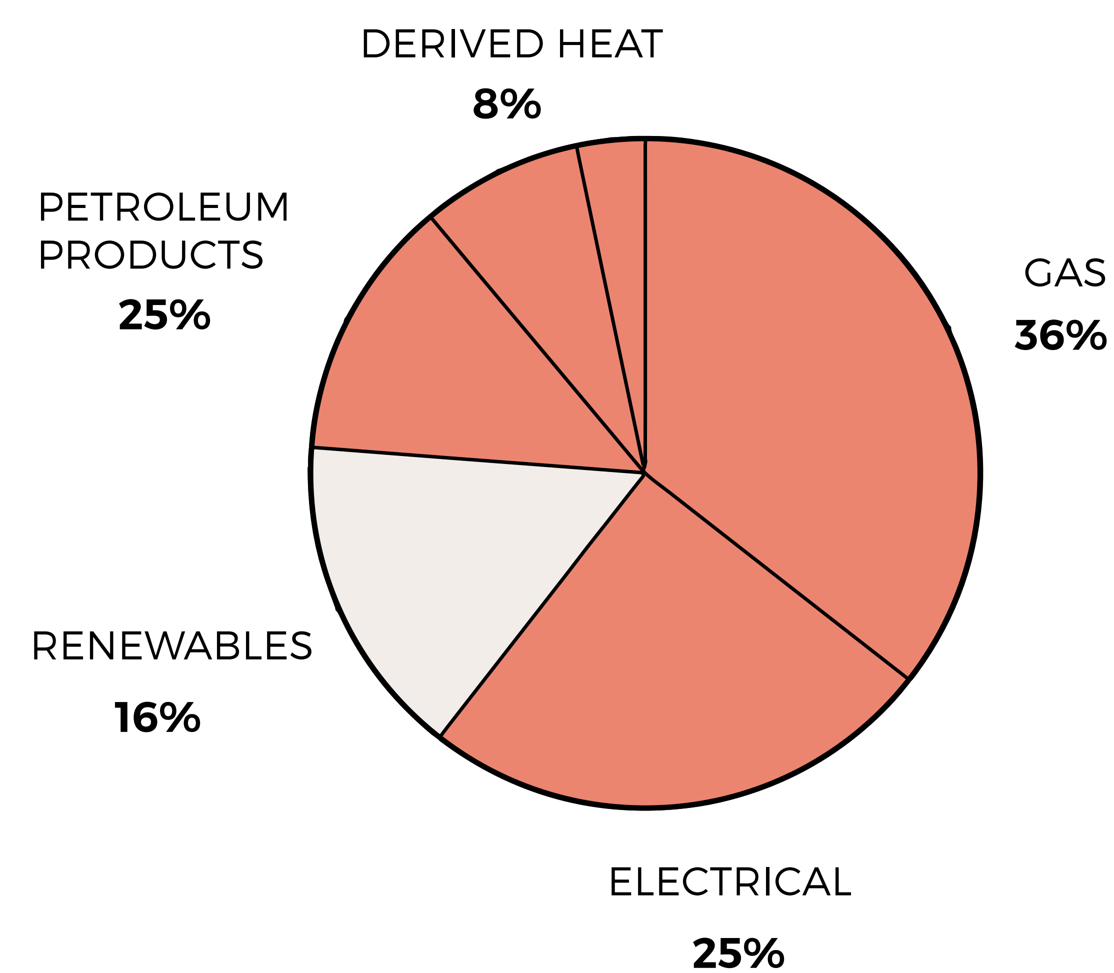


THE NEED TO ENERGY RETROFIT

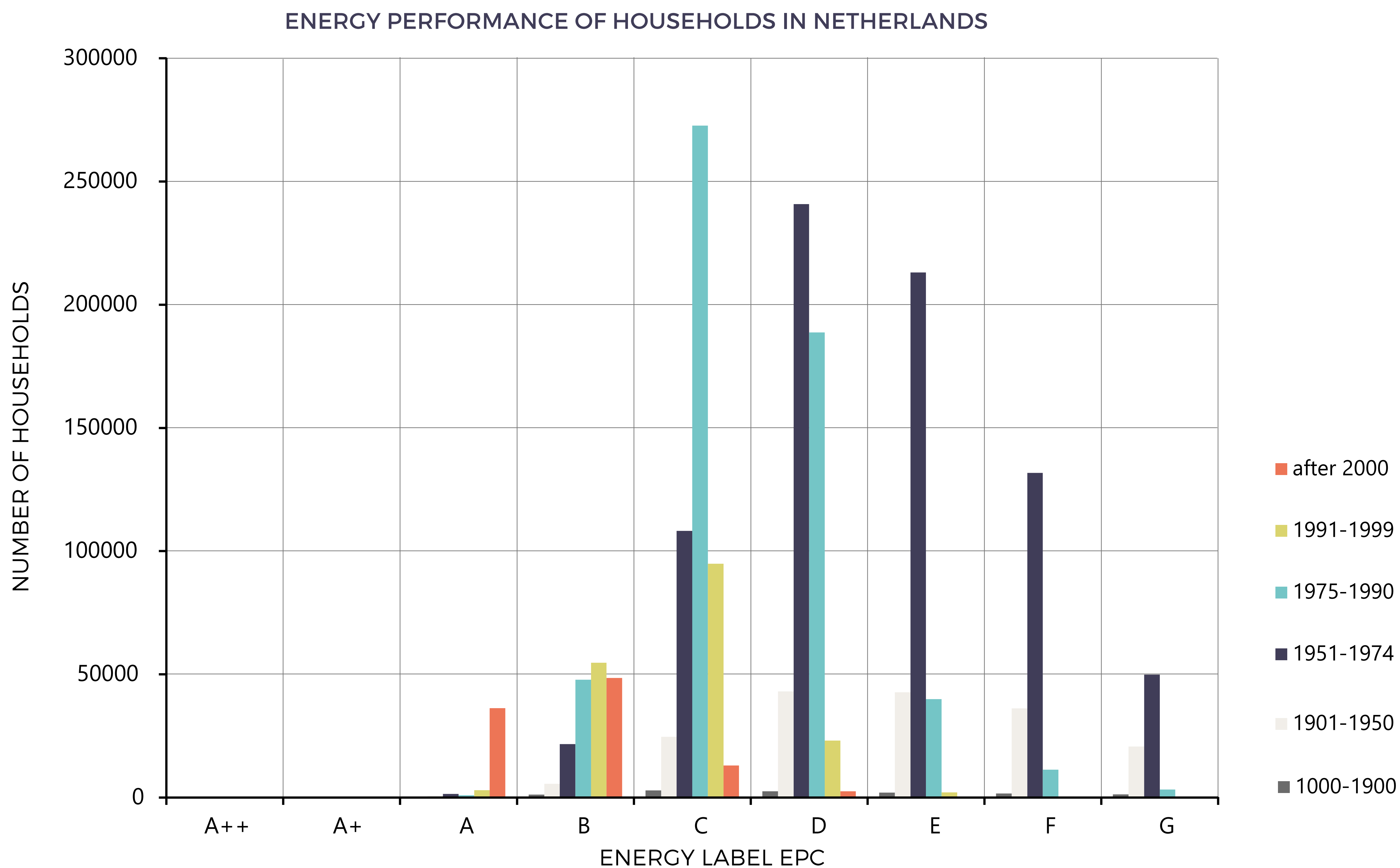
FINAL ENERGY CONSUMPTION EU-28 2015



FINAL ENERGY SOURCES FOR HOUSEHOLDS EU 2015



THE NEED TO ENERGY RETROFIT

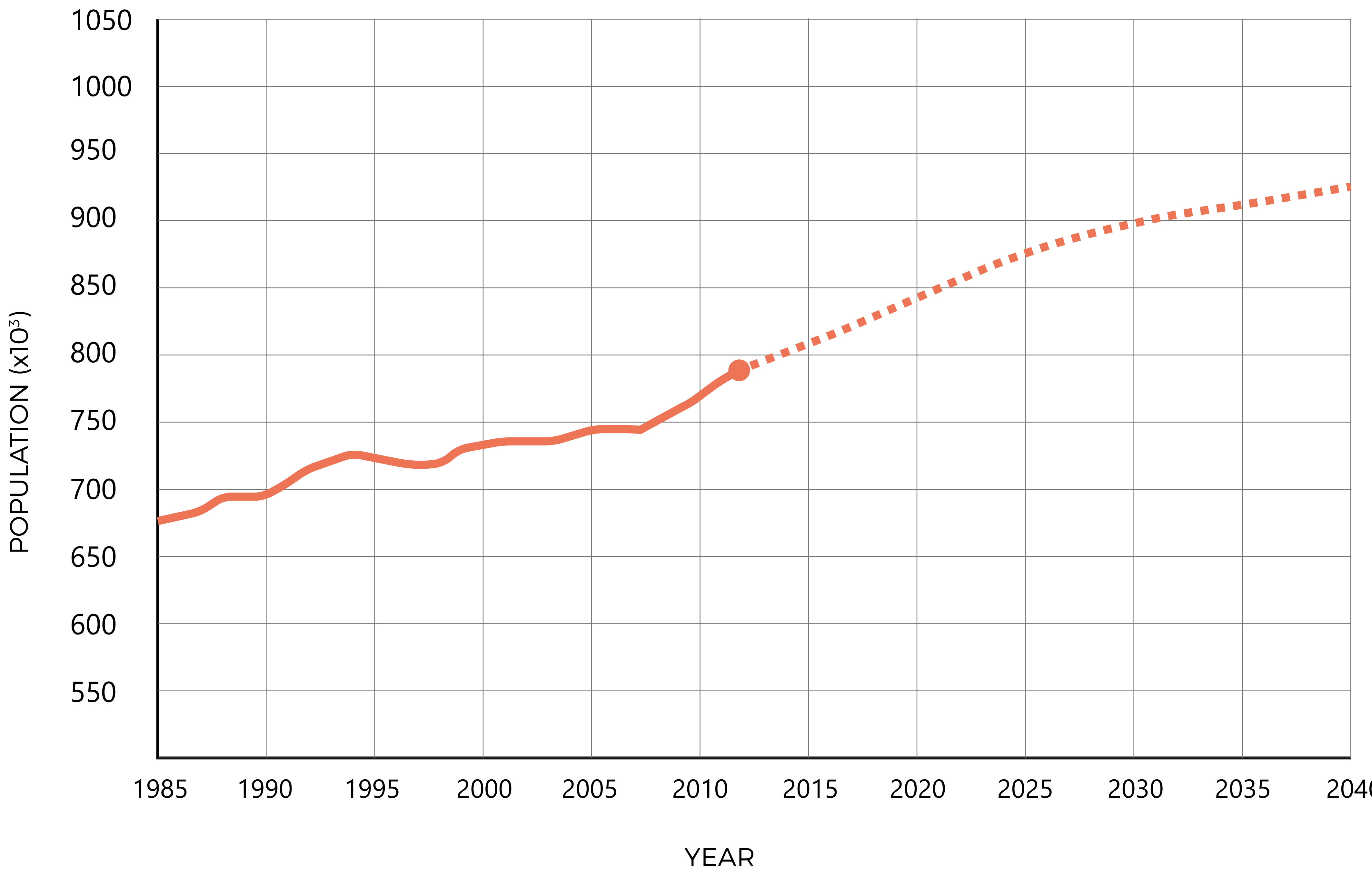


THE NEED TO ENERGY RETROFIT

AMSTERDAM

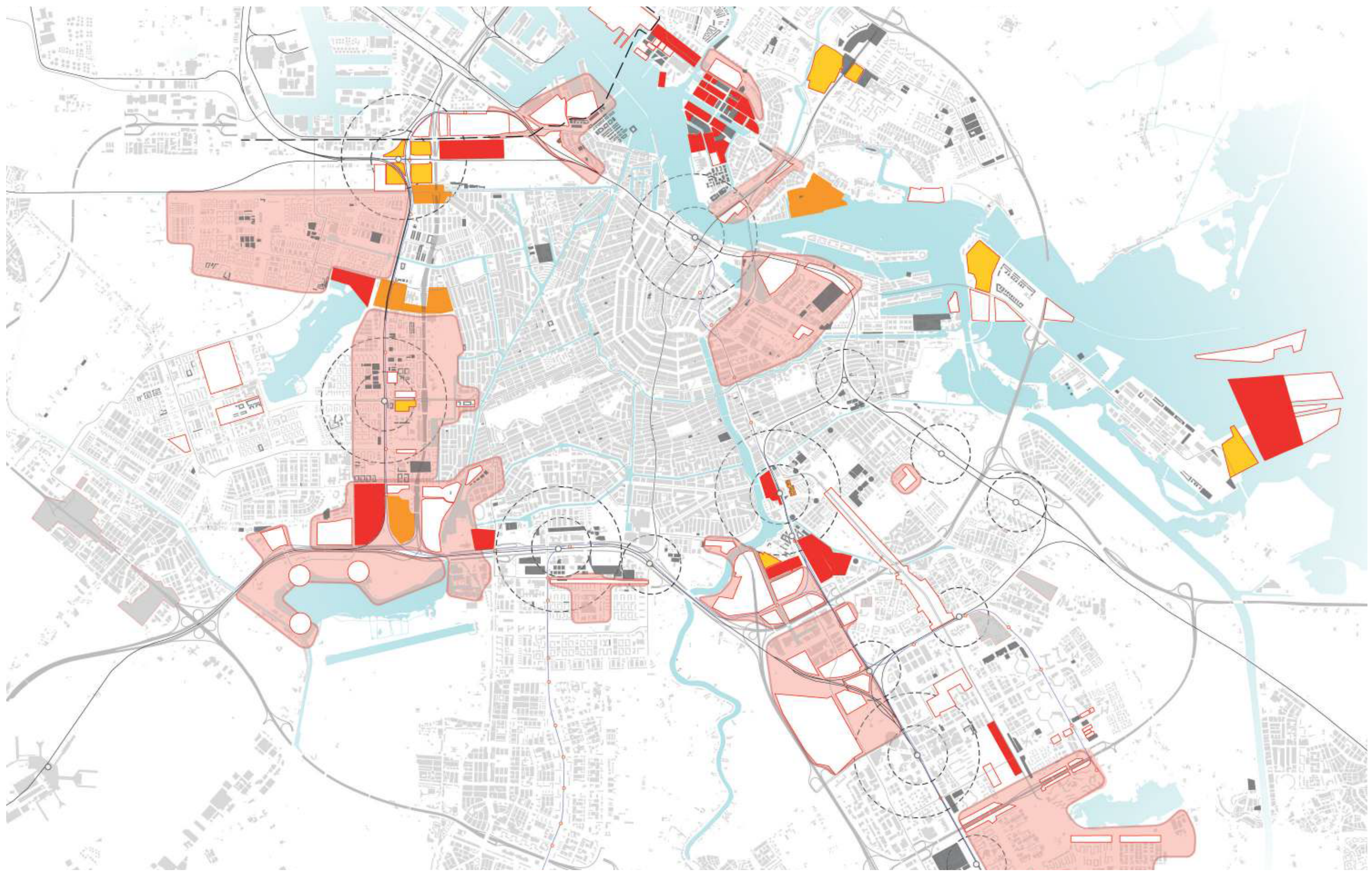
THE NEED TO DENSIFY

POPULATION GROWTH OF AMSTERDAM



THE NEED TO DENSIFY

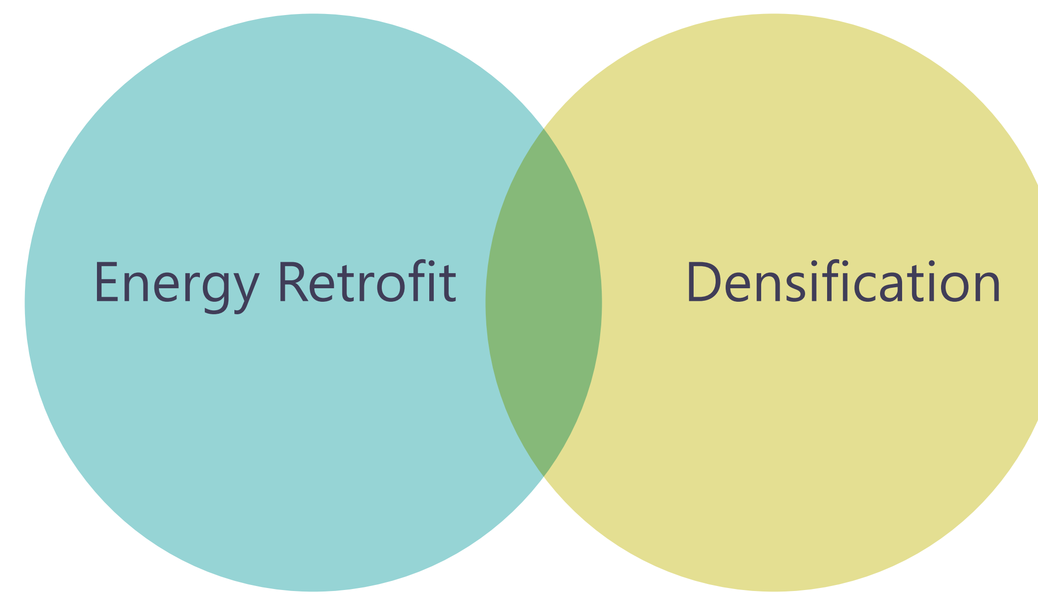
STRATEGIC AREAS FOR DEVELOPMENTS



- Running Projects
- Projects outside city of Amsterdam
- Gear location 2014 Tranche 2 (Strategic decision)
- Gear location 2014 Tranche 1 (Investment decision)
- Proposed new projects 2016
- Strategic areas for 2017-18
- Strategic areas for 2020
- Transportation nodes (OV)

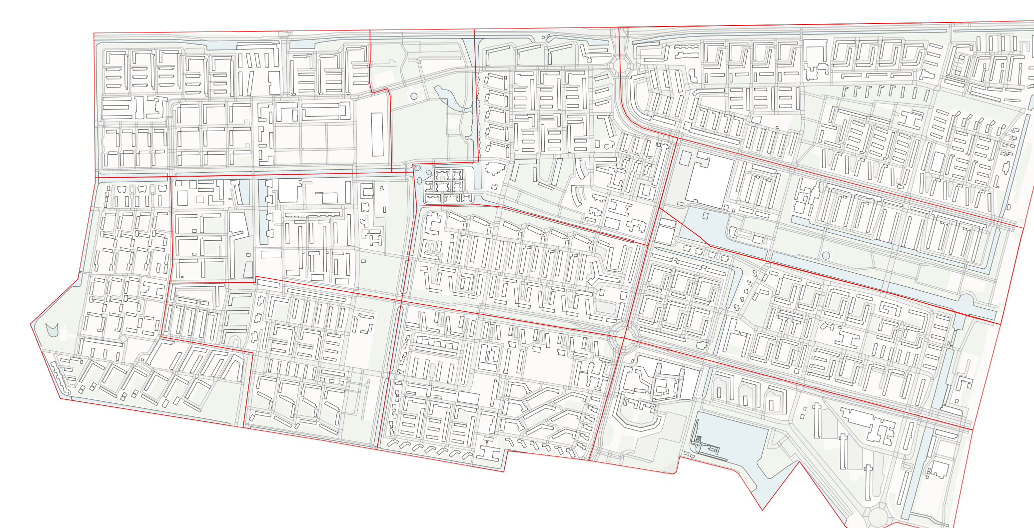
OPPORTUNITY?

- Current slow rate of retrofitting
- Ambitious targets for $C0^2$ Reductions and densification
- Can energy retrofitting and densification be aligned to provide integrated solutions?



OBJECTIVE

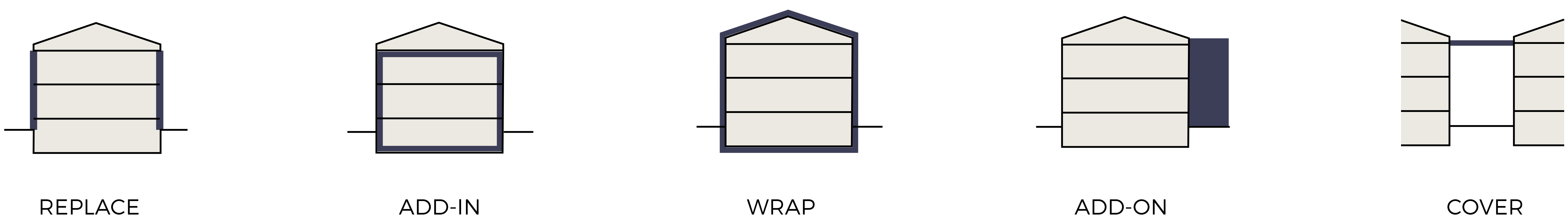
'to organize and quantify the need to energy retrofit and densify within the residential building stock of Amsterdam Nieuw-West, in order to develop a design of a retrofit measure for a suitable residential typology that provides integrated solutions to both these urban requirements.'



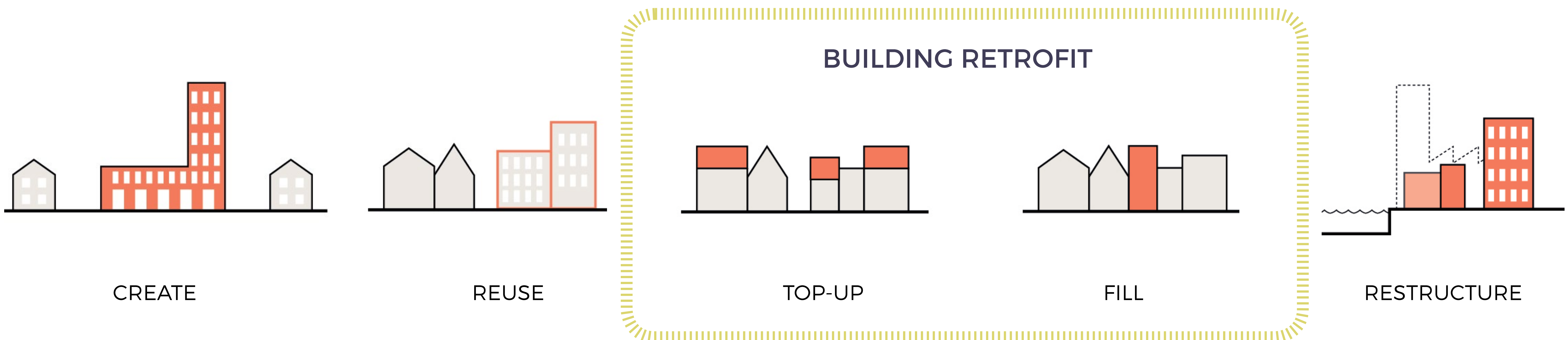
RESEARCH QUESTION

How can the design of a retrofit measure provide integrated solutions to energy reduction and densification for a suitable residential building typology in Amsterdam Nieuw-West?

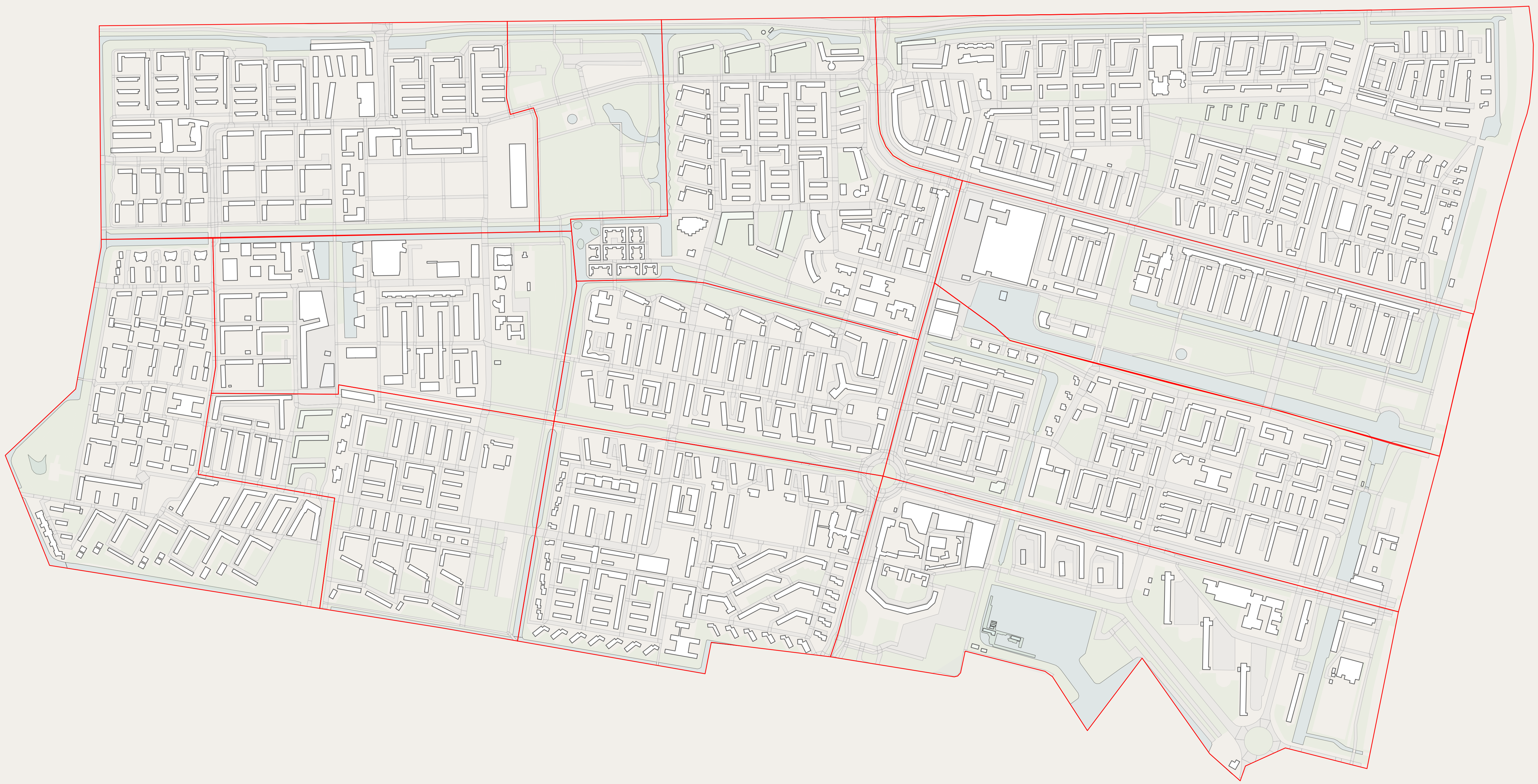
ENERGY RETROFIT STRATEGIES



DENSIFICATION STRATEGIES



CONTEXT ANALYSIS & SUITABLE BUILDING TYPOLOGY

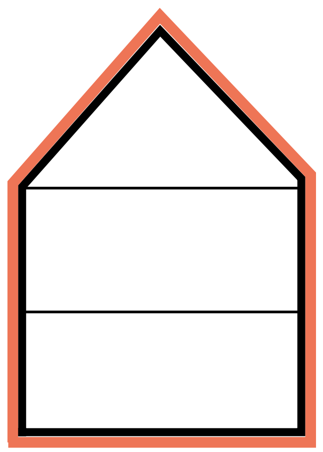


SUITABLE BUILDING TYPOLOGY

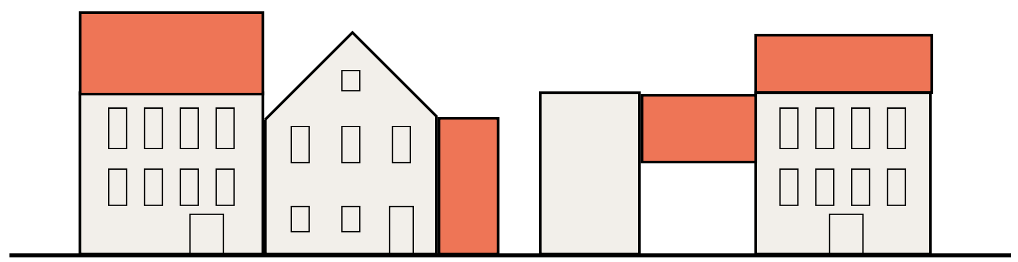
THE SUITIBLE TYPOLOGY DEFINED AS THE TYPOLOGY WITH THE GREATEST POTENTIAL TO INFLUENCE THE AREA GIVEN THE UNDERLYING THESIS OBJECTIVE

Approach Requirements:

1. Classication of building typology
    - 1.a. Dwelling Type
    - 1.b. Year of construction
    - 1.c. Stakeholder
2. Energy Retrofit
    - 2.a. Energy Demand (kWh/m^2)
    - 2.b. Tabula Database
3. Densification
    - 3.a. Roof types
    - 3.b. Footprint area
    - 3.c. Classification of open block typology

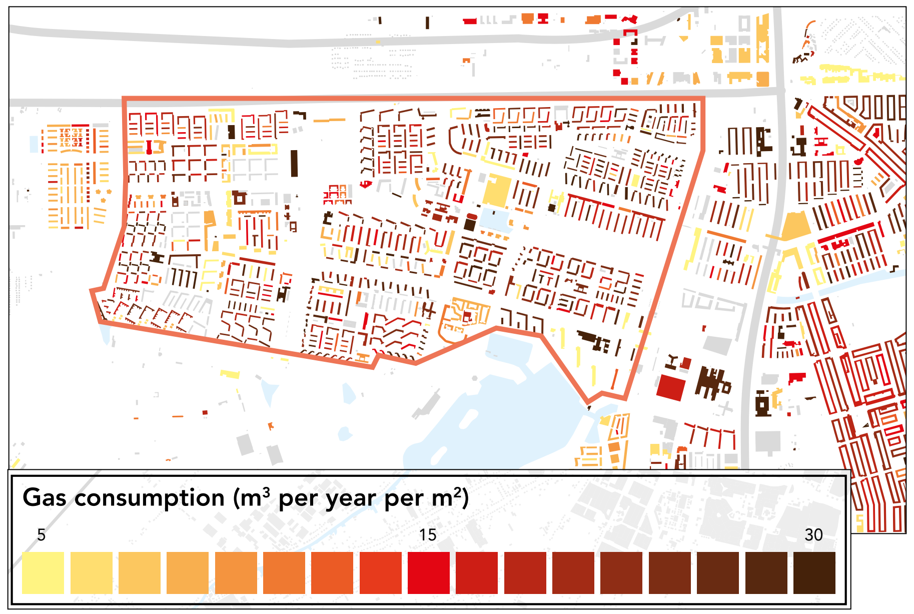


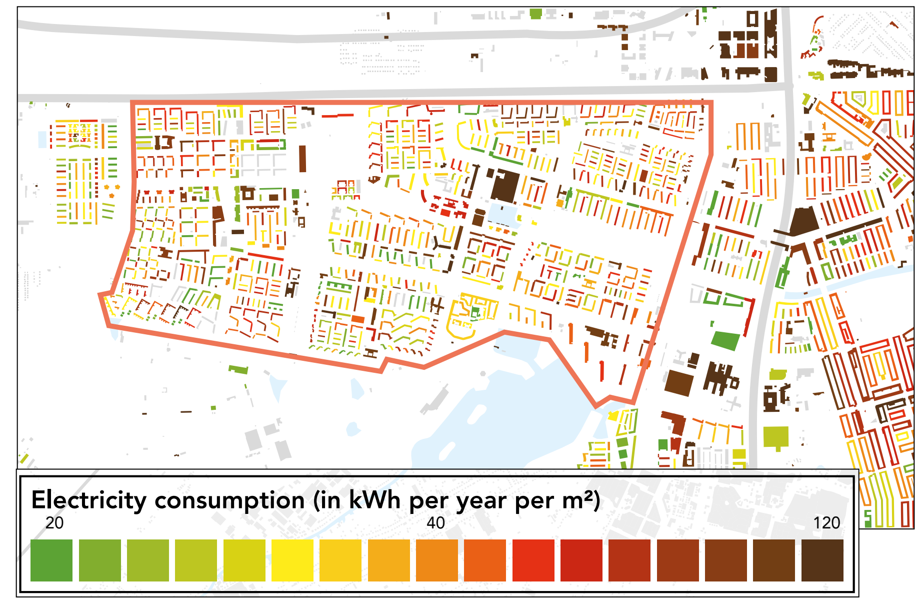
Energy Retrofit

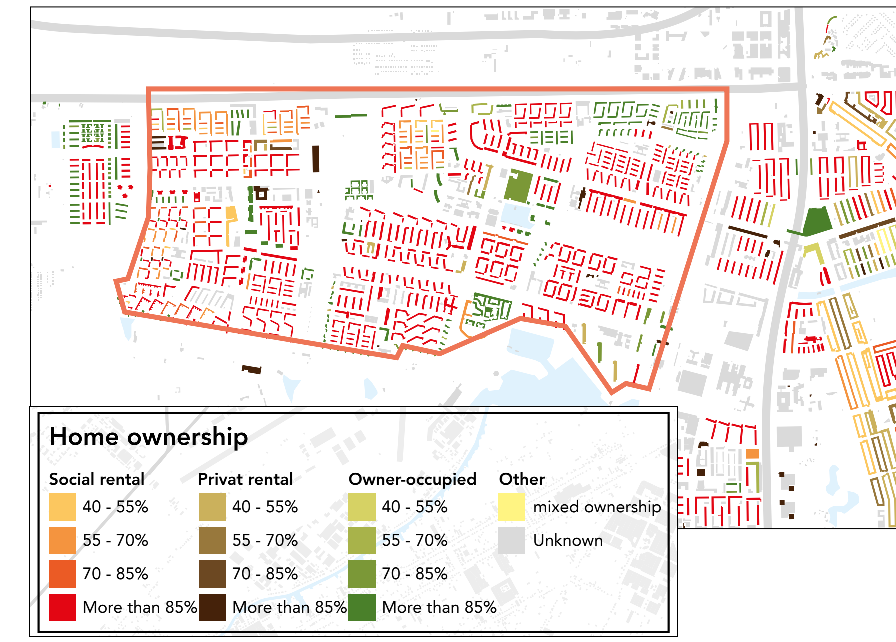


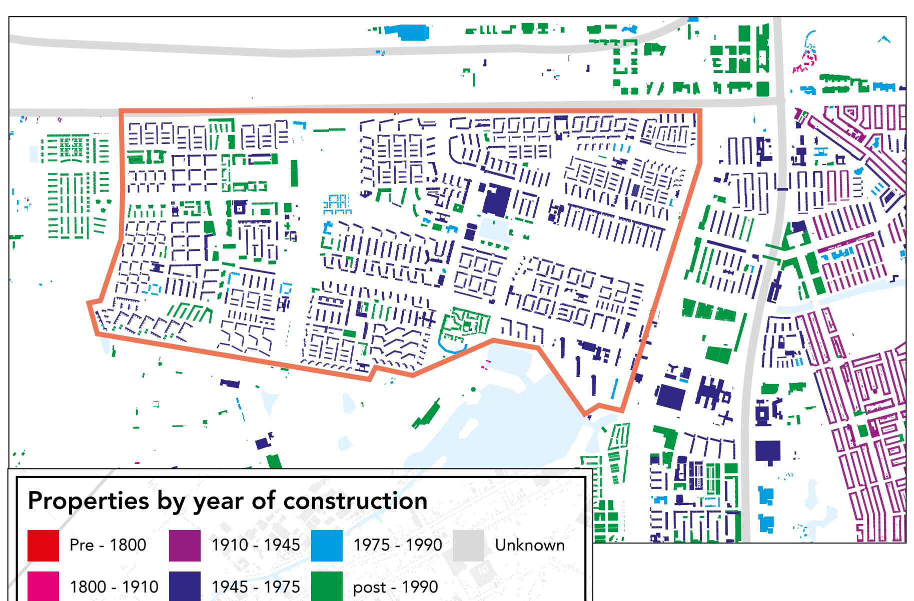
Densify

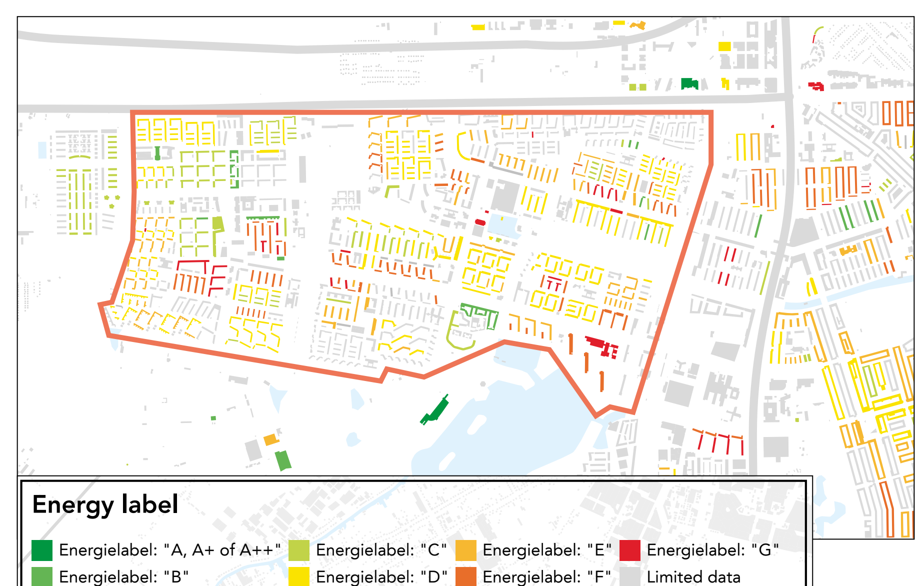
AMSTERDAM MAPS

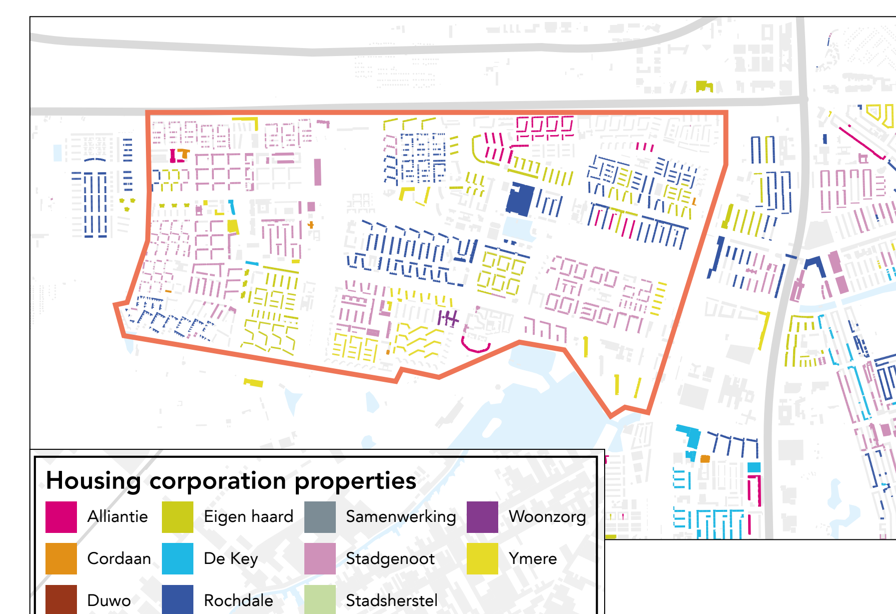




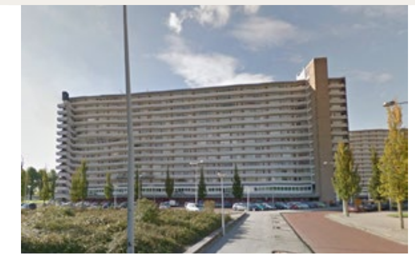
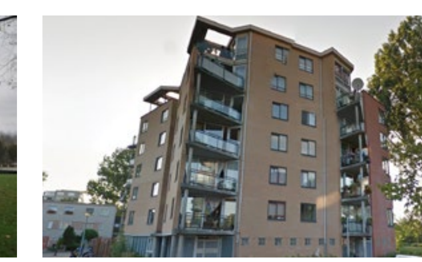




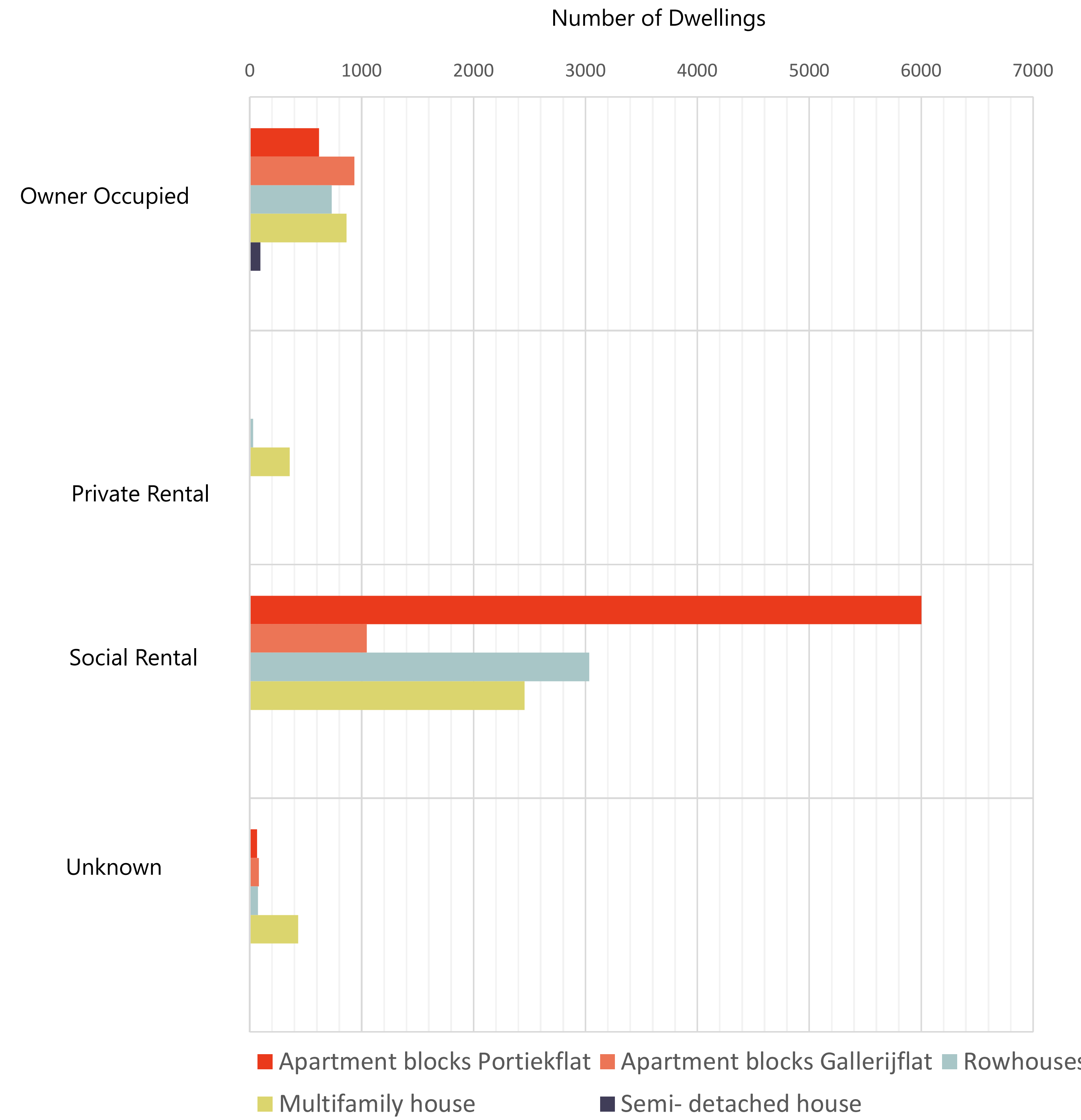




BUILDING TYPOLOGIES

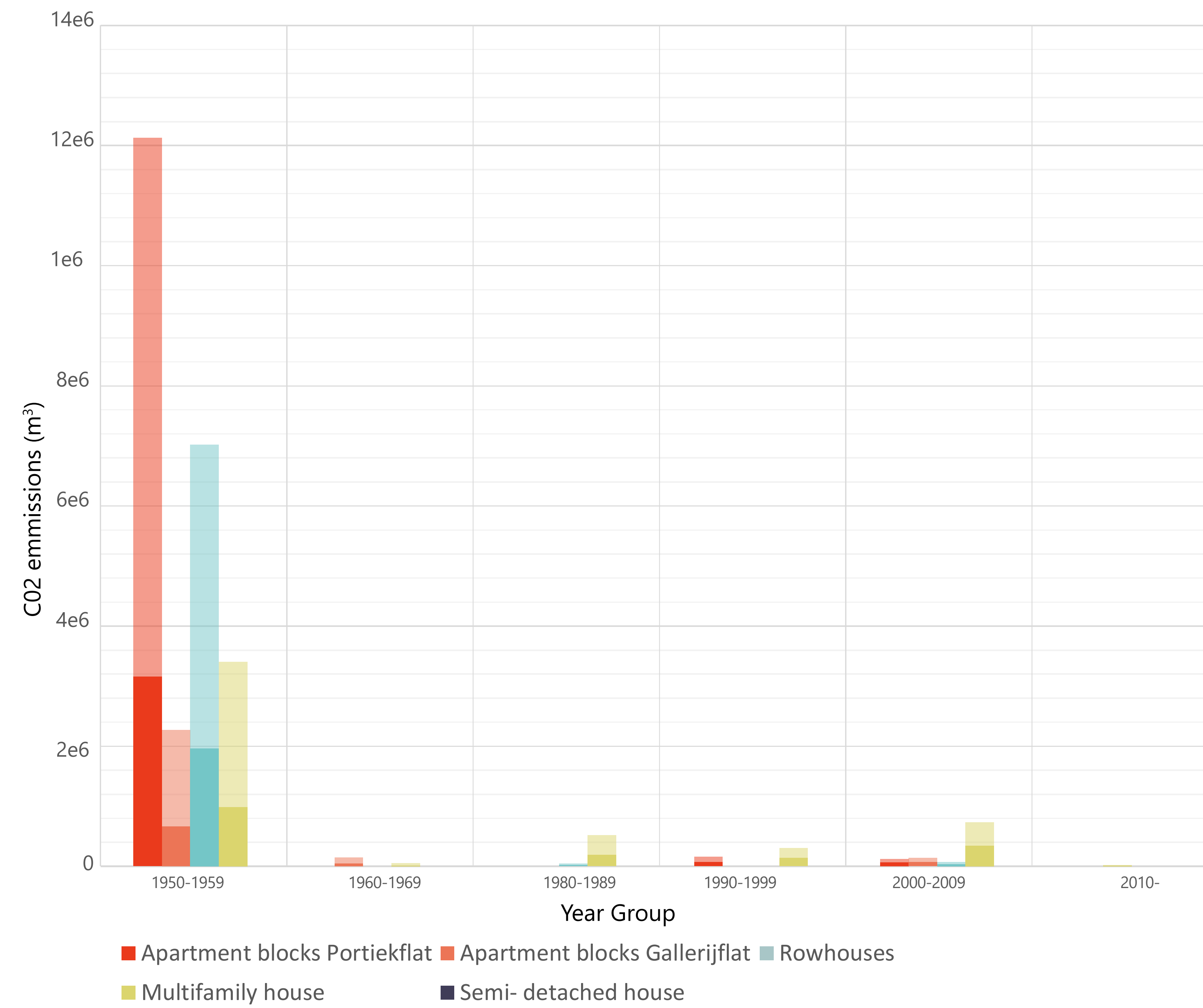
Typology	1950-1959	1960-1969	1970-1979	1980-1989	1990-present
APARTMENT BLOCK – PORTIEKFLAT					
APARTMENT BLOCK - GALLERY-FLAT					
ROWHOUSE					
MULTIFAMILY HOUSE					
SEMI-DETACHED HOUSE					
DETACHED HOUSE					

SUITABLE BUILDING TYPOLOGY

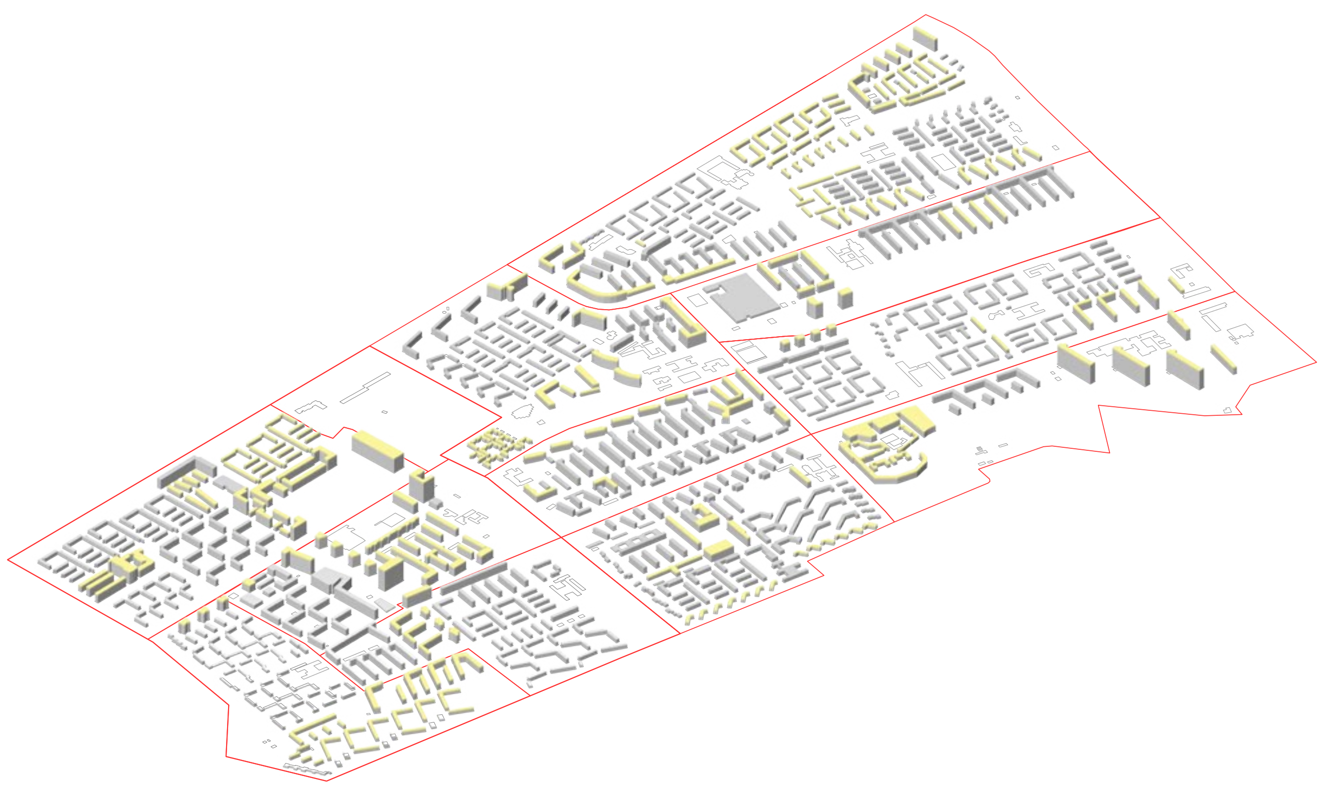


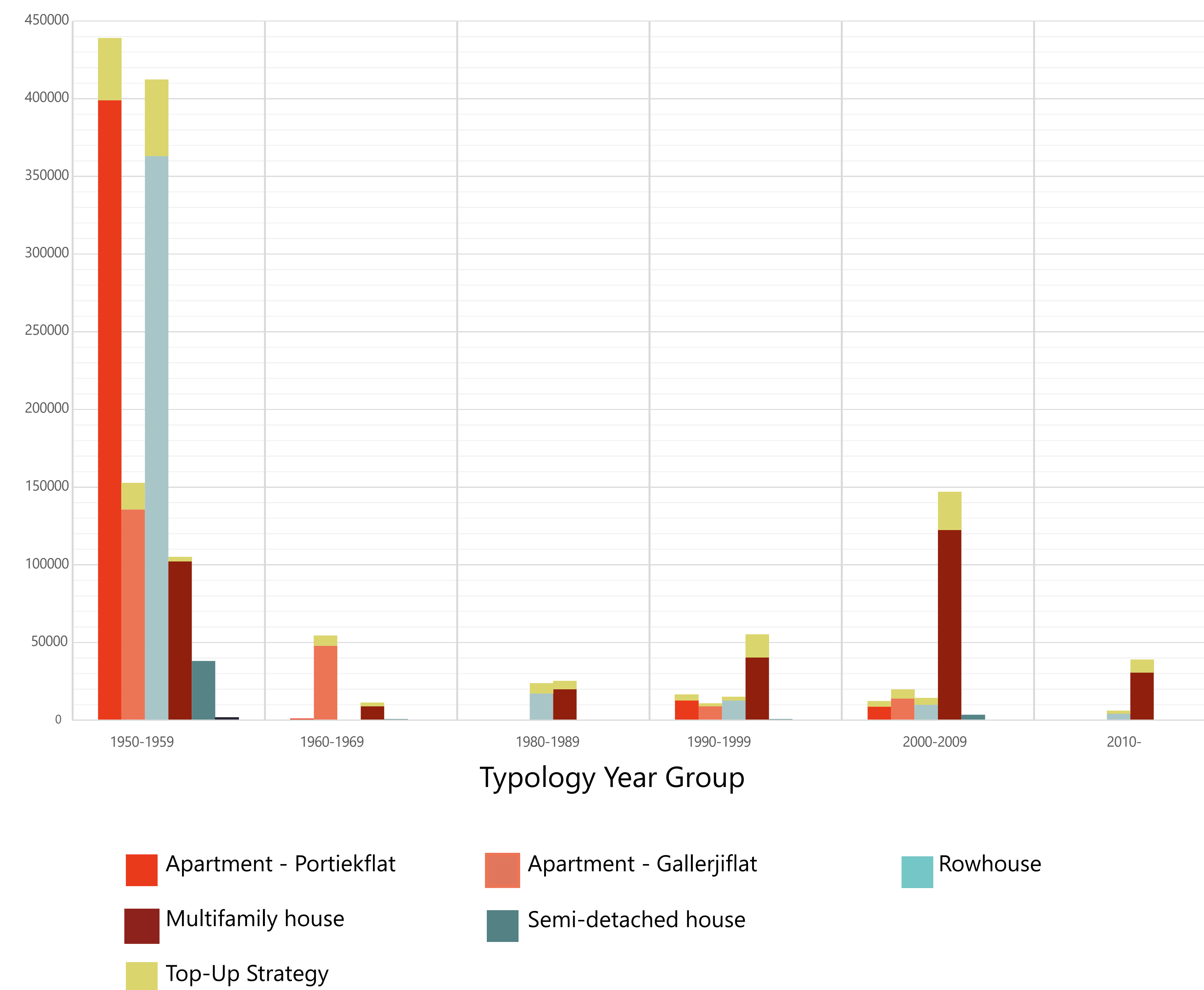
CO^2 REDUCTIONS FOR SOCIAL RENTAL

Typology	BENCHMARK ENERGY SAVING POTENTIAL (TABULA) WITH RETROFIT MEASURES TO EPC 0.6					
	1940 -1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-
Galleryflat	71%	69%	62%	53%	49%	41%
Portiekflat	74%	69%	57%	53%	49%	41%
Rowhouses	72%	69%	63%	52%	48%	50%
Multifamily house	70%	69%	63%	53%	48%	53%
Semi-detached	71%	70%	62%	54%	47%	49%

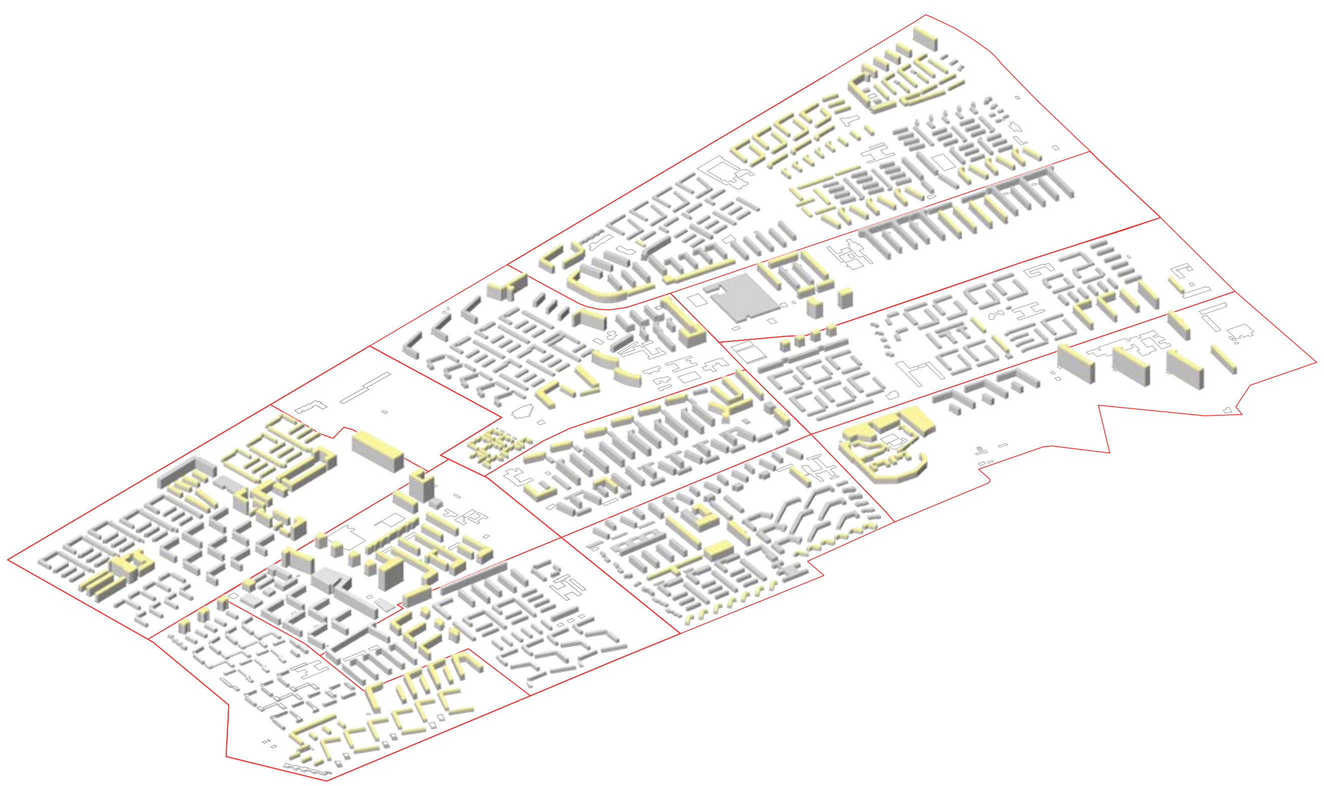


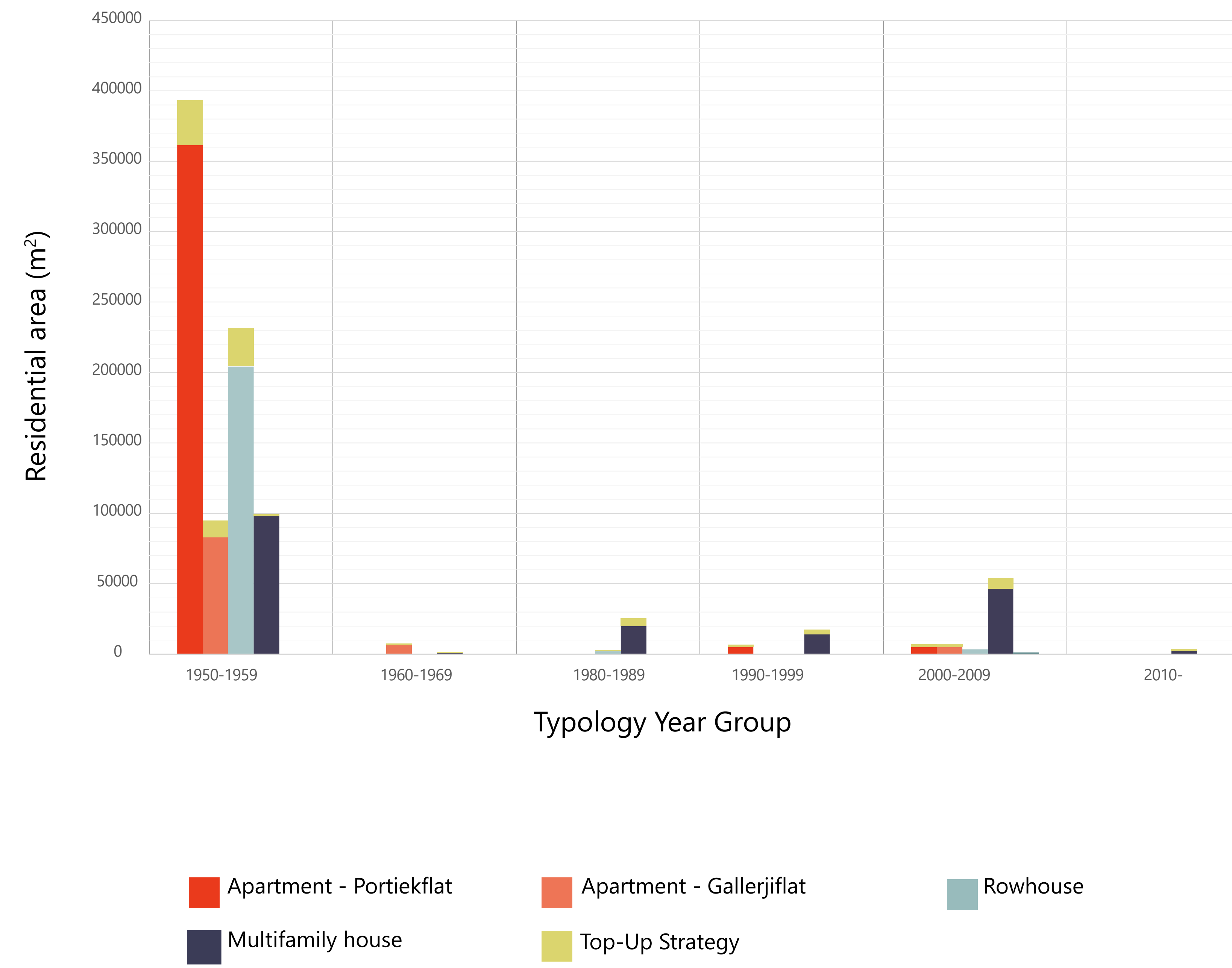
TOP-UP POTENTIAL



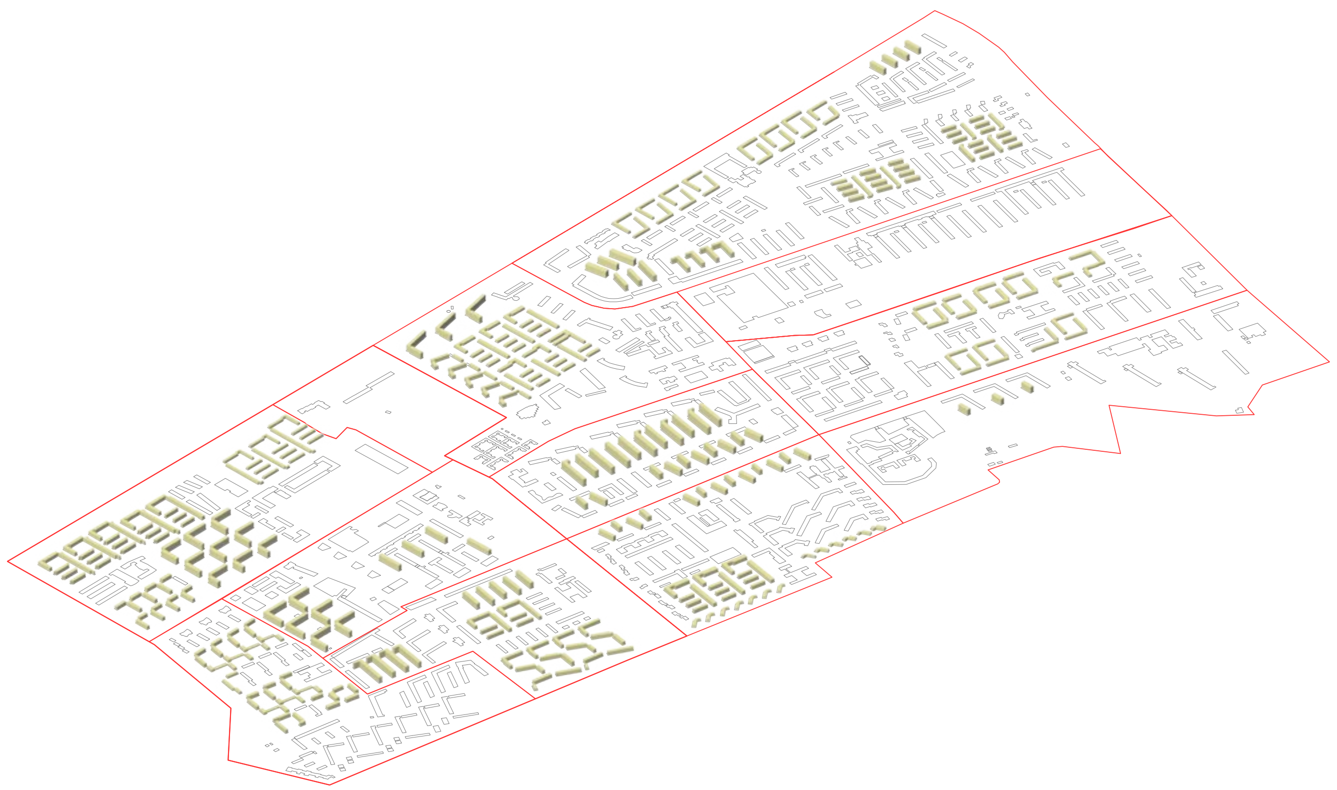


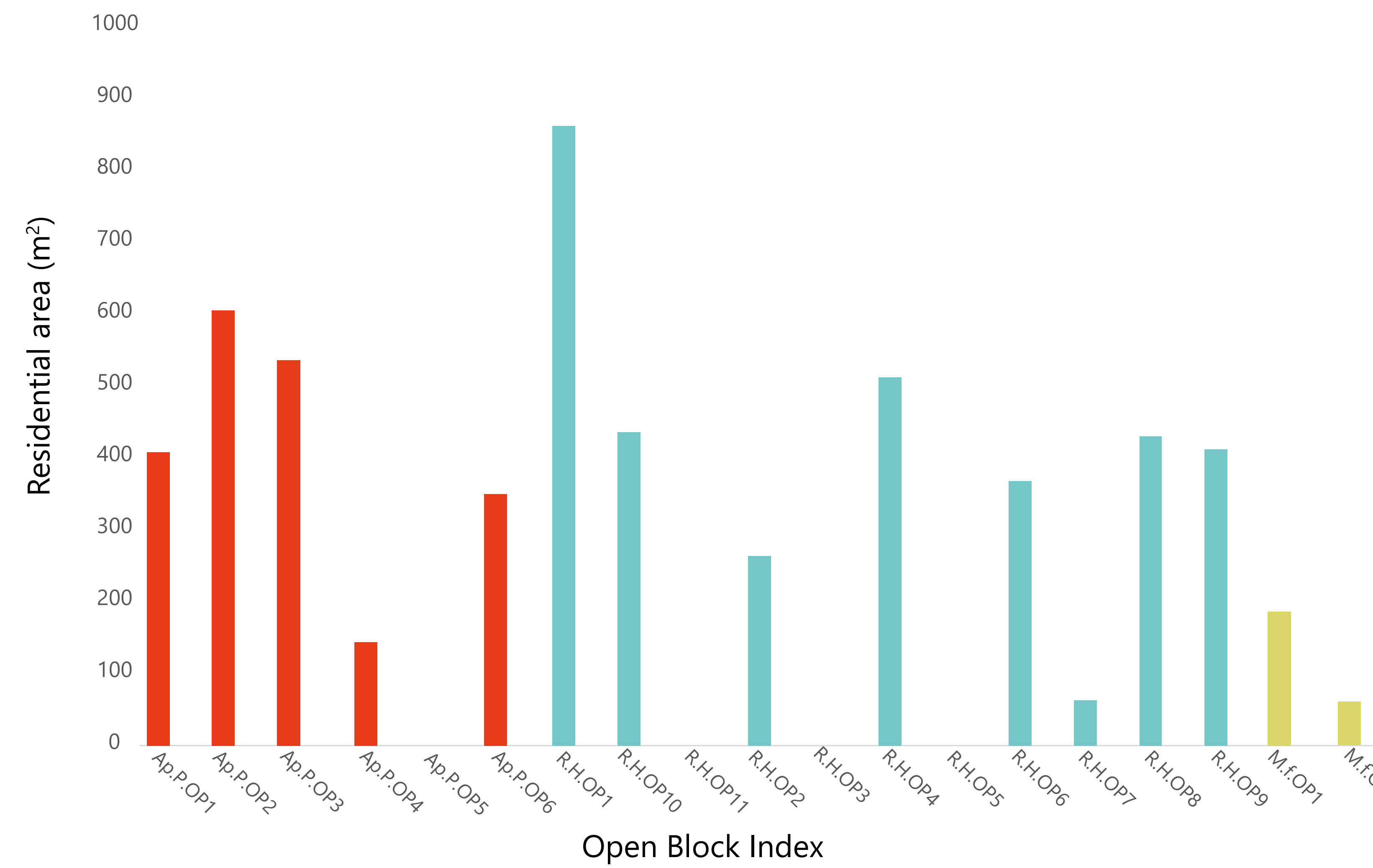
TOP-UP POTENTIAL FOR SOCIAL RENTAL

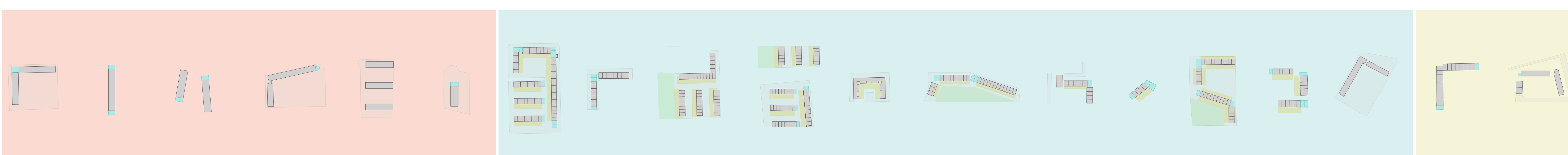




FILL POTENTIAL

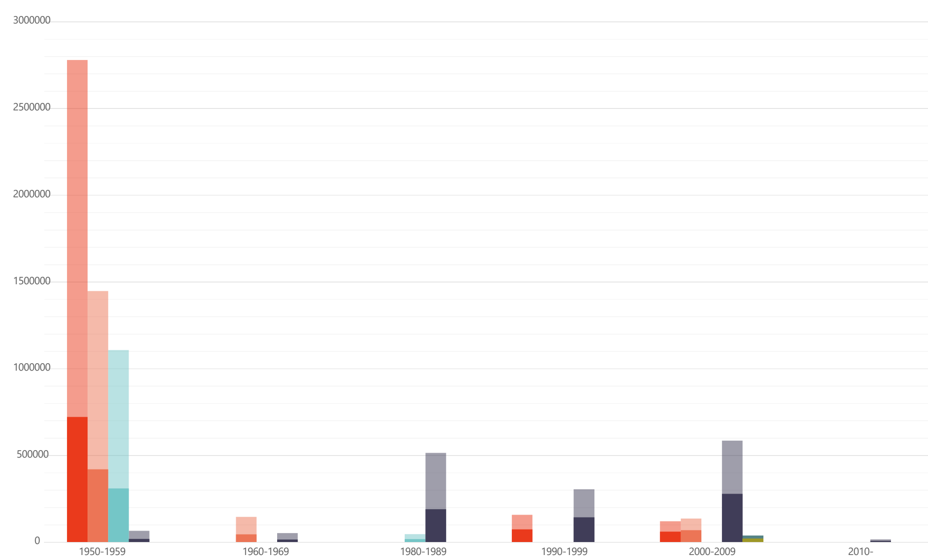




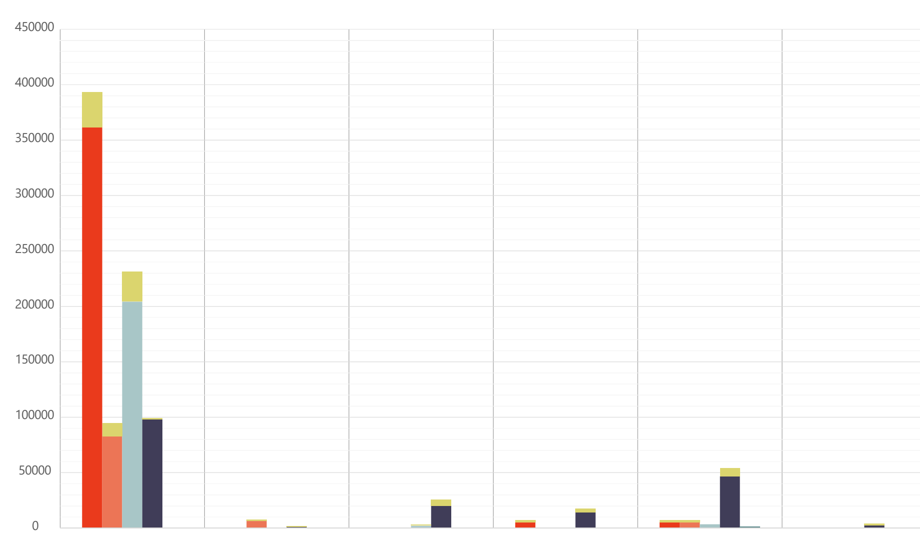


SUITABLE BUILDING TYPOLOGY

Emission reduction results

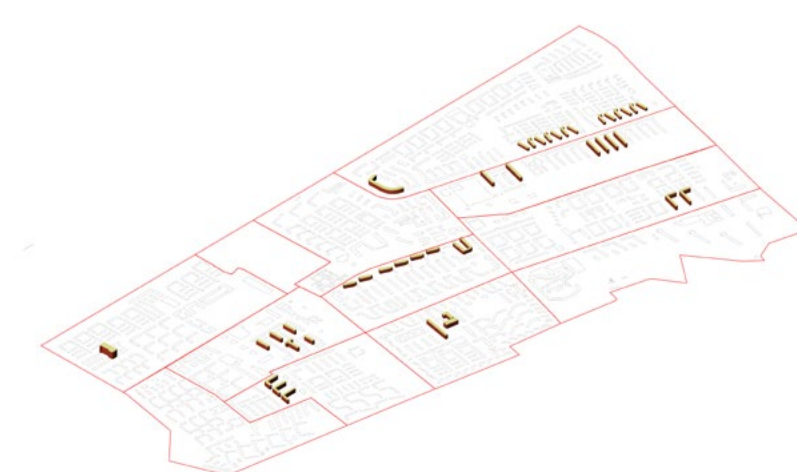


Densification results



MOST SUITABLE RESIDENTIAL TYPOLOGY FOR AMSTERDAM NIEUW-WEST

1950’s Social Housing Portiekflat

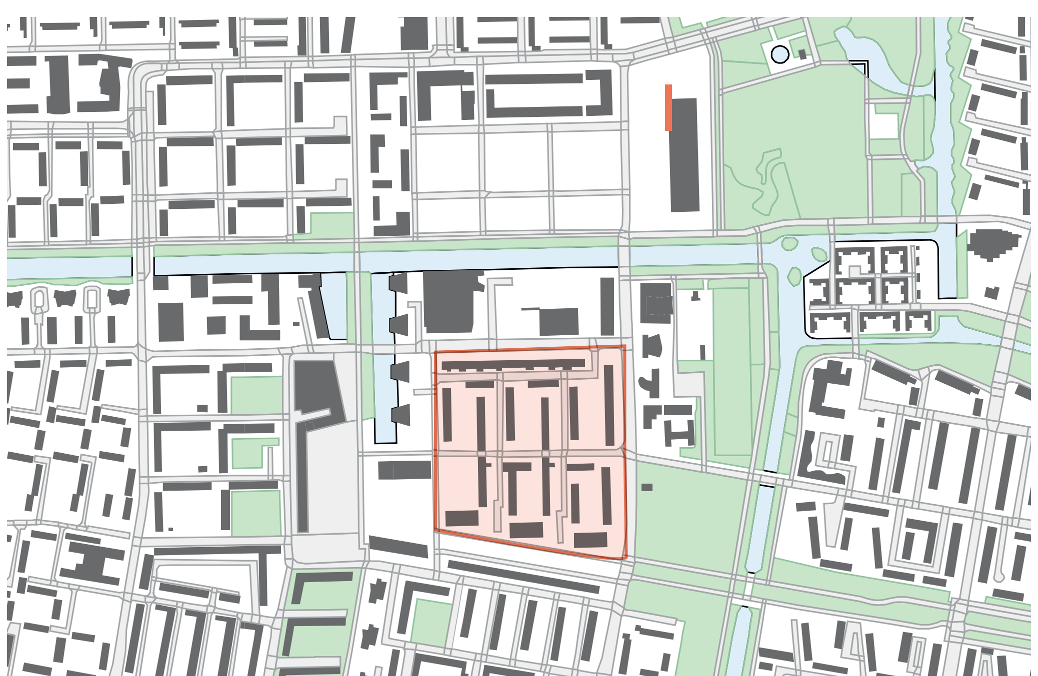


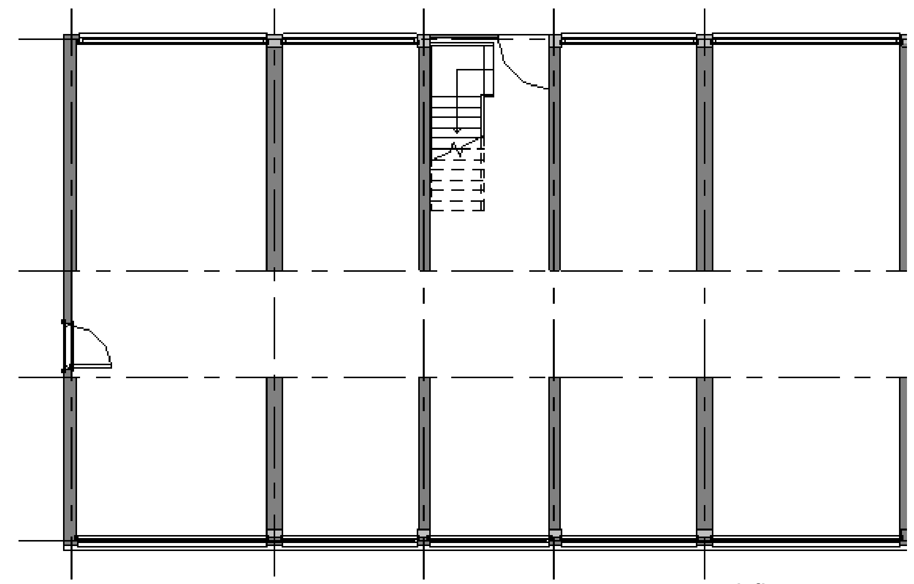
5.8% Potential C0^2 ↓

2.5% Potential Densification ↑

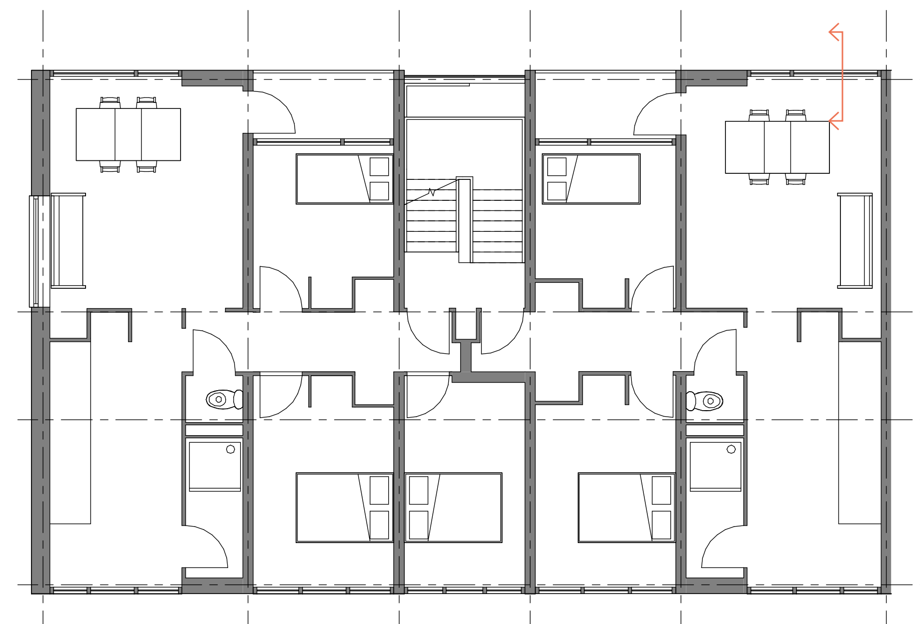
THE 1950'S PORTIEKFLAT

CASE-STUDY: BOUWEN ERWOUTSZSTRAAT

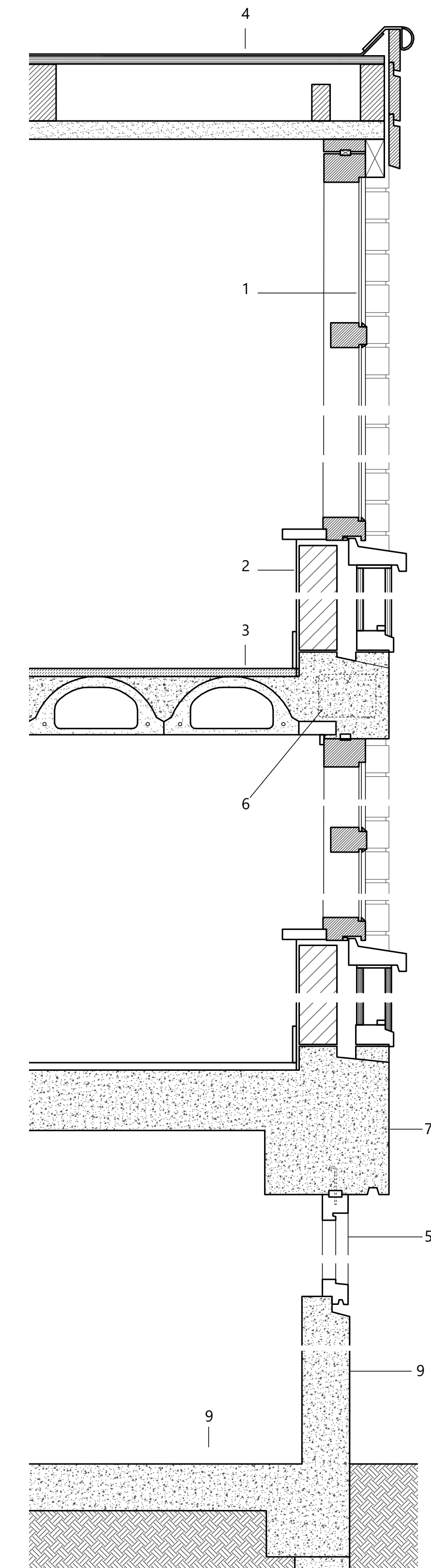




Ground floor



1st-4th floor



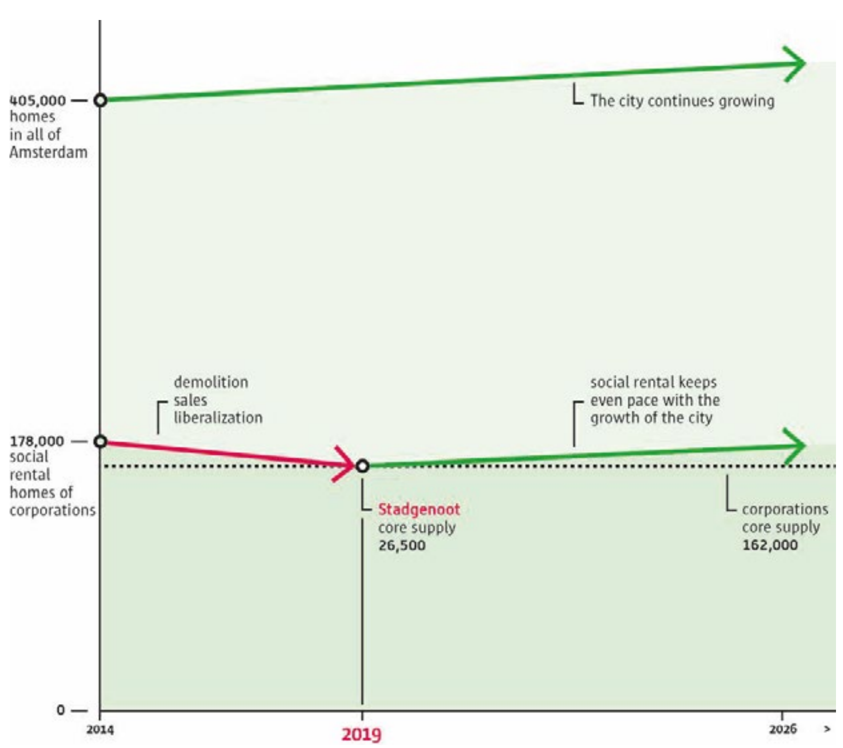
1. Single glazing in wooden framed panel
2. External wall construction: 95mm of wooden board construction; 50mm cavity; 103mm korrel beton
3. Floor construction: flooring; 22mm screed; 160mm hollow core slab
4. Roof construction: 2 layers of bitumen; 27mm wood board; 180mm timber beams, anchored with steel wire; 50mm concrete-wool ceiling
5. Single glazing framed in wooden frame
6. in situ concrete junction with reinforced steeld
7. Concrete perimeter beam: 400x 335mm
8. 150mm in situ concrete wall
9. Ground floor: 200mm in situ concrete floor slab

Detailed Section

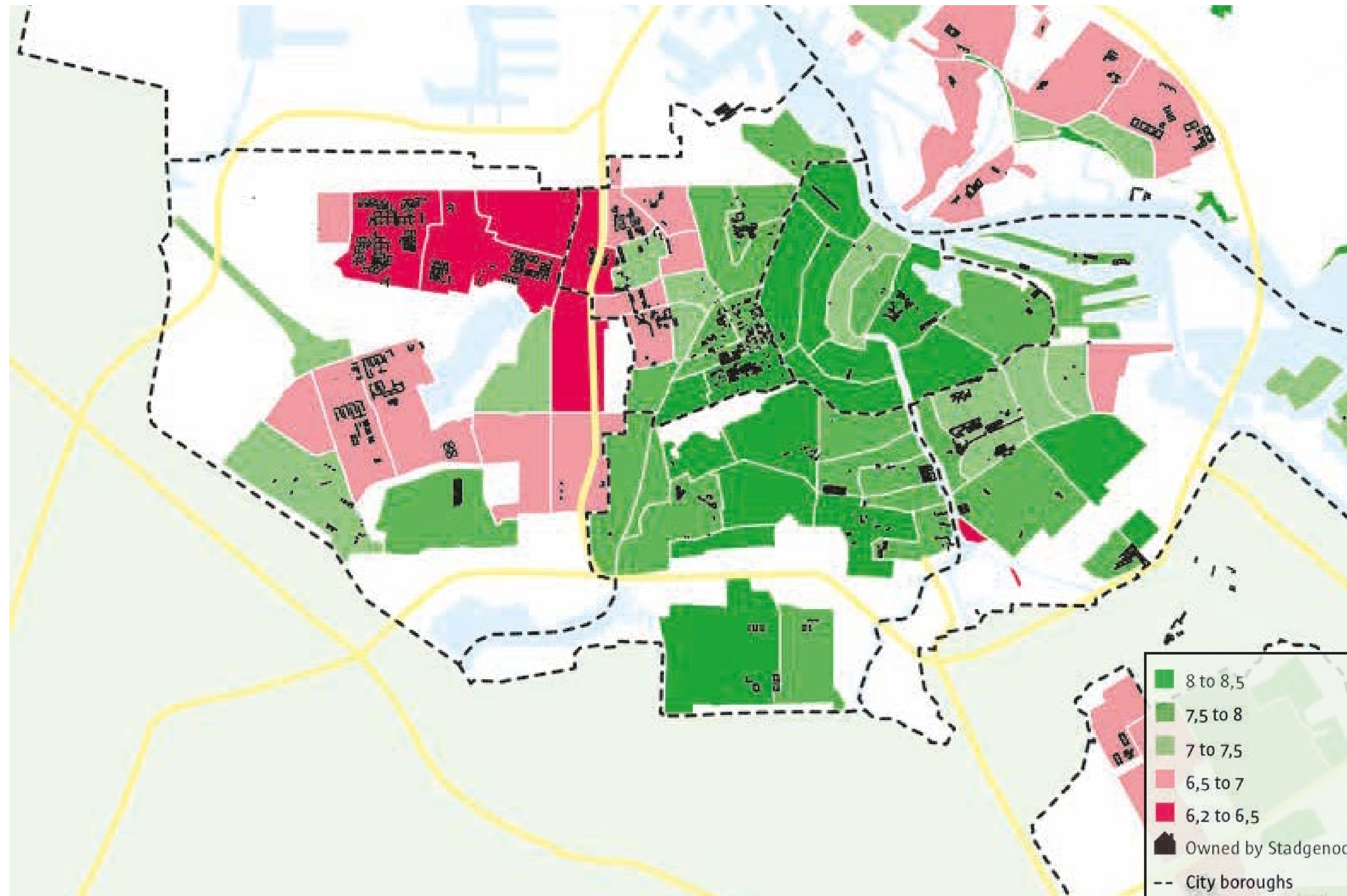
THE STAKEHOLDER
STADTGENOOT

STADEGENOOT

- Provide affordable housing totalling 29.912 dwellings
- By 2019 reduce core supply to 26.503 to reinvest in new developments.
- Lack diversity in dwelling types. Alot of their stock is longer suitable for the urbanization of Amsterdam.
- Their goal is to achieve average EPC label C by 2020



LIVABILITY SCORES FOR AMSTERDAM



RETROFIT DESIGN ASPECTS
CASE-STUDY RESULTS

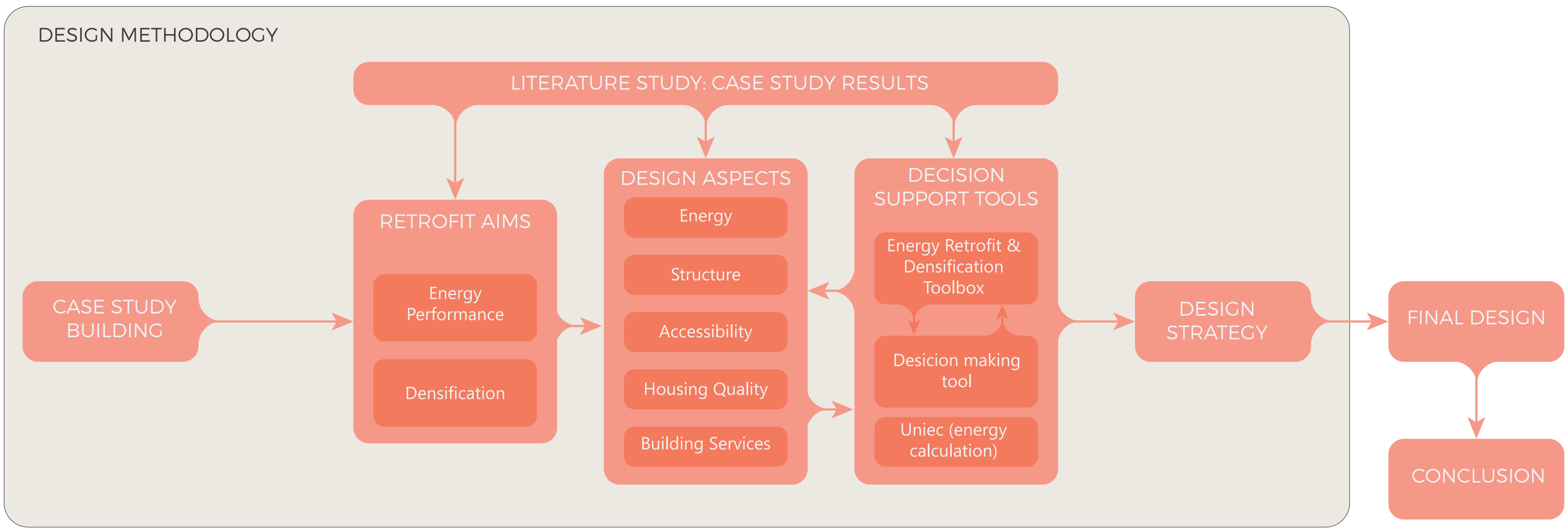
ENERGY RETROFIT CASE STUDIES

	LUCELLESTRAAT, AMSTERDAM	SIBOLDUSSTRAAT, BOLSWARD	MARTIN CAMPSLAAN, RIJSWIJK	DE LUTTEBRINK, ENCHEDE
				
RETROFIT STANDARD	A++	A++	A	A++
ENVELOPE				
EXTERNAL WALL	External 50mm EPS insulation applied	• Cavity wall insulation with high thermal resistance foil		400mm outer-wall insulation
WINDOW	Double glazing (HR+) upgrade	• Double glazing (HR+ upgrade	Double glazing (HR+) upgrade	Triple glazing
BALCONY			Gallery insulation upgraded to 50-80mm insulation panels	
GROUND FLOOR	100mm Glass wool Insulation under first floor	300mm of thermoparels +60mm of hard insulation in crawl space	85mm of wood fibre insulation applied on bottom of first floor	180mm insulation under crawl space
ROOF	External 50mm EPS applied	135mm of insulation added	80mm of hard insulation	380mm outer-wall insulation
BUILDING SERVICES				
HEATING	HR-107 combi boiler	Air-heat pump	HR107 Furnace + HT individual	HR-107 boiler
DHW	combitap HR	Air-heat pump	Intergas HRE 24/18 CW3	Combitap HR (HR-107 + solar-water boiler)
VENTILATIONS	Mechanical	MVHR ventilation	Natural supply + mechanical extraction	MVHR ventilation

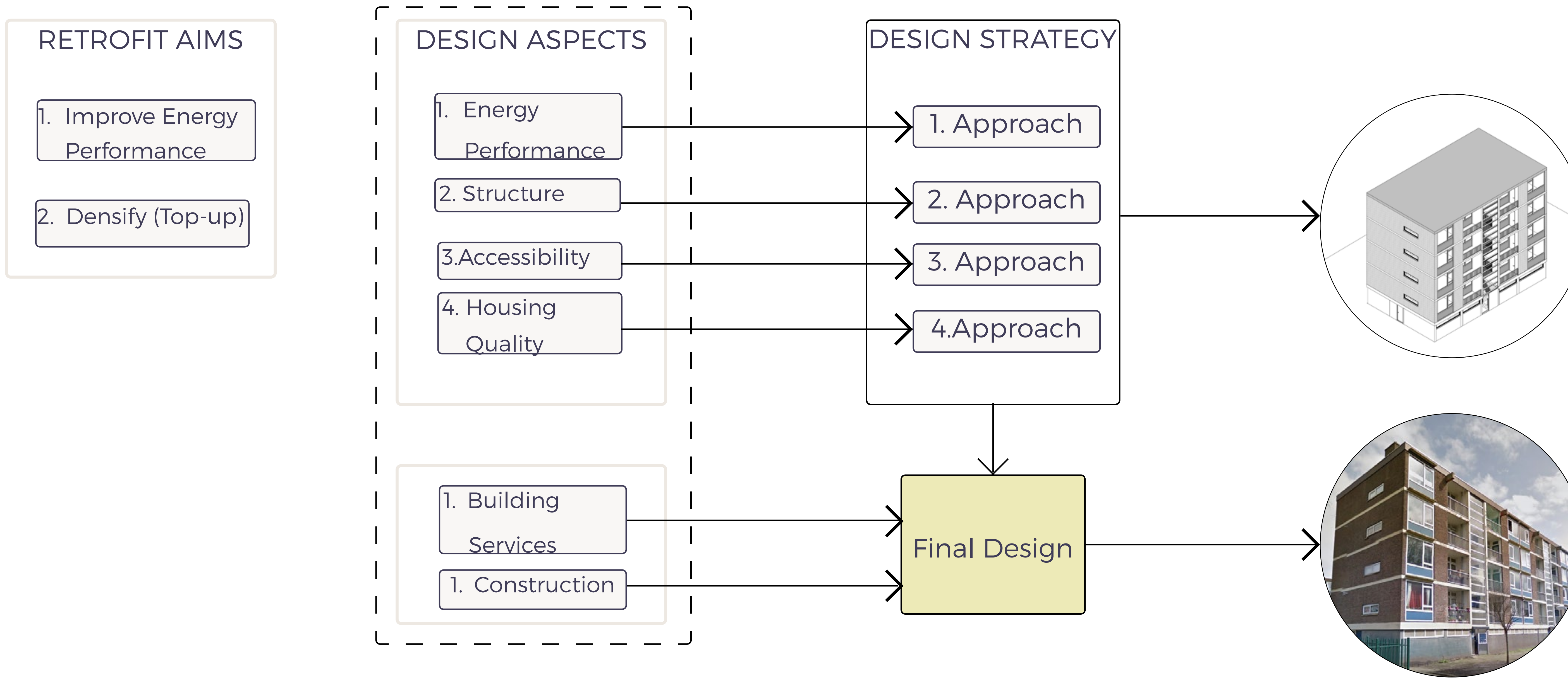
TOP-UP CASE STUDIES

	MELIS STOKELAAN, THE HAGUE	RAUTISTRASSE, ZURICH	RABENHAUPTSTRAAT, GRONIGEN	KAMERSTRAAT, ROTTERDAM
				
ACCESSIBILITY	• External added • Half-landing staircase replaced with straight staircase	• Exisiting vertical acesss used	• Complete externalization of vertical circulation	• Exisitng vertical circulation extended and one external elevator incorperated
STRUCTURE	• New loads carried by existing structure	• Reinforced structural members to increase structural capacity and distribute new loads	• Top-up stands on its own new columns that have been integrated into the existing building	• New-loads carried by existing structure
	• Prefabricated aerated concrete elements	• Prefabricated timber platform construction • CLT panels used as crosswalls	• Completely prefabricated units stacked on top of each other	• Prefabricated steel elements
BUILDING SERVICES	• Services placed between first floor of top-up and existing roof. • Runs into existing shafts	• Top-up dwelling services seperate from existing building services. • Plumbing and ducts placed in between top-up adn existing elements.		• Services run between first and top-up floor • Plumbing runs into existing drains

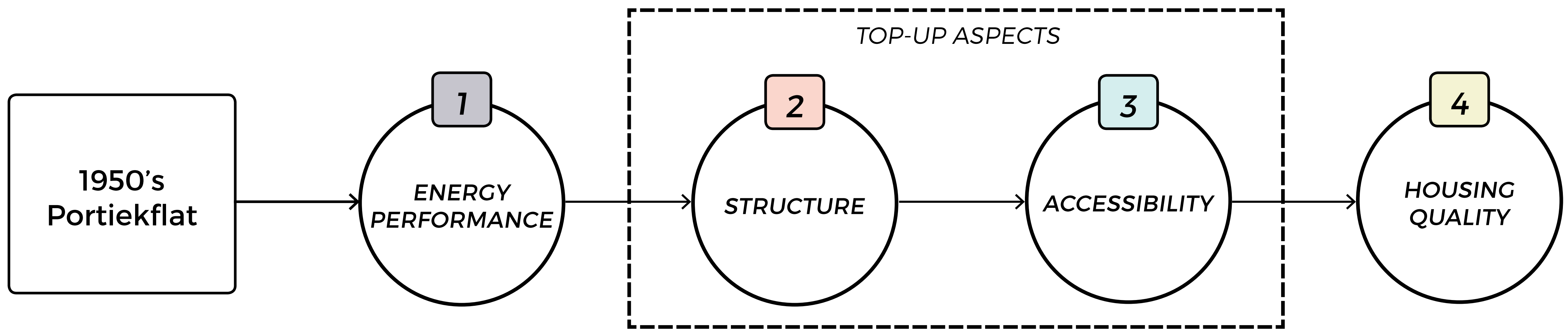
DESIGN METHODOLOGY



THE RETROFIT DESIGN



DESIGN PRIORITIES



RETROFIT DESIGN

DESIGN DECISIONS

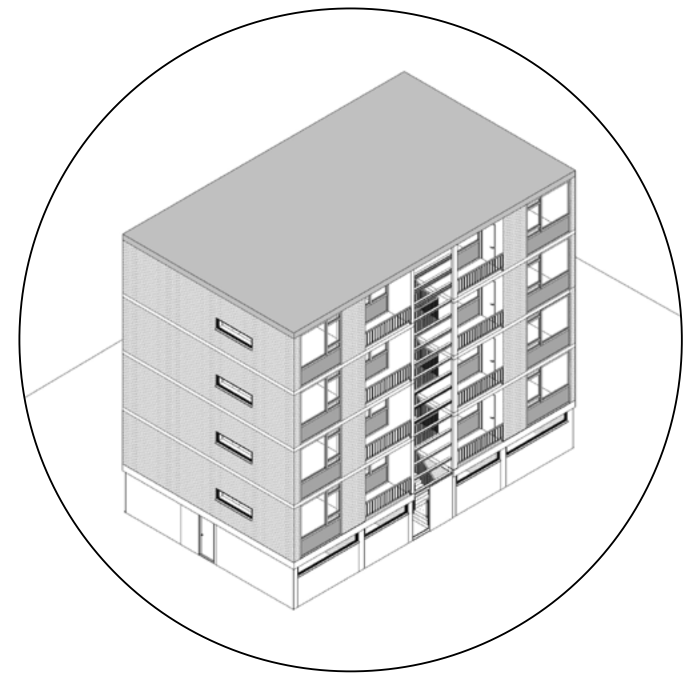
Retrofit Portiekflat (1950-1960)?

1 **ENERGY PERFORMANCE**

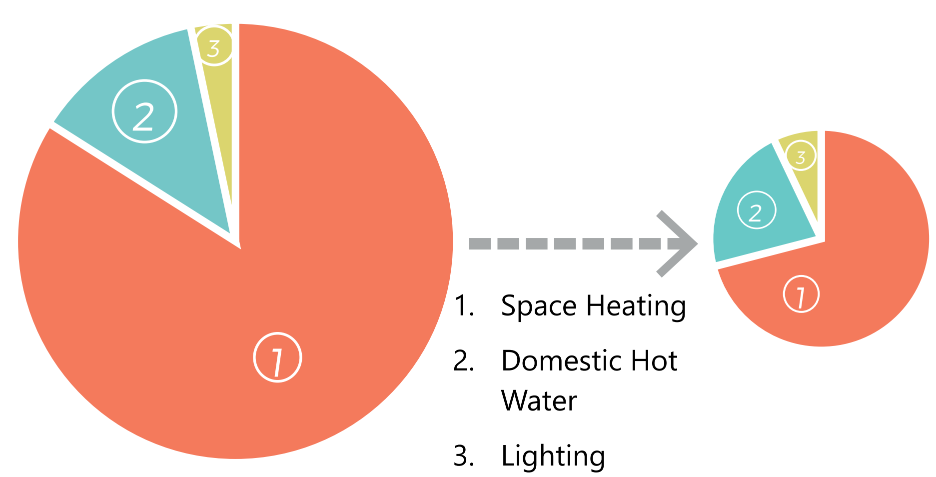
To what standard should be retrofitted to?

Option 1: Minimal intervention

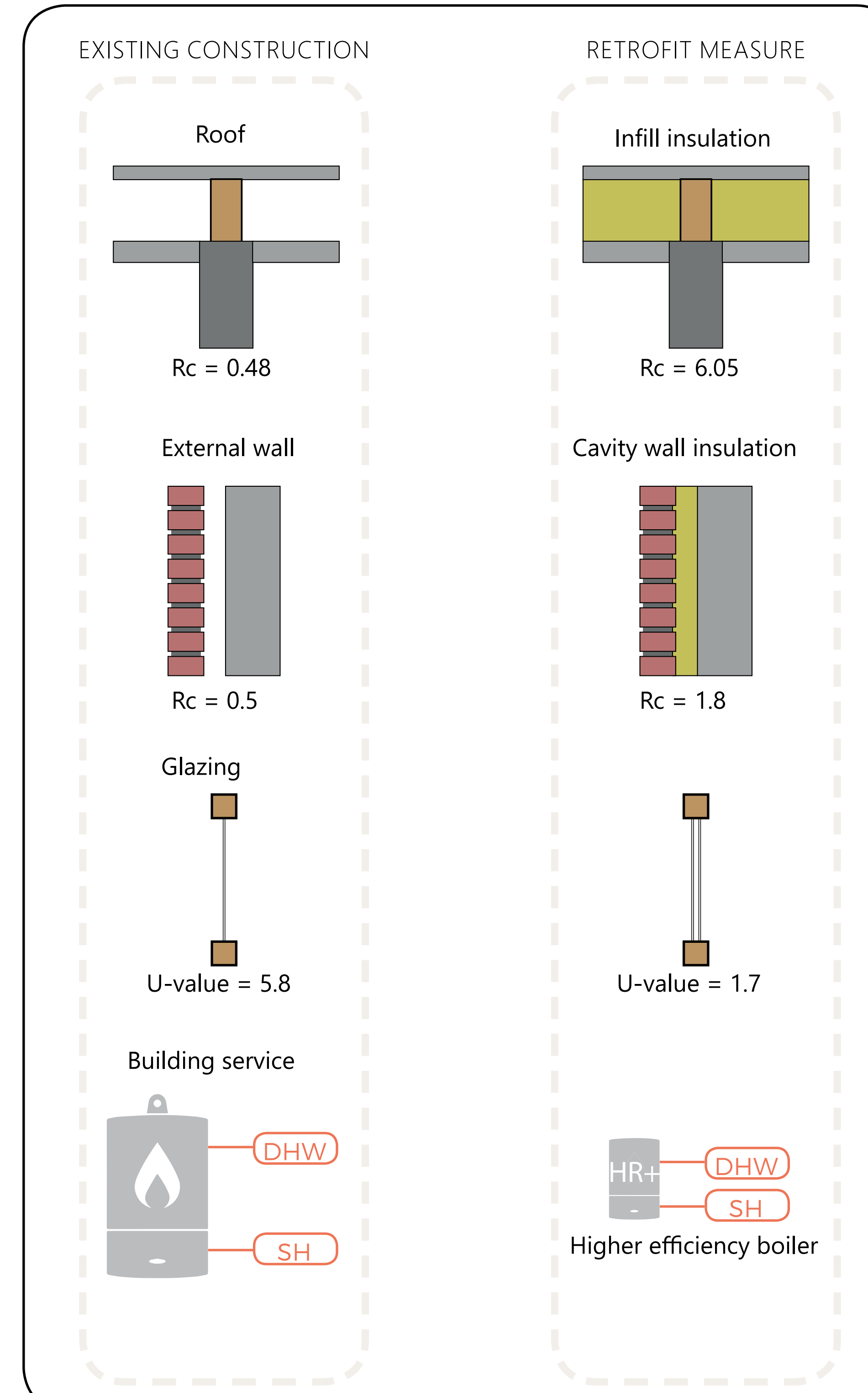
EPC Label **B**

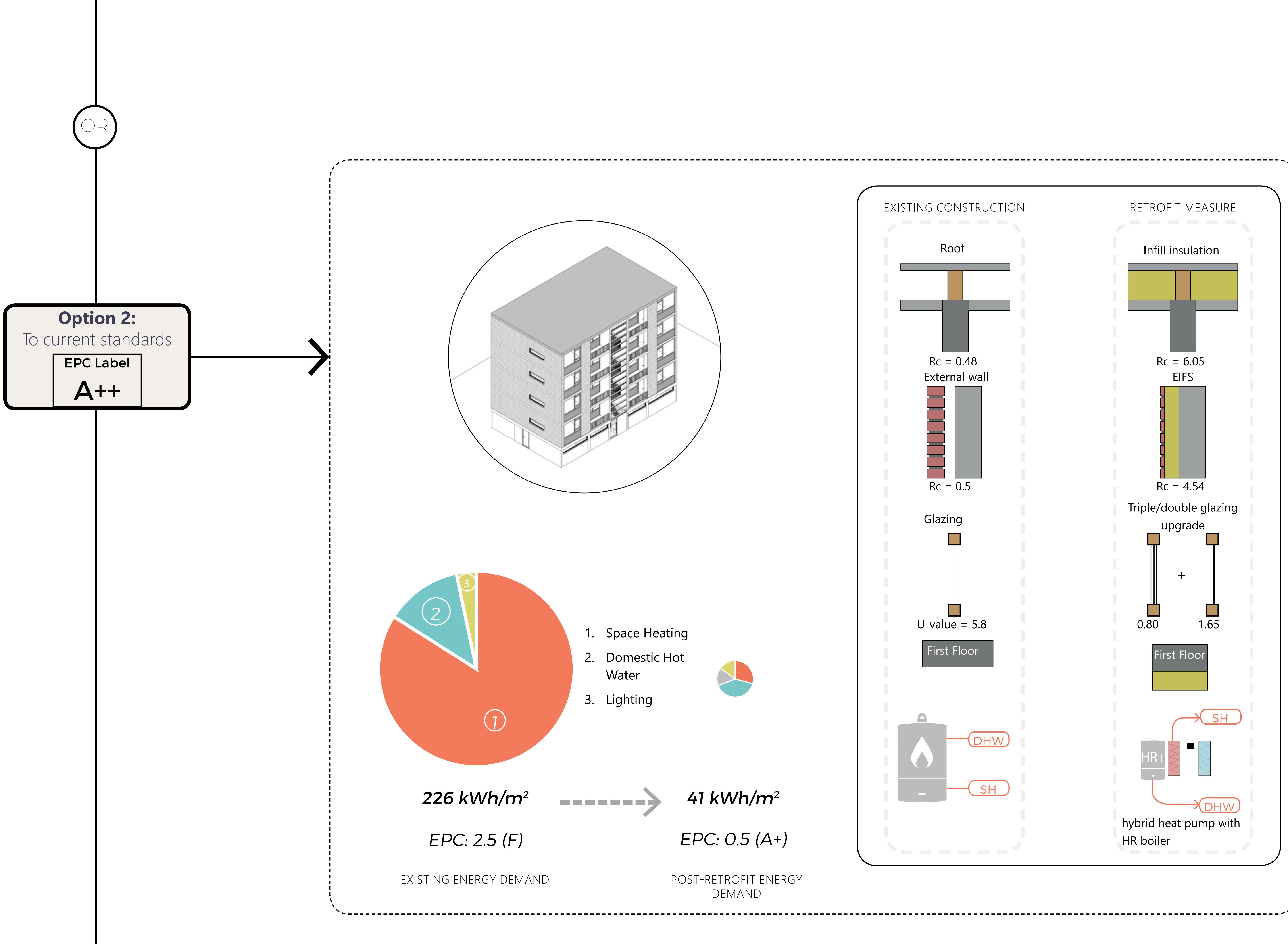


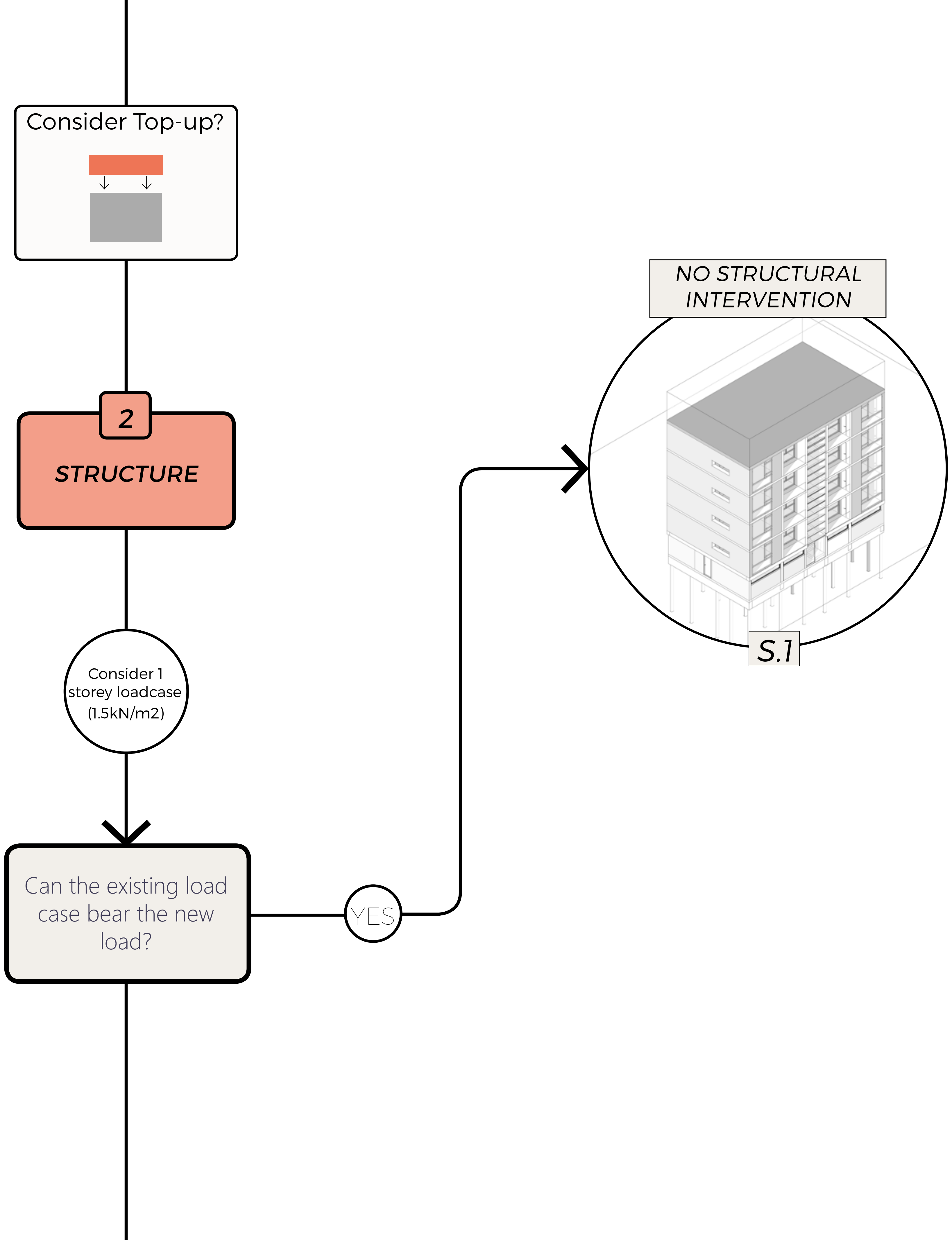
EXISTING ENERGY DEMAND



EXISTING ENERGY DEMAND	POST-RETROFIT ENERGY DEMAND
226 kWh/m²	***112 kWh/m²***
EPC: 2.5 (F)	*EPC: 1.2 (B)*



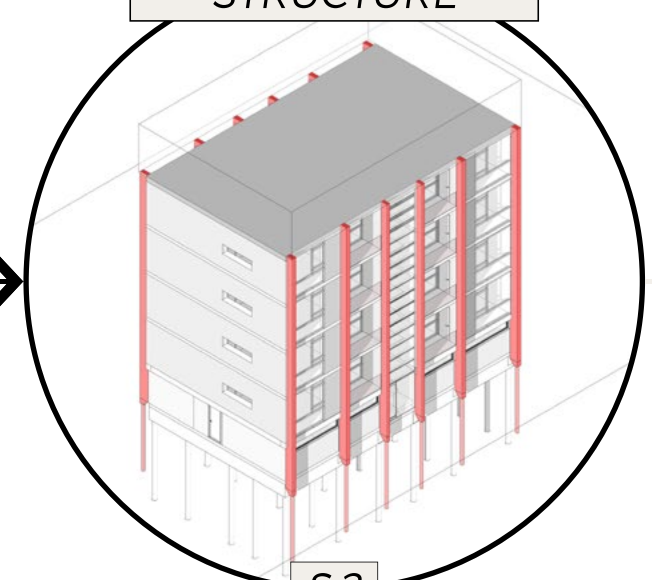

OR
Option 2:
To current standards
EPC Label
A++
1. Space Heating
2. Domestic Hot Water
3. Lighting
226 kWh/m²
EPC: 2.5 (F)
EXISTING ENERGY DEMAND
41 kWh/m²
EPC: 0.5 (A+)
POST-RETROFIT ENERGY DEMAND
EXISTING CONSTRUCTION
Roof
Rc = 0.48
External wall
Rc = 0.5
Glazing
U-value = 5.8
First Floor
DHW
SH
RETROFIT MEASURE
Infill insulation
Rc = 6.05
EIFS
Rc = 4.54
Triple/double glazing upgrade
0.80
1.65
First Floor
SH
HR+
DHW
hybrid heat pump with HR boiler


Consider Top-up?
2
STRUCTURE
Consider 1 storey loadcase (1.5kN/m2)
Can the existing load case bear the new load?
YES
NO STRUCTURAL INTERVENTION
S.1

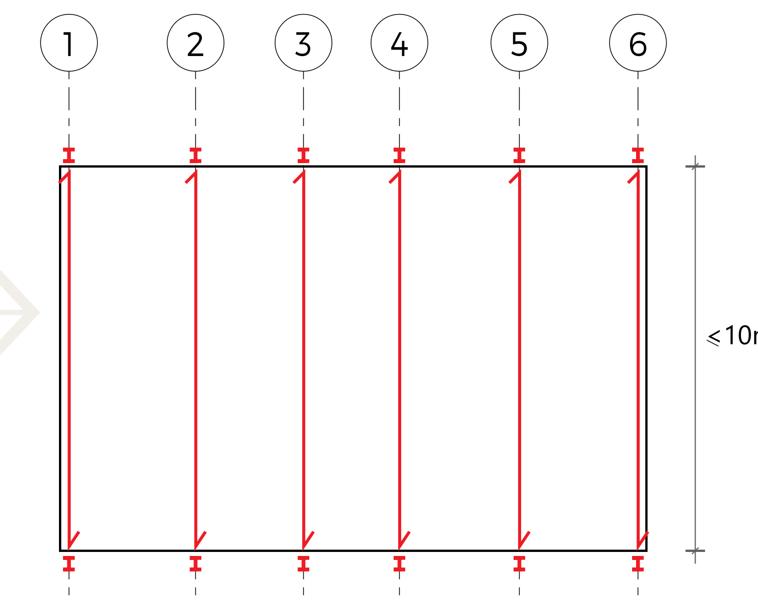
Can an external structure be applied?

YES

EXTERNAL STRUCTURE



S.2

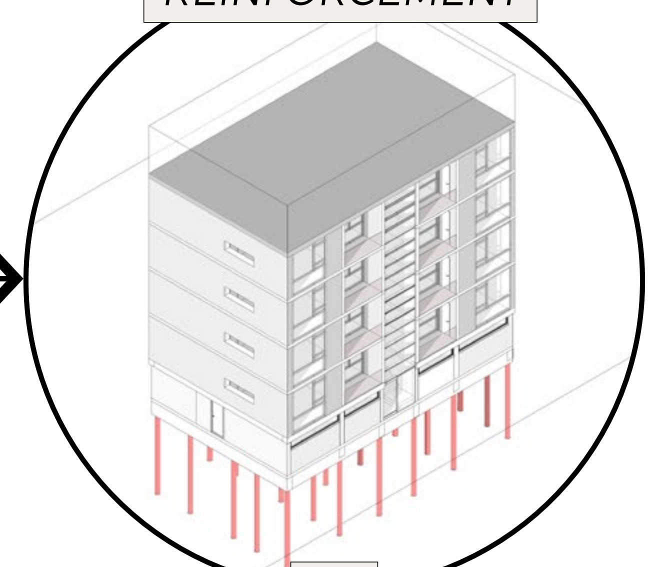


NO

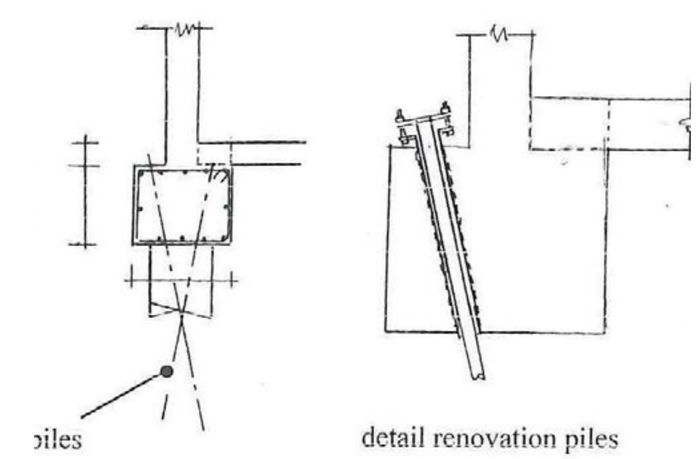
Can the existing load-bearing elements bear the new load-case?

YES

FOUNDATION REINFORCEMENT



S.3



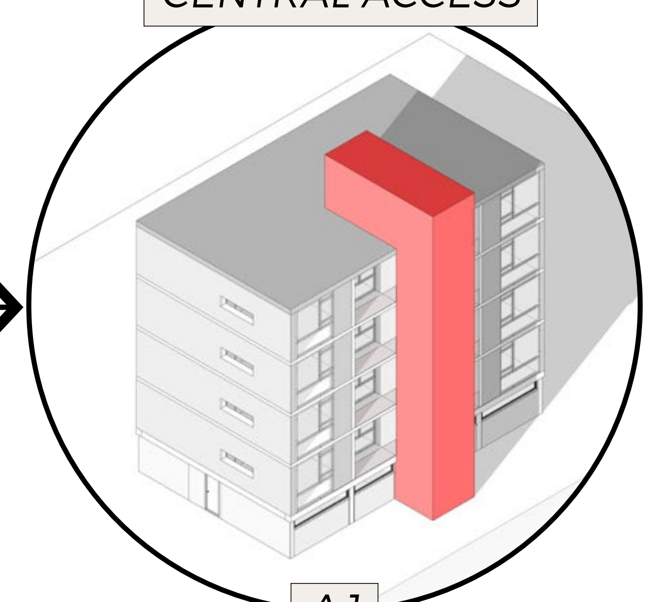
3

ACCESSIBILITY

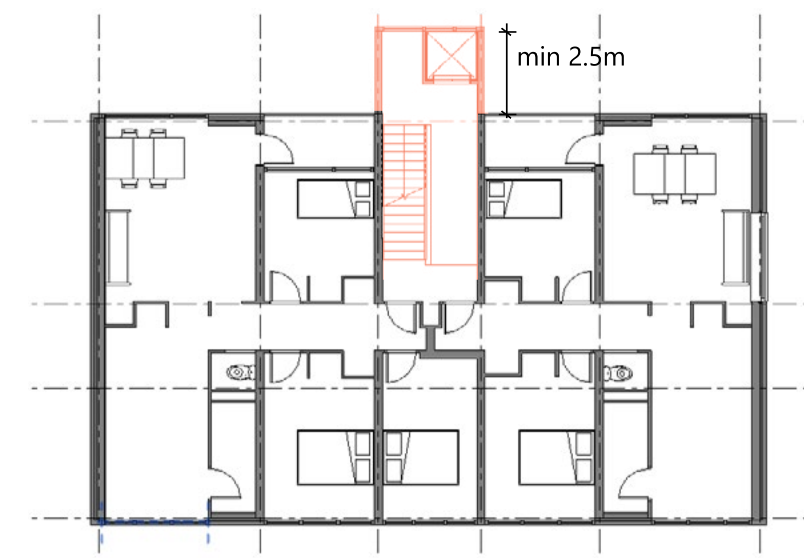
Remodel existing core? Minimum of 2m of external space required

YES →

CENTRAL ACCESS



A.1

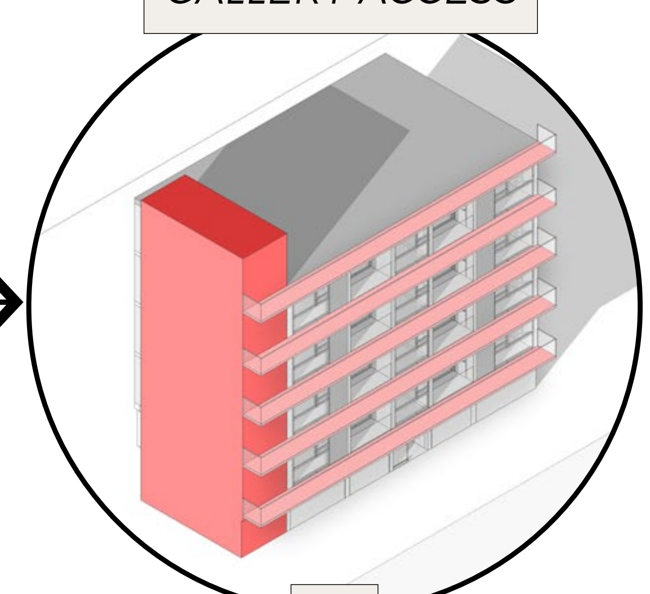


NO ↓

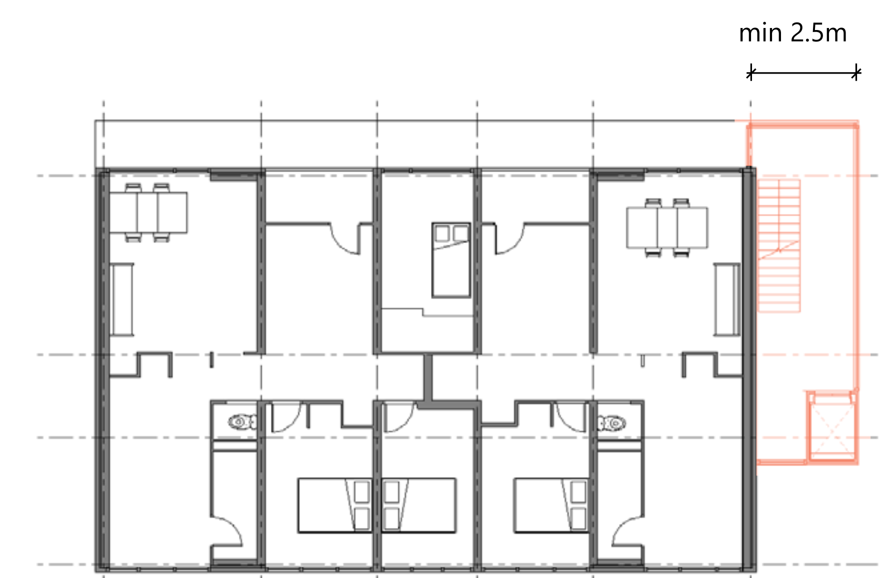
Provide new vertical core on the side of the block? Minimum 2.5m of exterrnal space

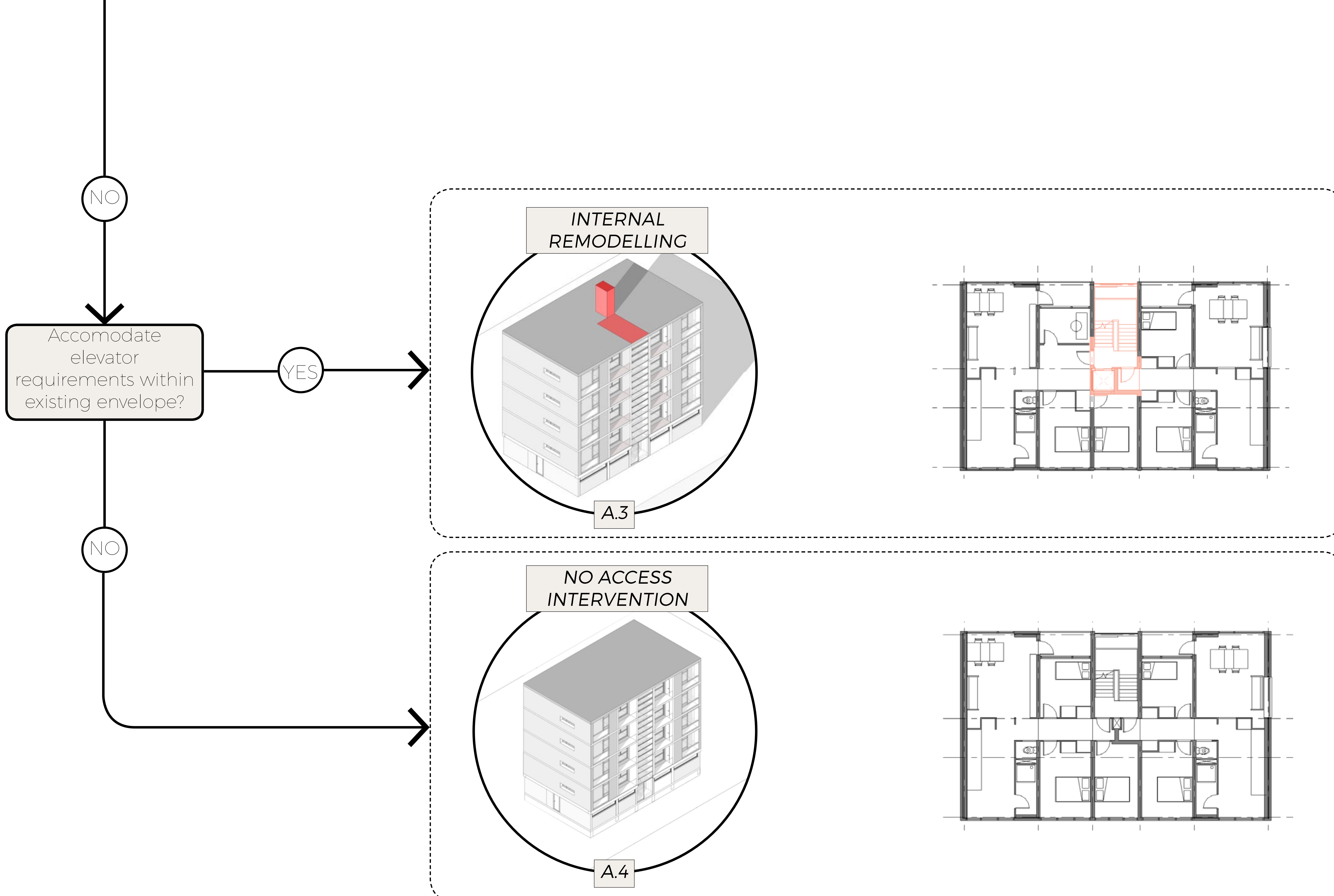
YES →

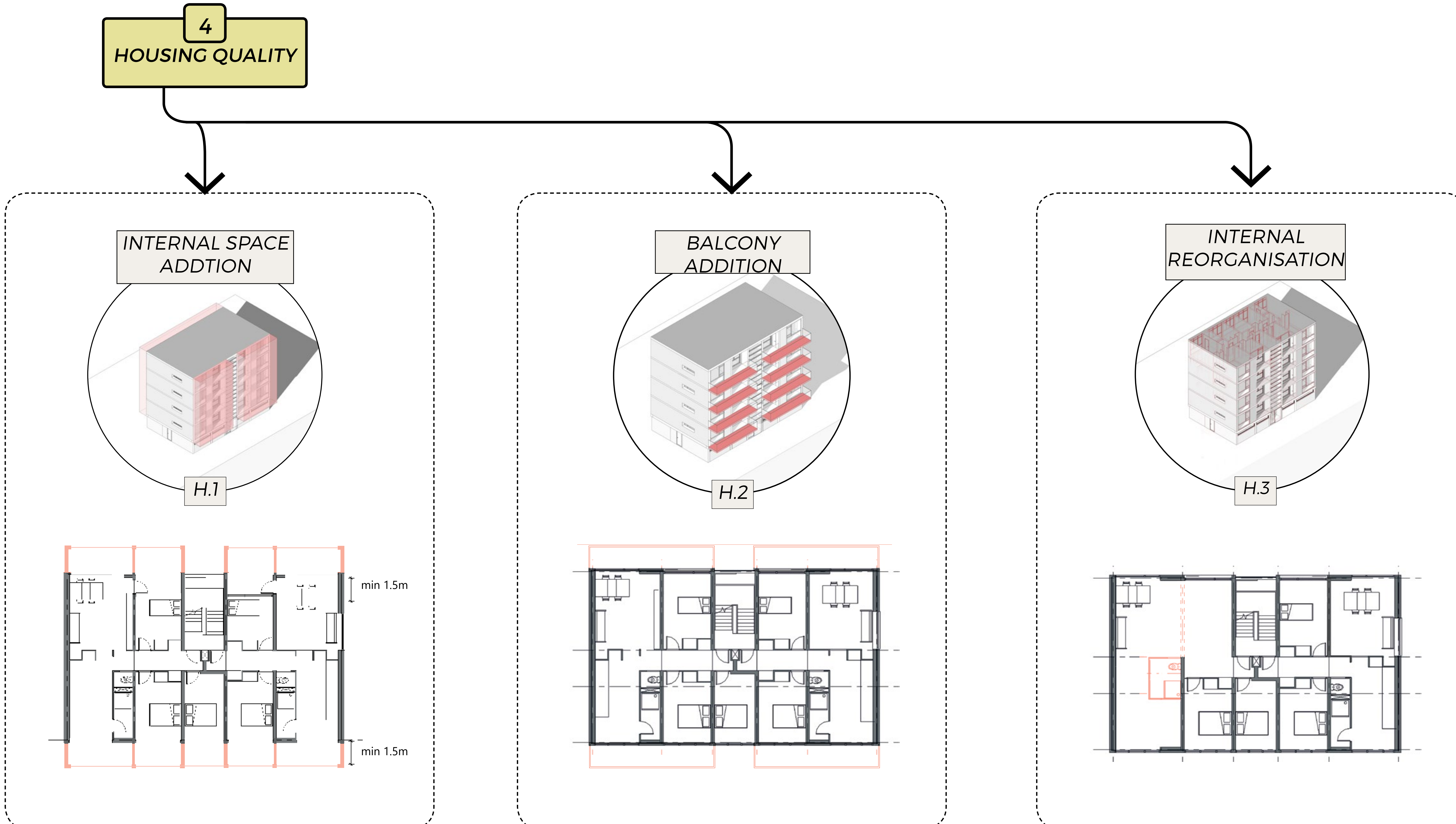
GALLERY ACCESS



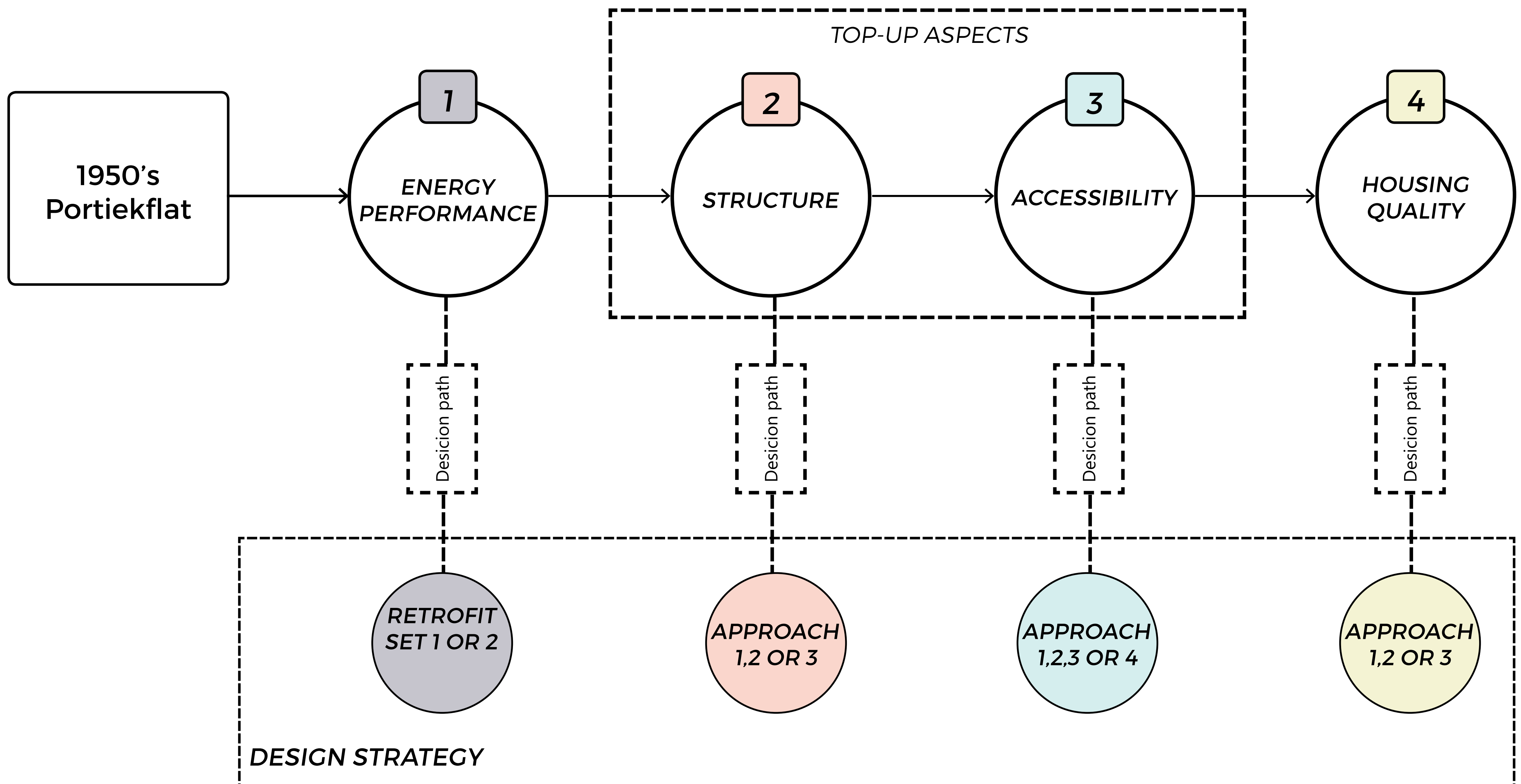
A.2



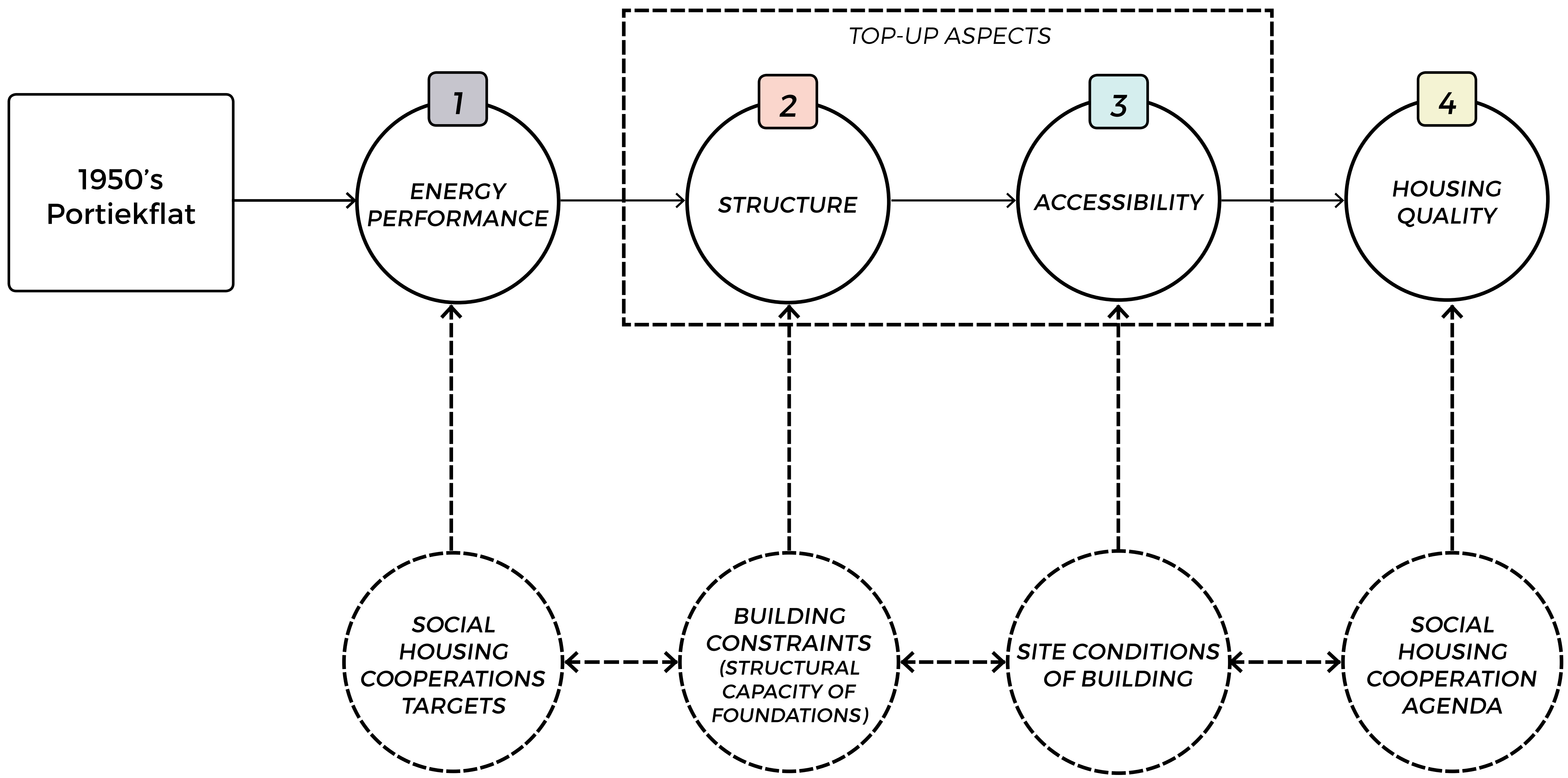

NO
Accomodate elevator requirements within existing envelope?
YES
INTERNAL REMODELLING
A.3
NO
NO ACCESS INTERVENTION
A.4


4
HOUSING QUALITY
INTERNAL SPACE ADDTION
H.1
min 1.5m
min 1.5m
BALCONY ADDITION
H.2
INTERNAL REORGANISATION
H.3

DESIGN DECISION STRUCTURE

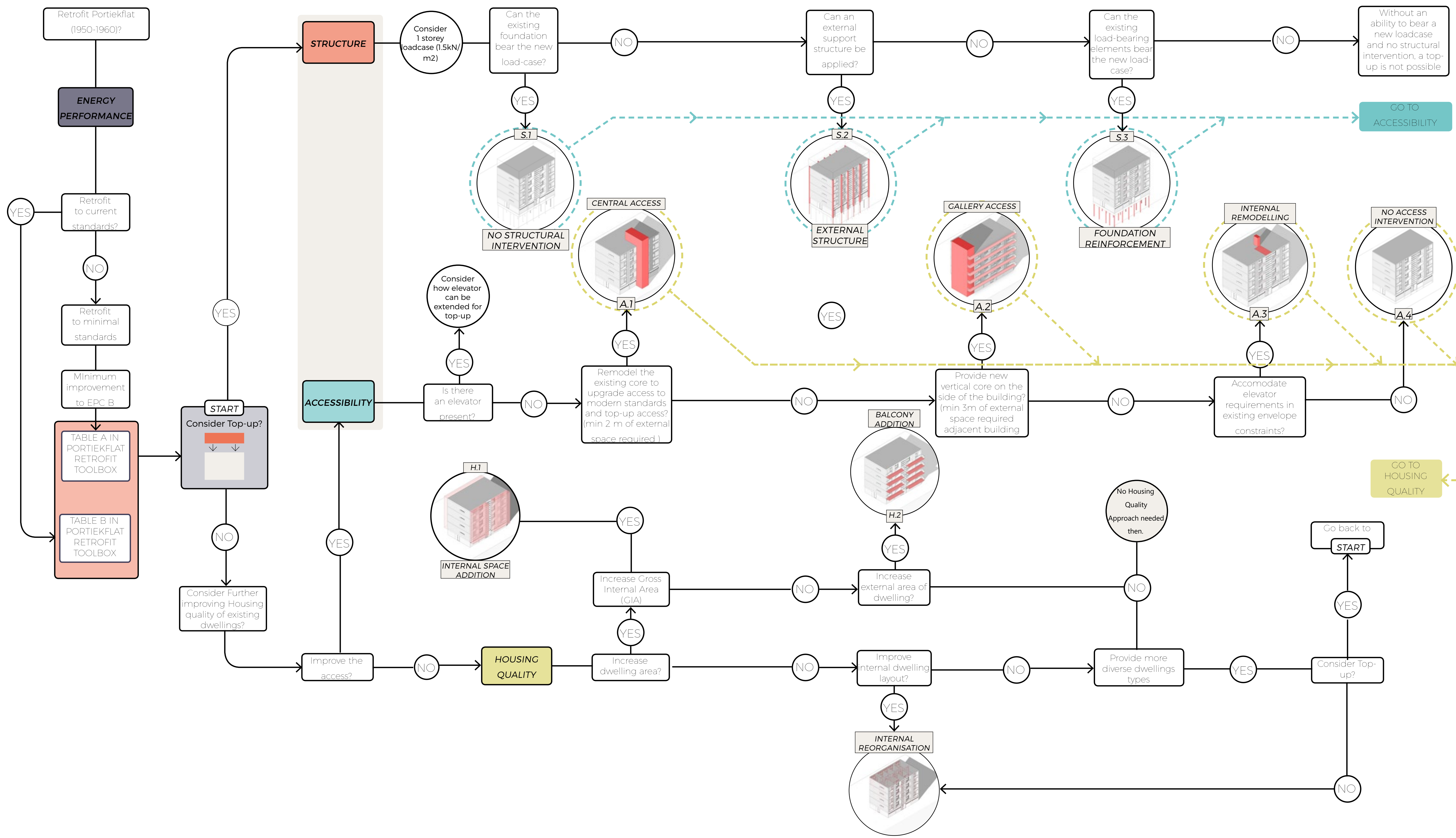


DESIGN DECISION STRUCTURE



RETROFIT DESIGN

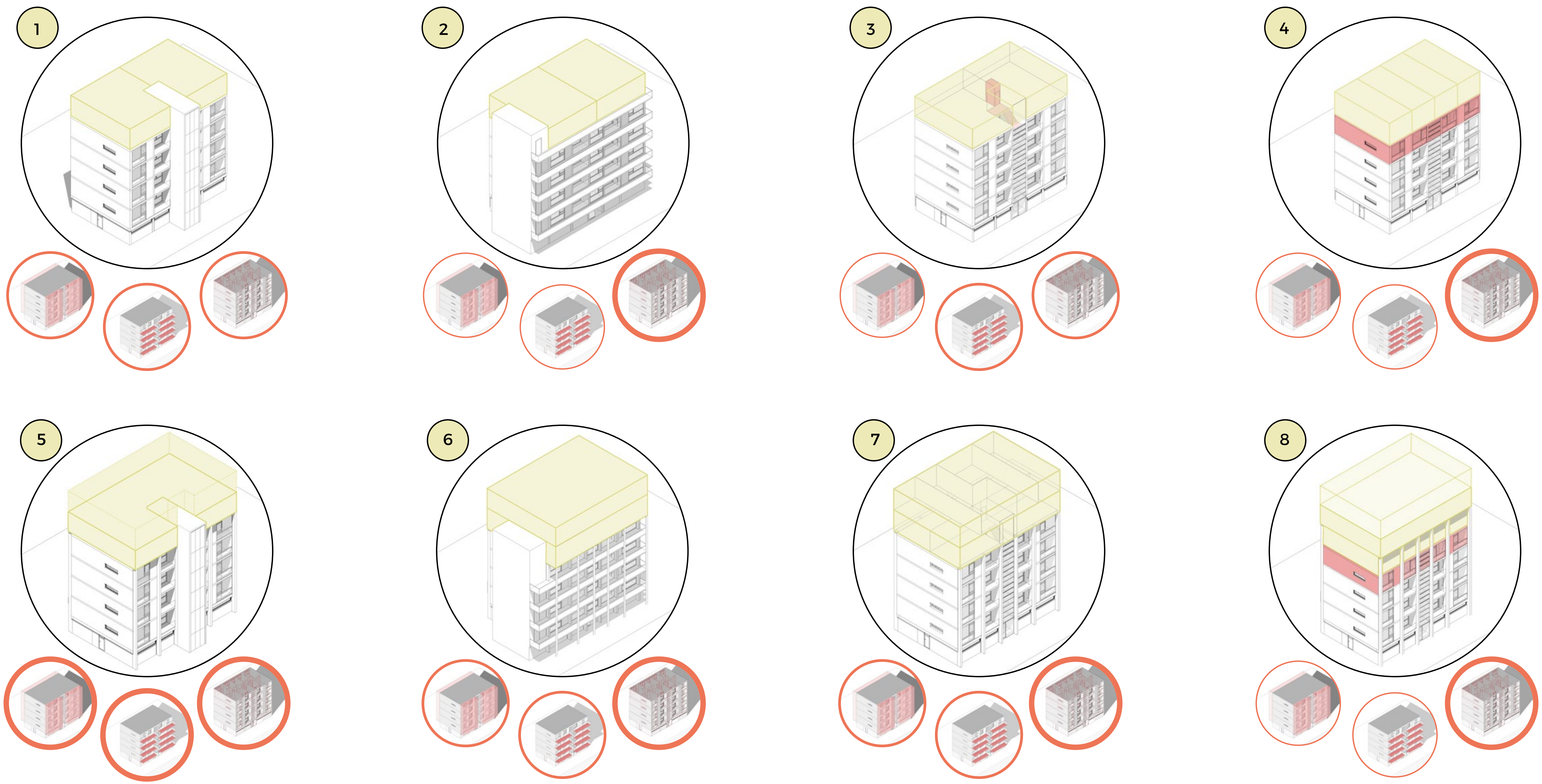
DESIGN-DECISION TOOL



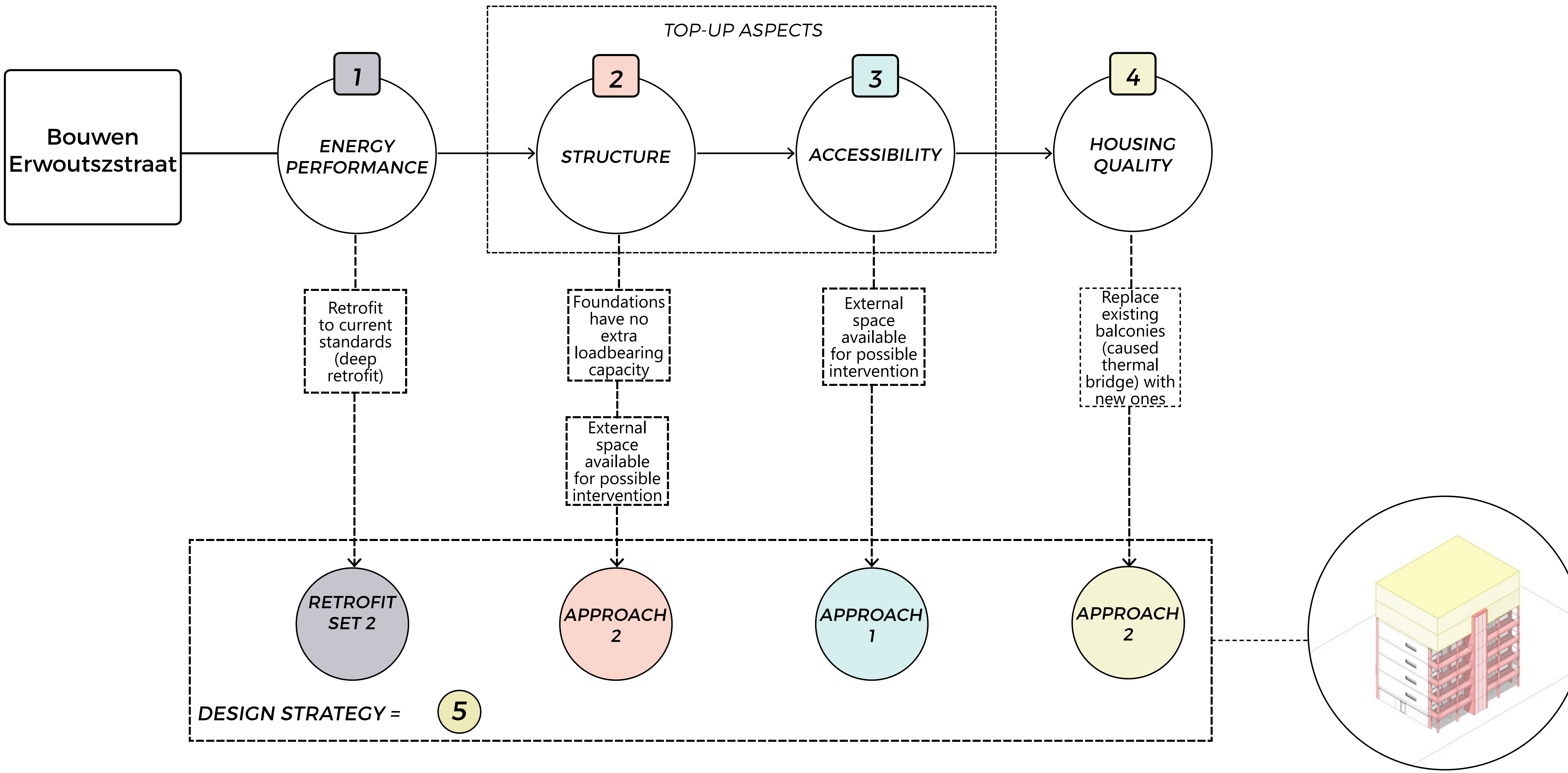
APPROACH COMBINATIONS

TOP-UP ASPECTS	*STRUCTURE*	1.A												1.B												1.C											
	ACCESIBILITY	2.A			2.B			2.C			2.D			2.A			2.B			2.C			2.D			2.A			2.B			2.C			2.D		
HOUSING QUALITY		3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C	3.A	3.B	3.C
DESIGN STRATEGY		1			2			3			4			5			6			7			8			1			2			3			4		

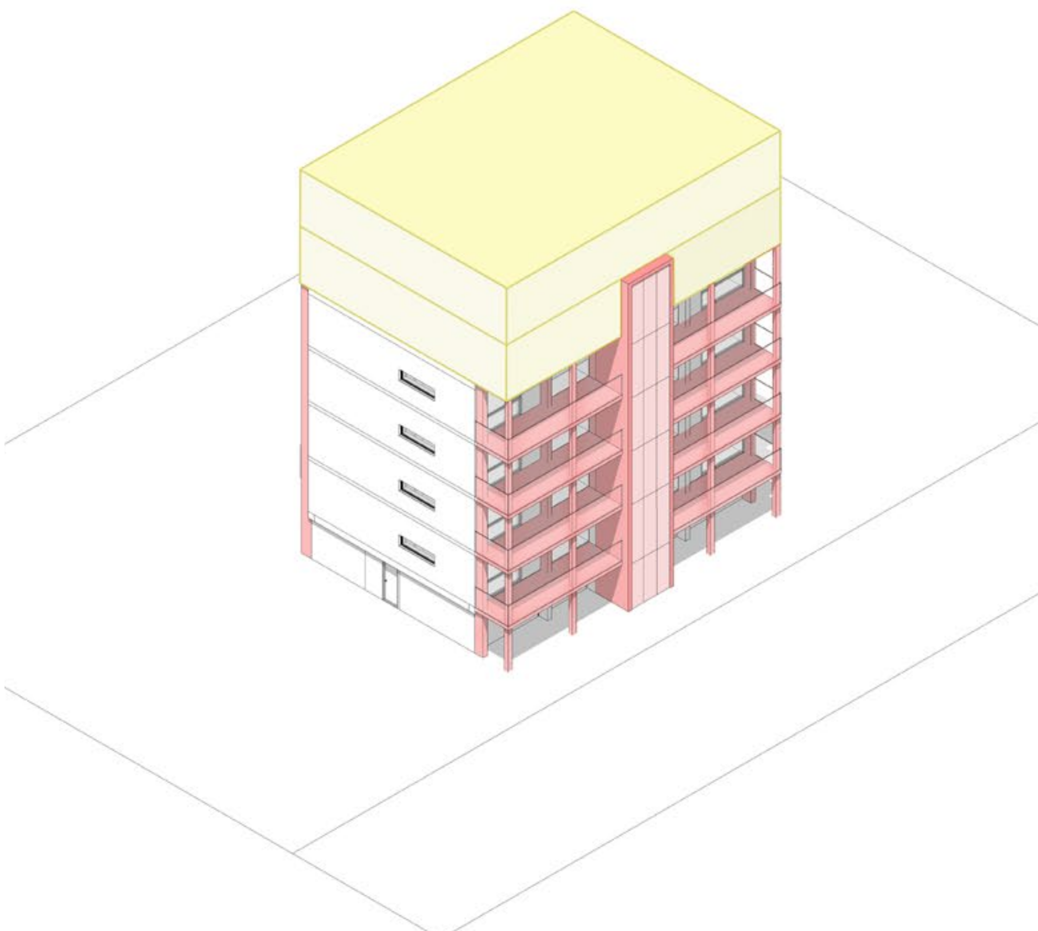
DESIGN STRATEGIES



CASE-STUDY STRATEGY



FINAL DESIGN STRATEGY

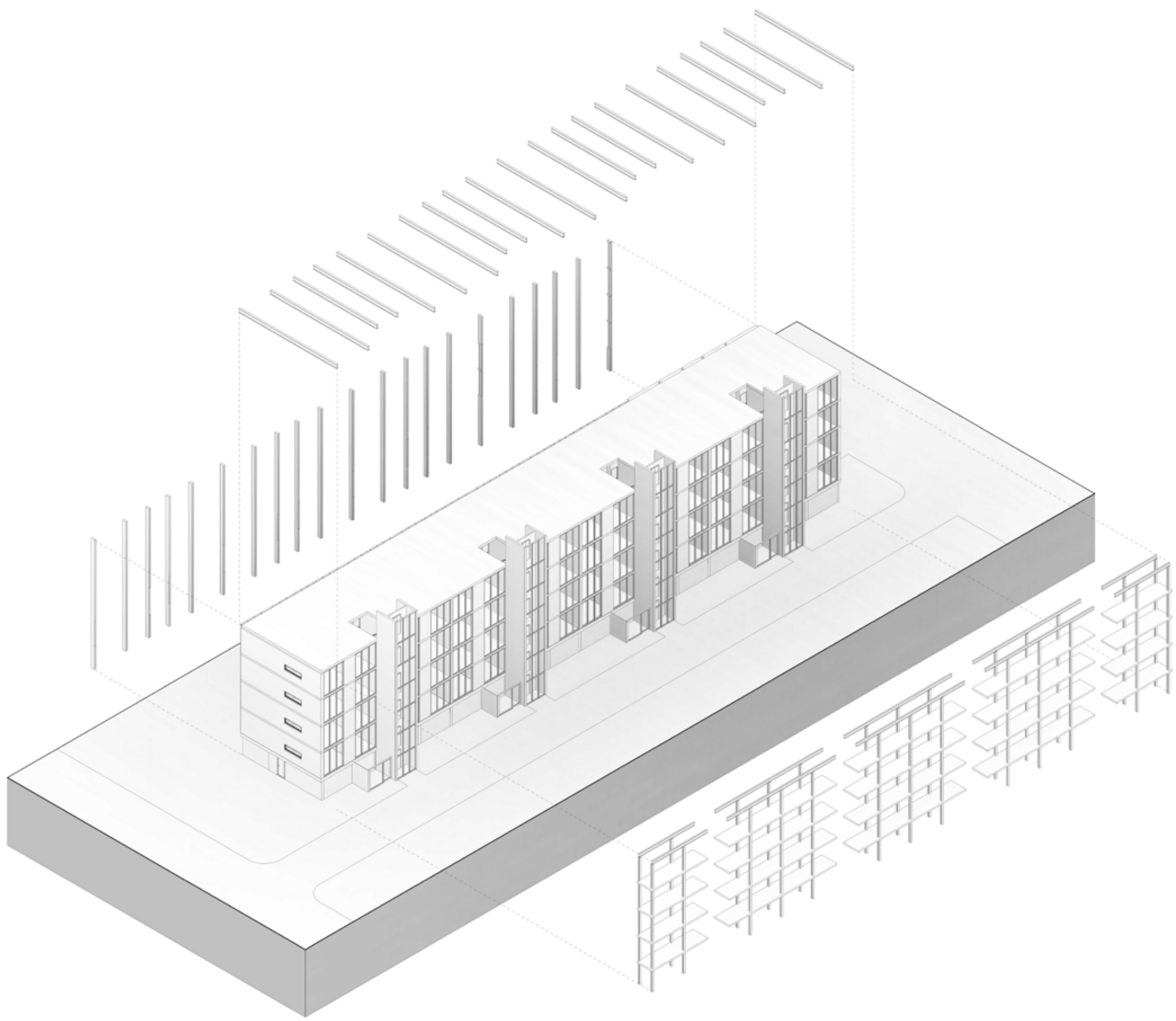


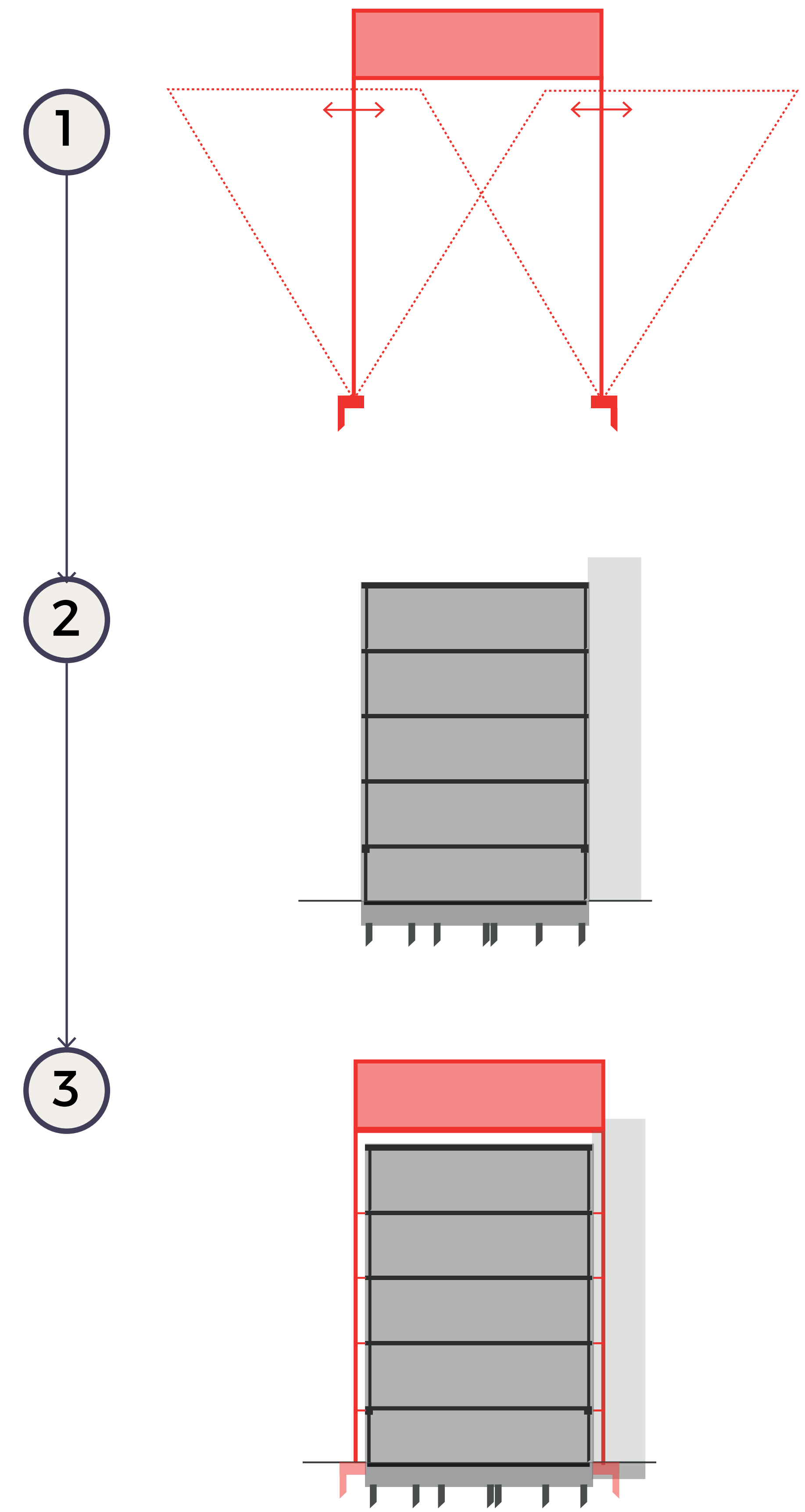
EPC: A++ (0.4)		
BUILDING ENVELOPE	*TARGET (W/ m^2K)*	*MEASURE*
1. External Wall	0.22	Removal of outer leaf and application of EIFS
	022	Removal of outer leaf and application of EIFS
	0.22	Application of EIFS
2. Window	1.65	Replace with double glazing
	0.80	Replace with triple glazing
3. Balcony	0.23	Enclose balcony with panel and glazing construction
4. Roof	0.17	Infill insulation between beams (mineral fibre, 5.26m^2K/W) Replace underside cement board 50mm (0.55m^2K/W)
5. Ground Floor	0.13	Application of insulation underneath first storey floor.
BUILDING SERVICES		
Space Heating		Air heat pump/HR boiler
Domestic Hot Water		HR boiler
Ventilation		Mechanical ventilation
ENERGY REDUCTION		*81%*
PRE		*213.5 kWH/m^2*
POST		*40.9kWH/m^2*

Final Design:

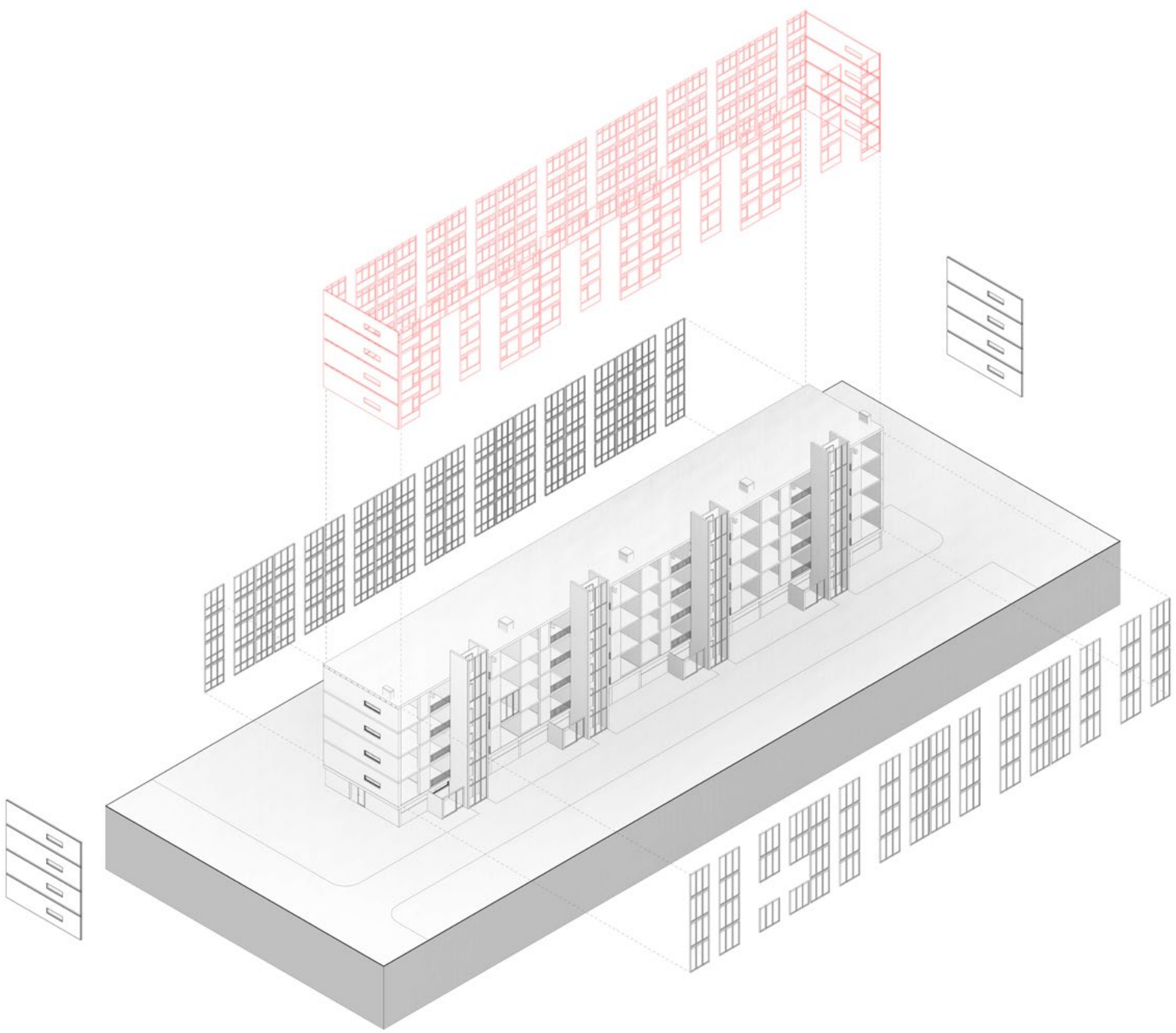
- Can the external structure provide sufficient support for more than one storey?
- Can the Retrofit measures be improved to improve energy performance?
- What type of dwelling should the top-up provide?
- How can the top-up be constructed?

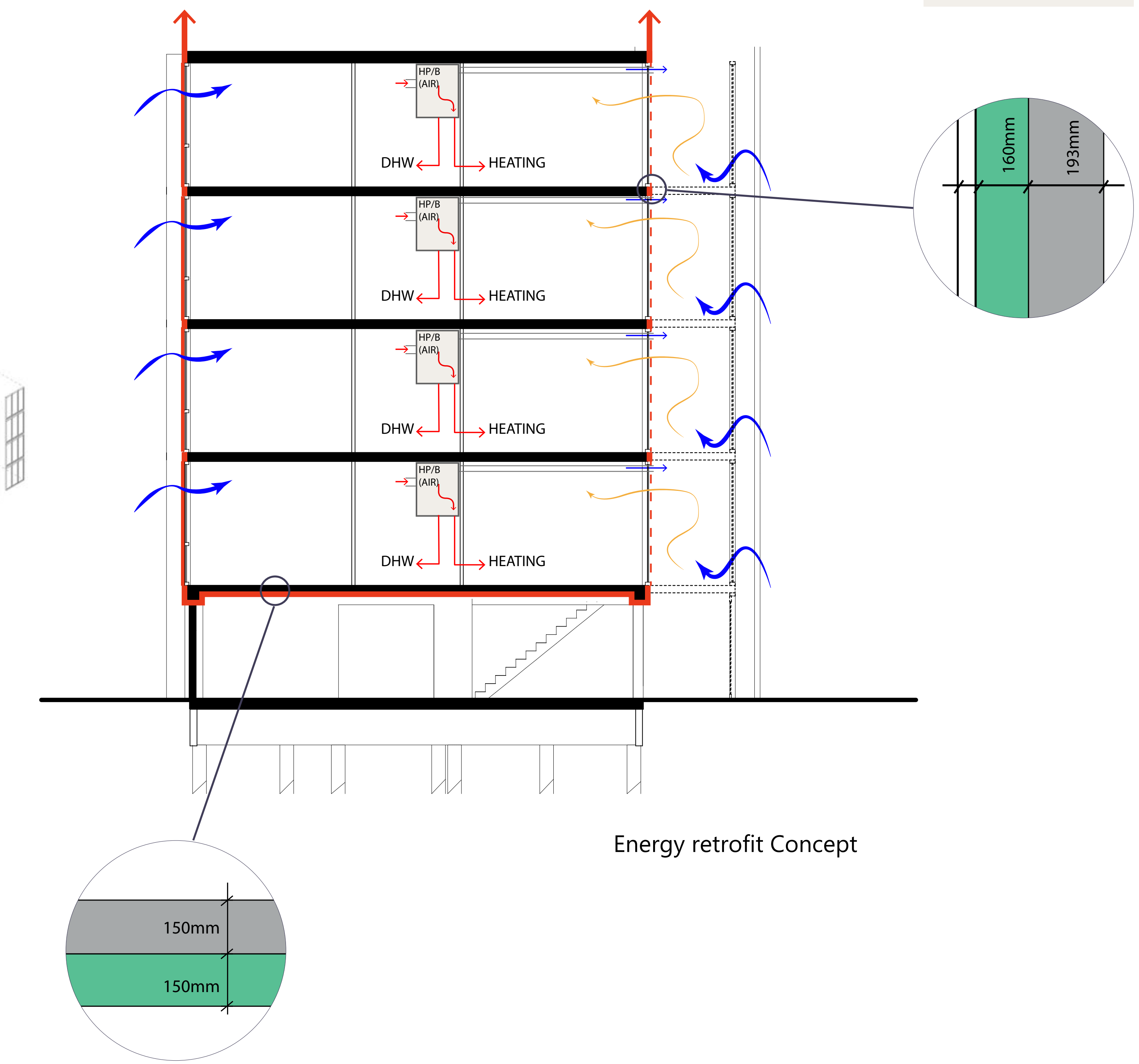
EXTERNAL STRUCTURE



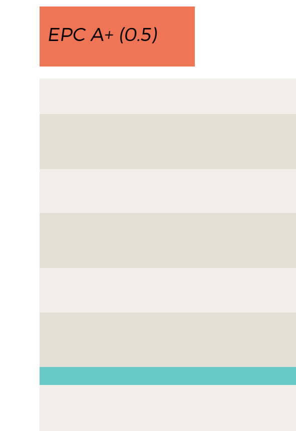


RETROFIT OPPORTUNITY



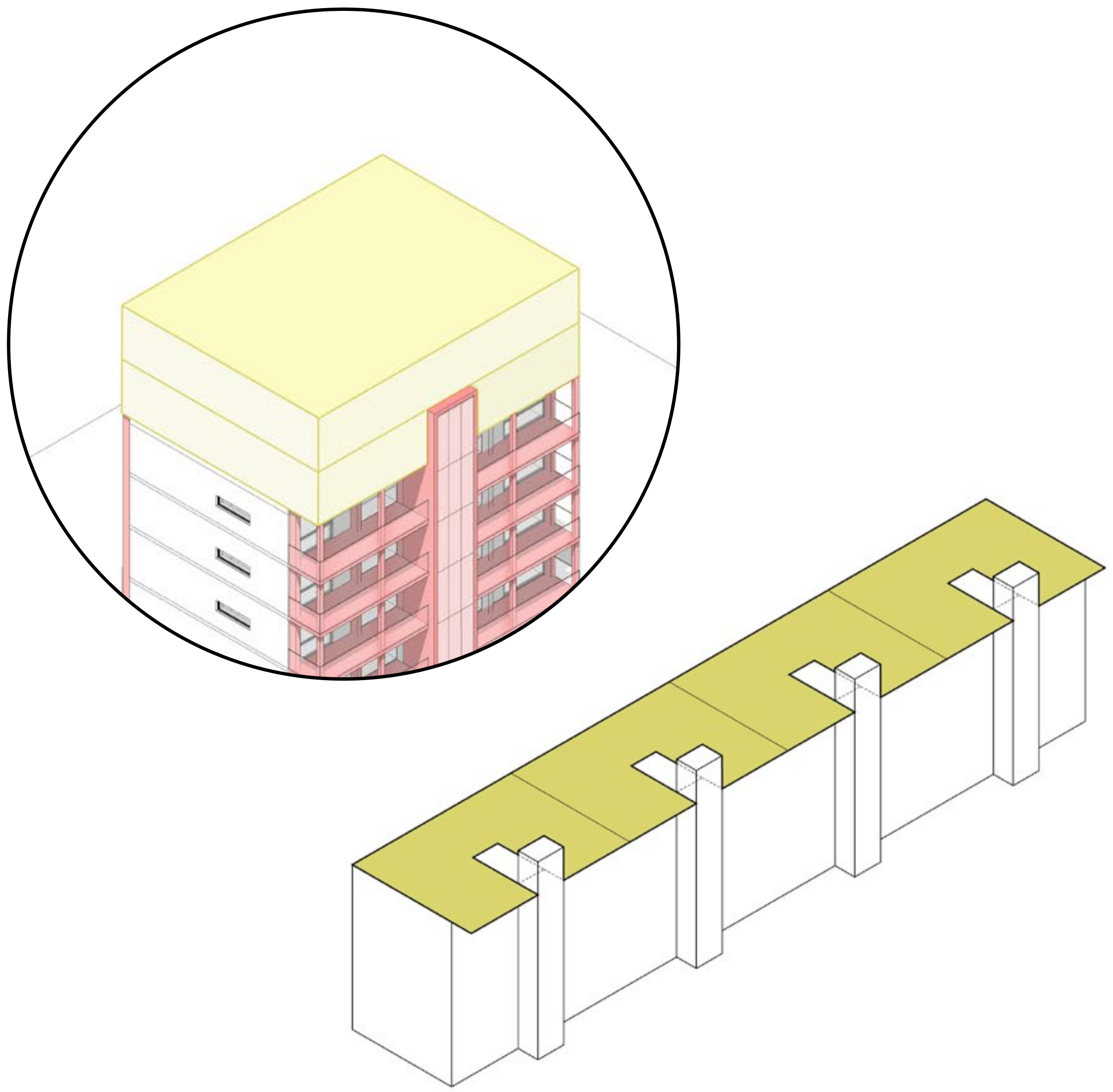


Energy retrofit Concept



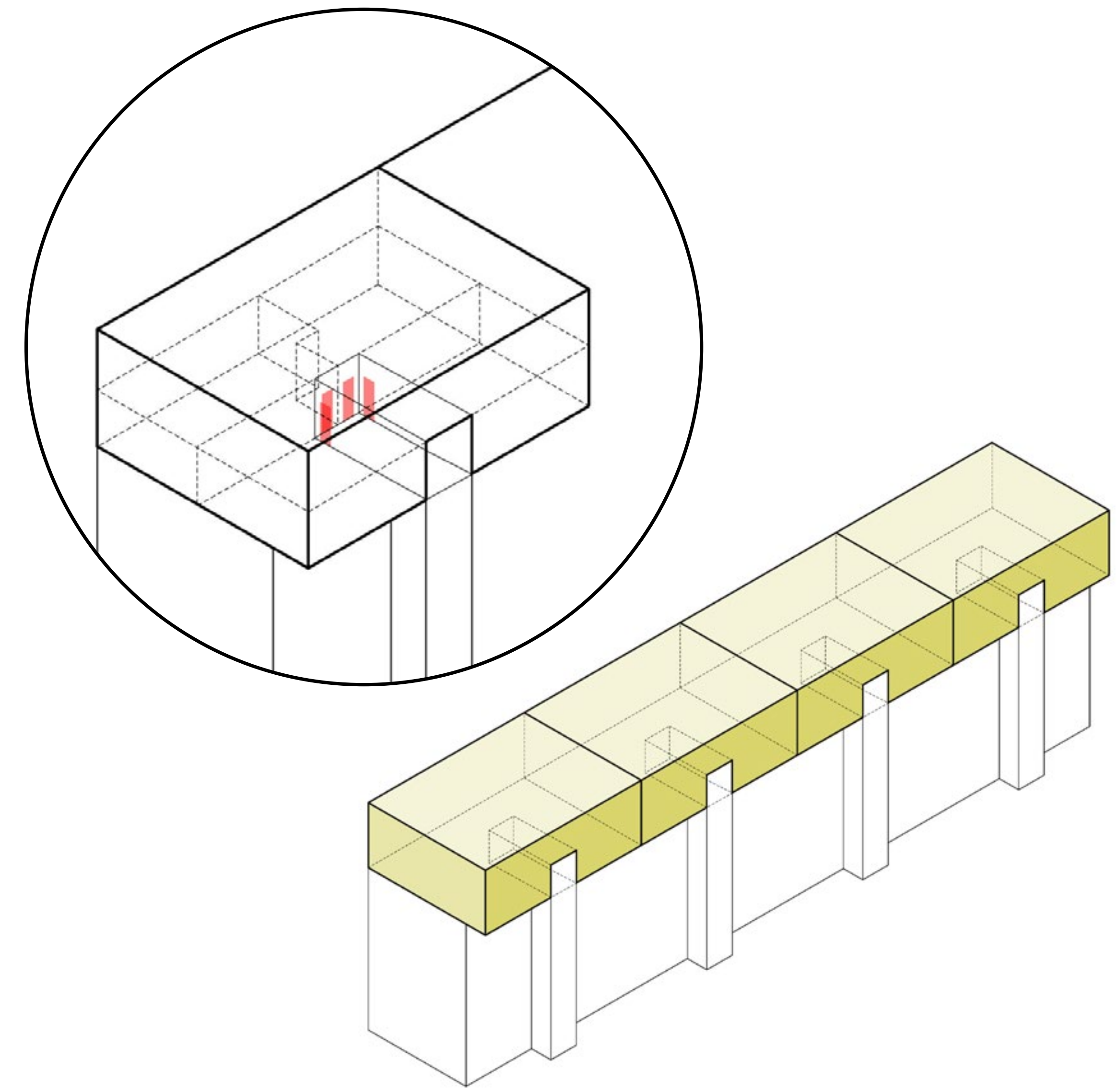
TOP-UP DWELLING

1.



Top-up area: 644m2 - 750m2

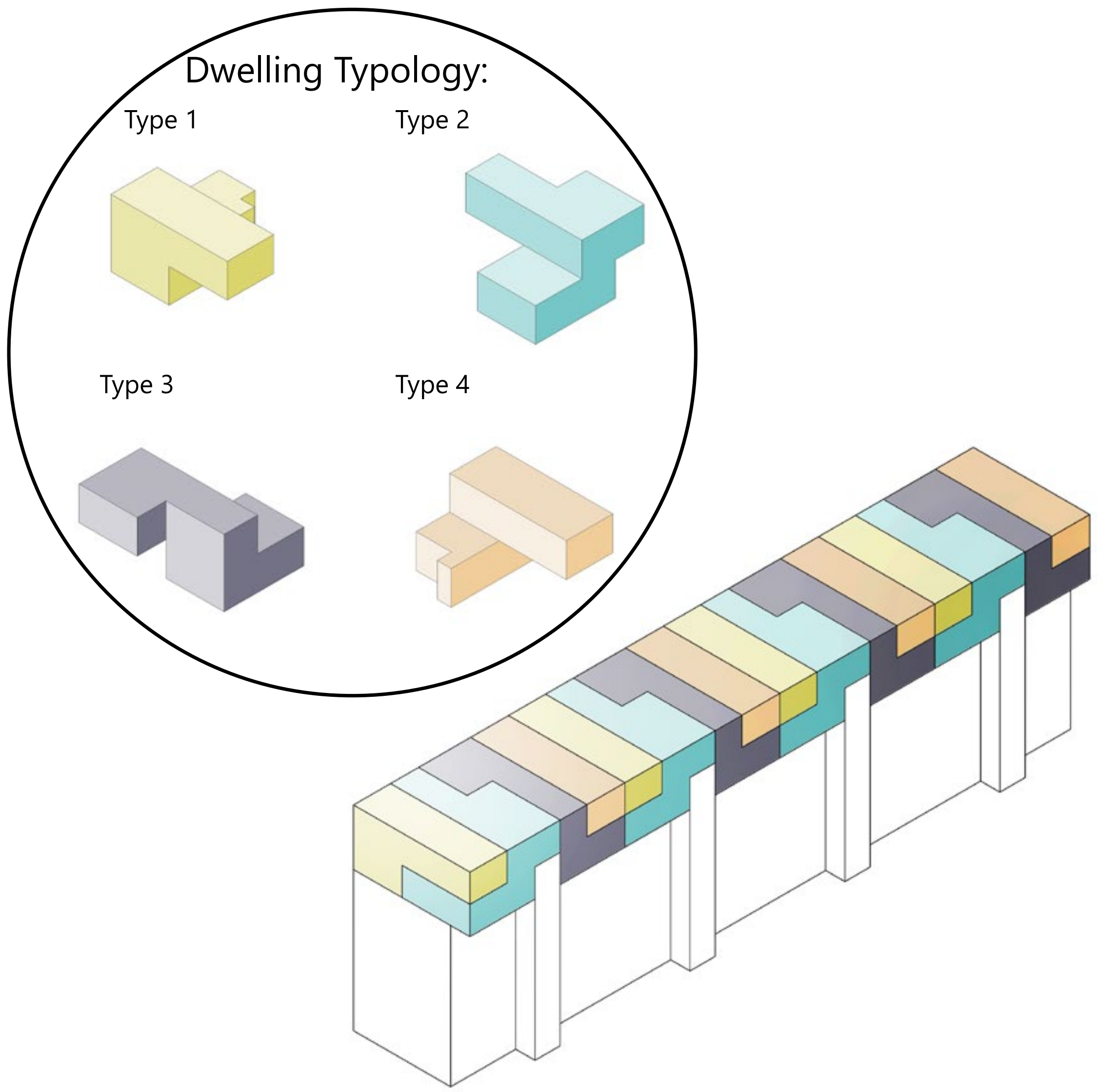
2.



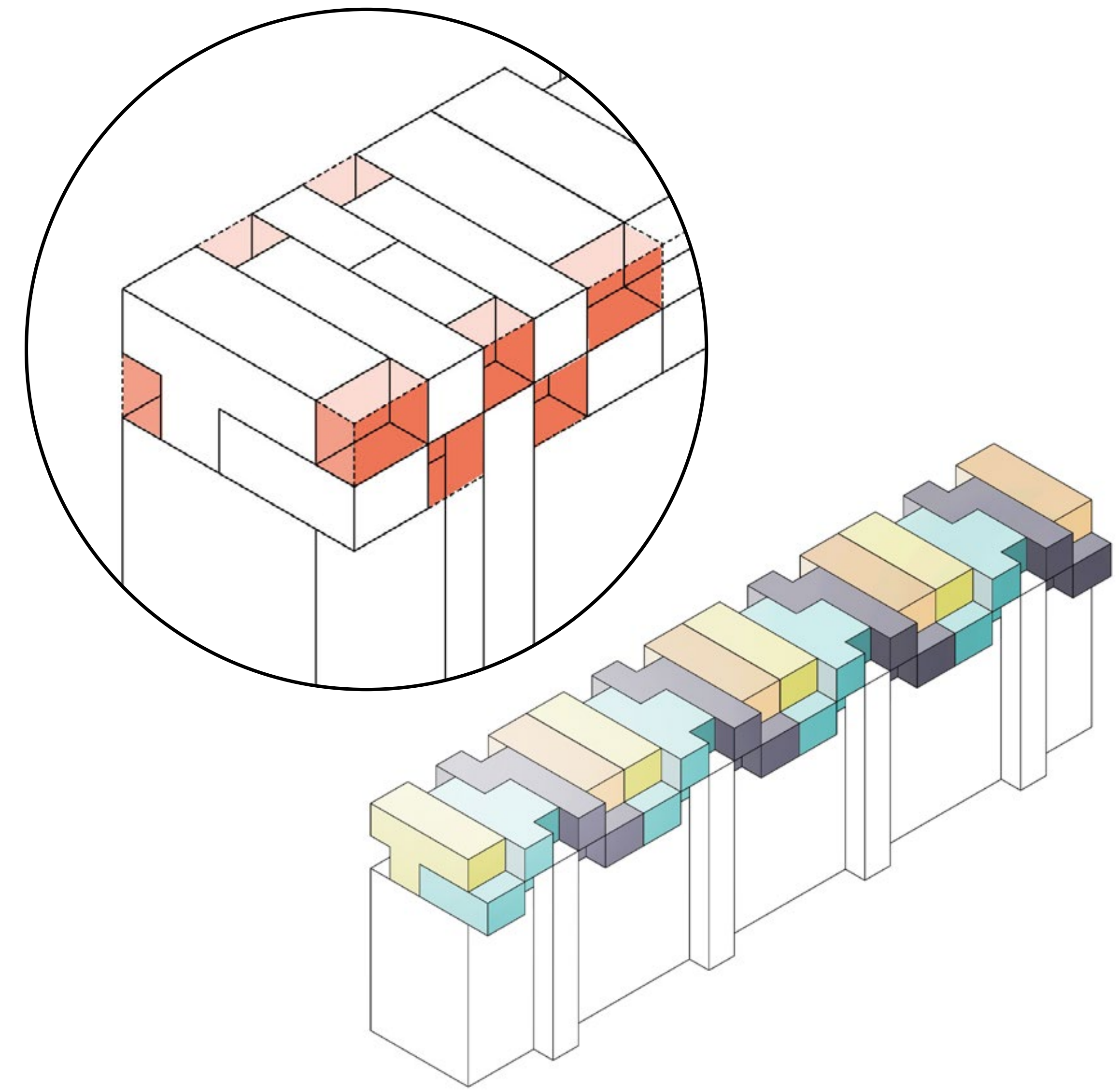
2 Storey Possible with external structure

TOP-UP DWELLING

3.

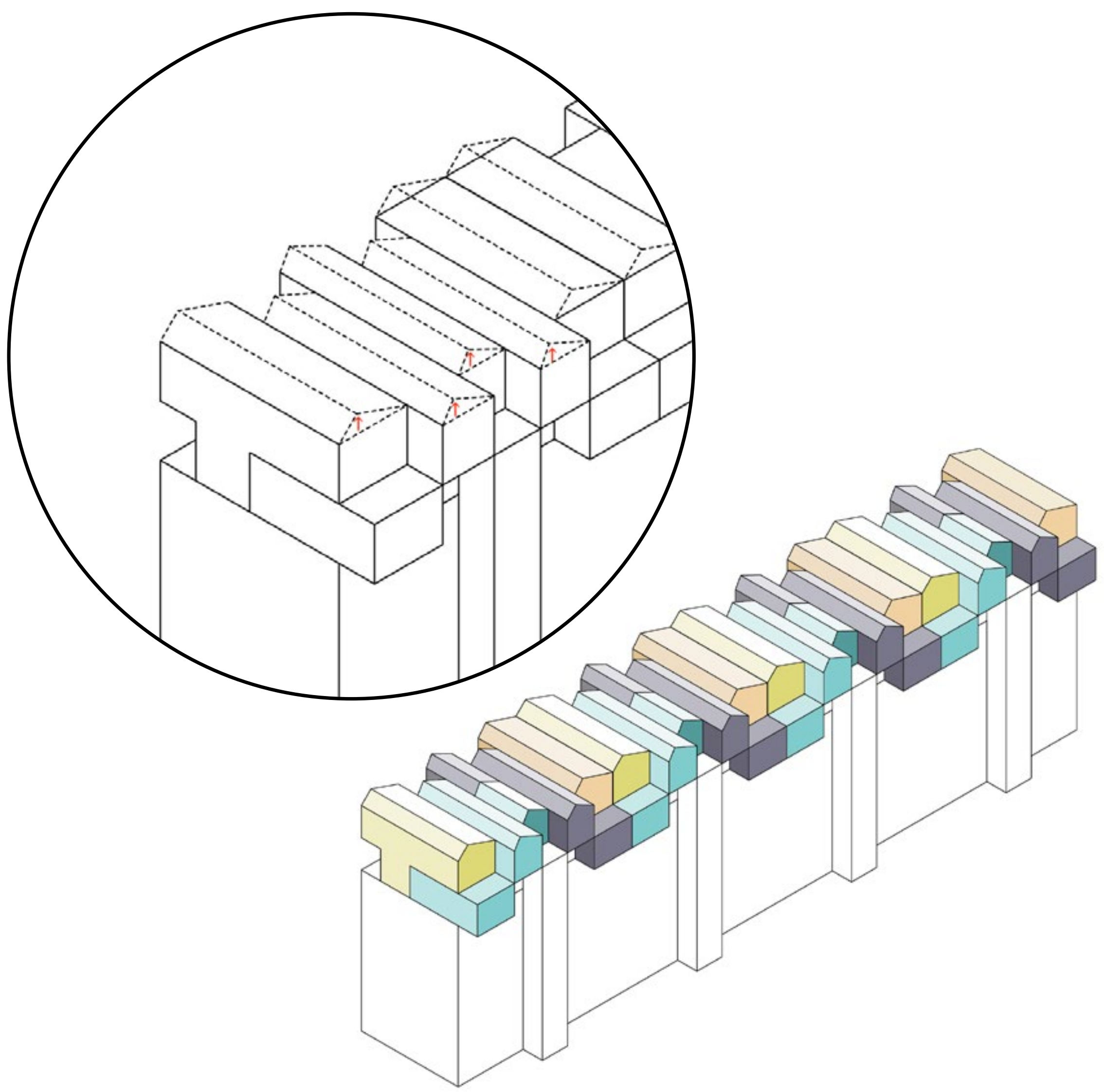


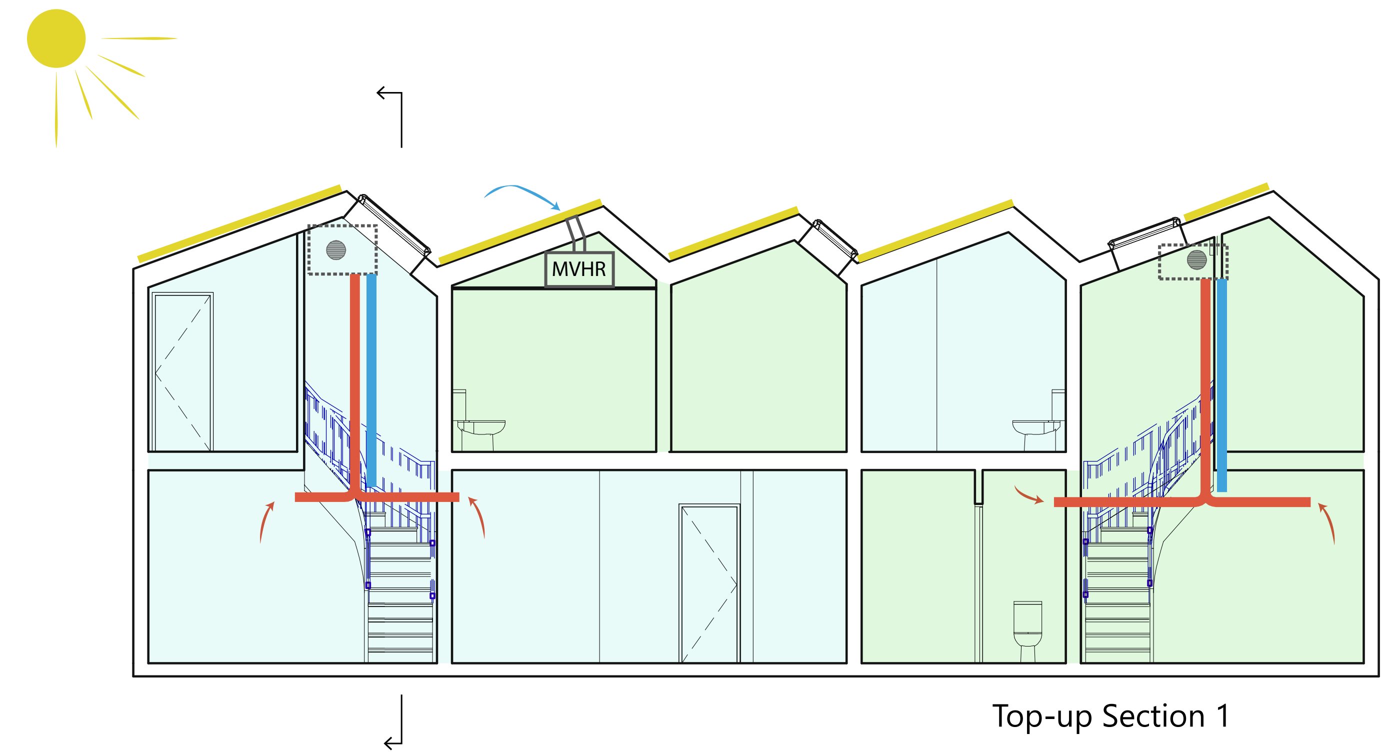
4.



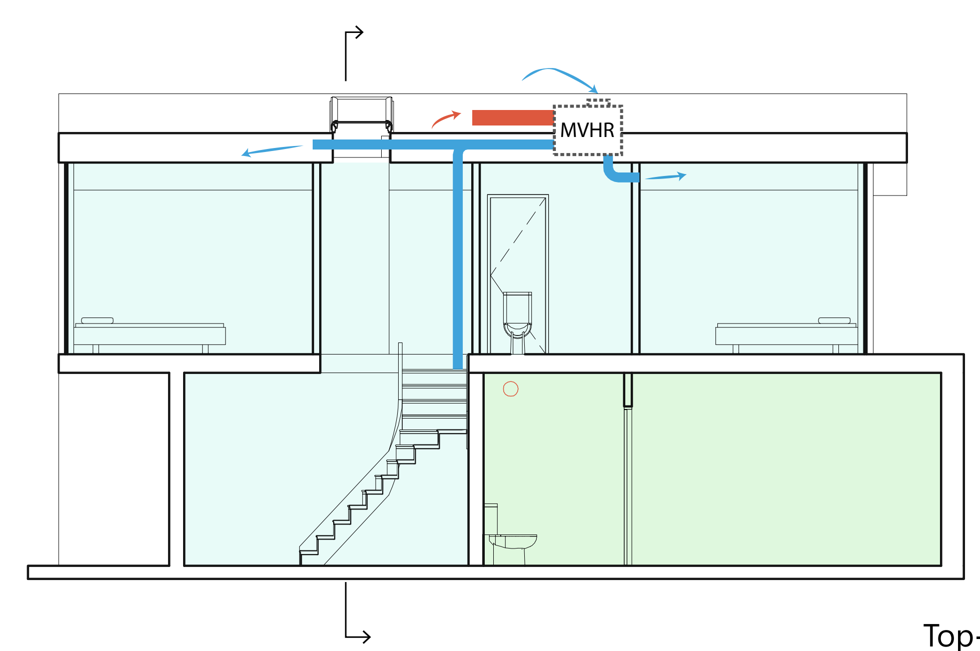
TOP-UP DWELLING

5.



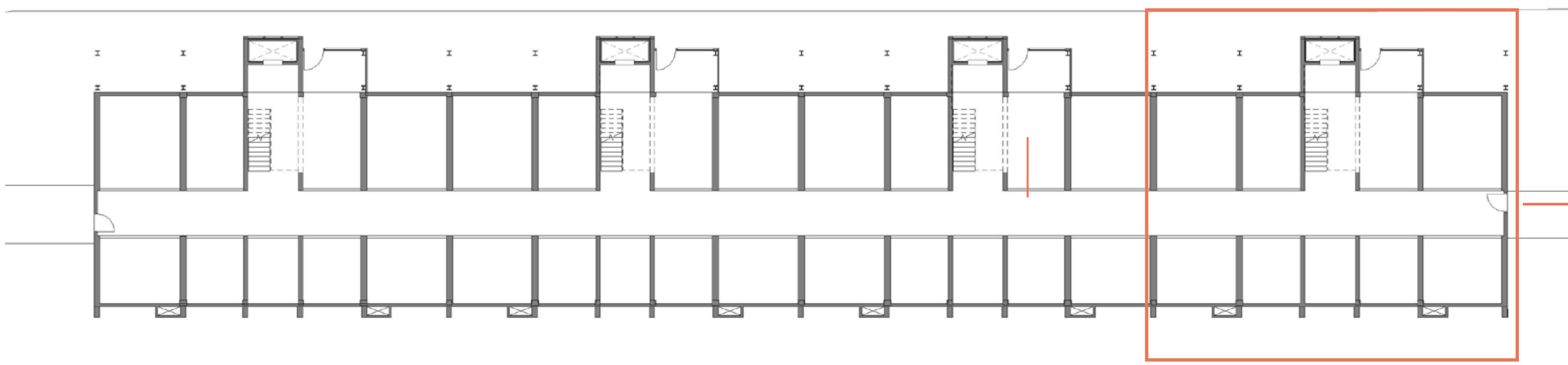


Top-up Section 1

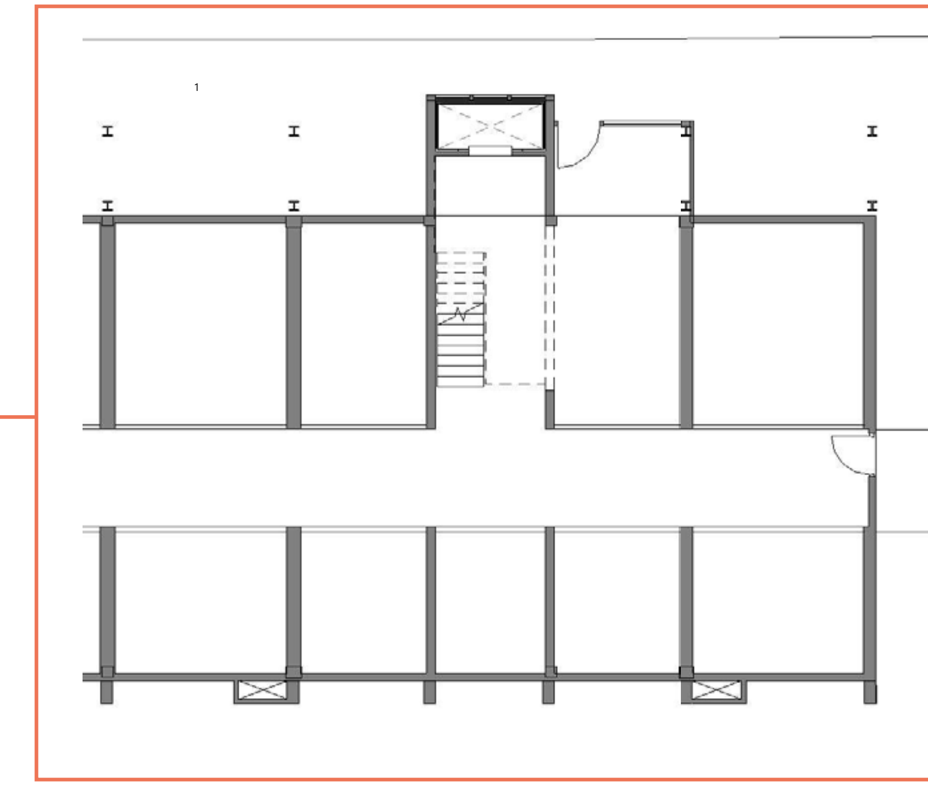


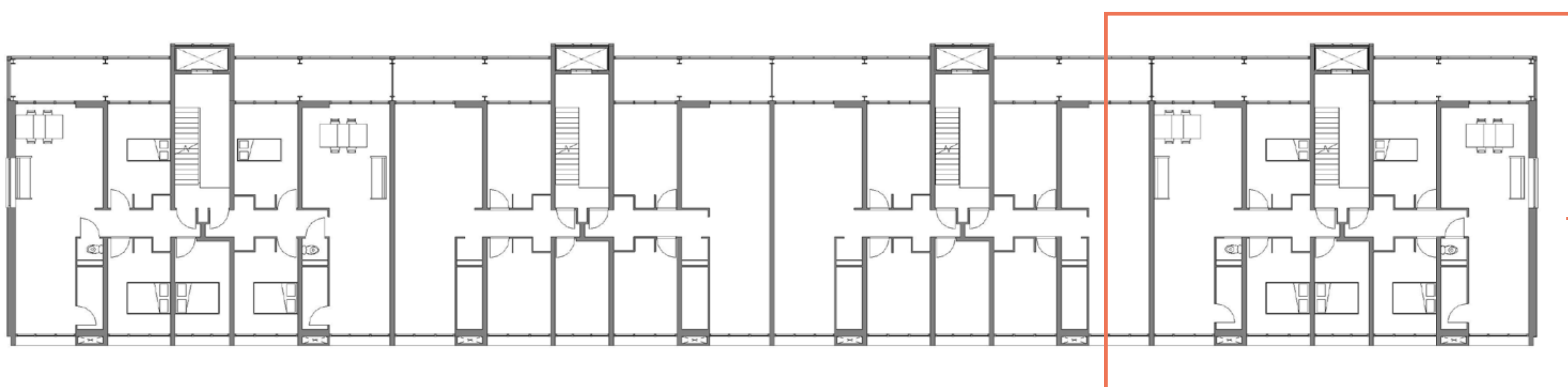
Top-up Section 2

RETROFIT PLANS

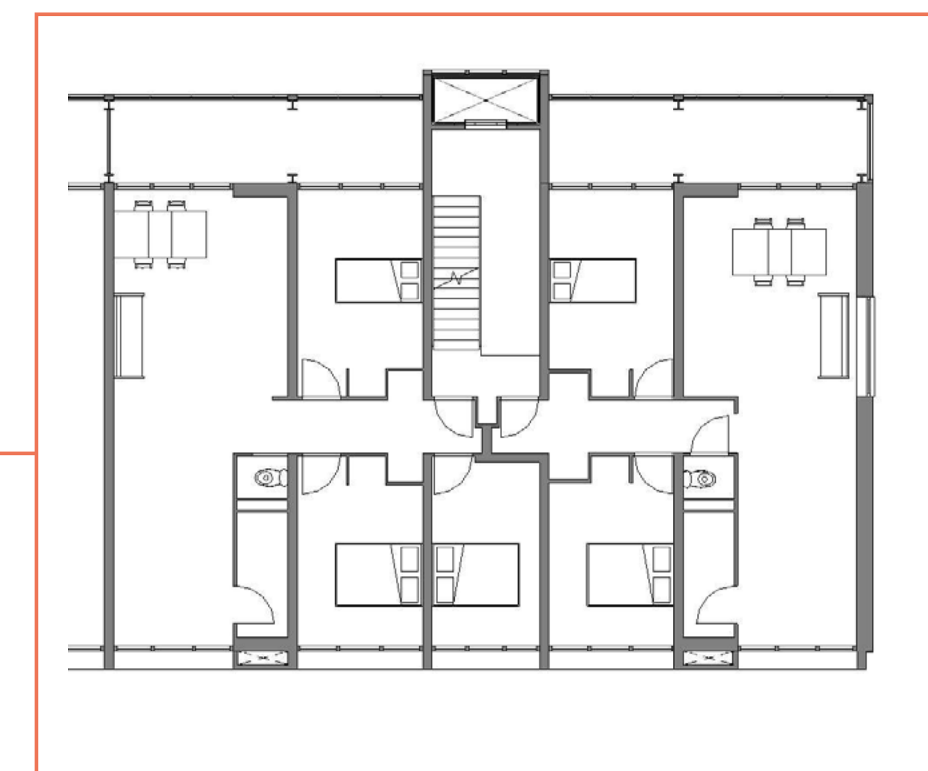


Ground floor

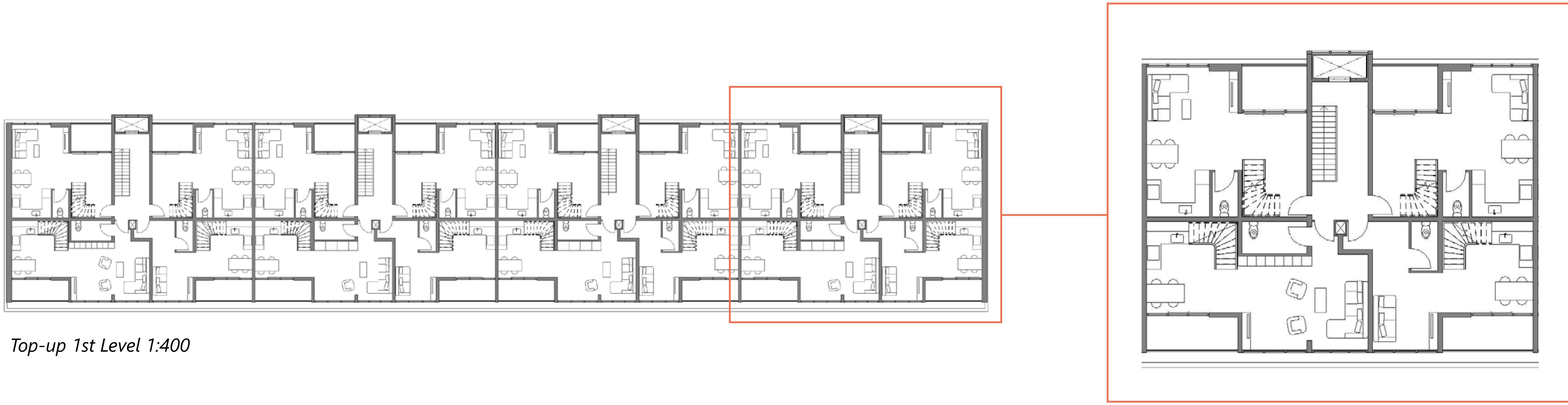




1-4th floor



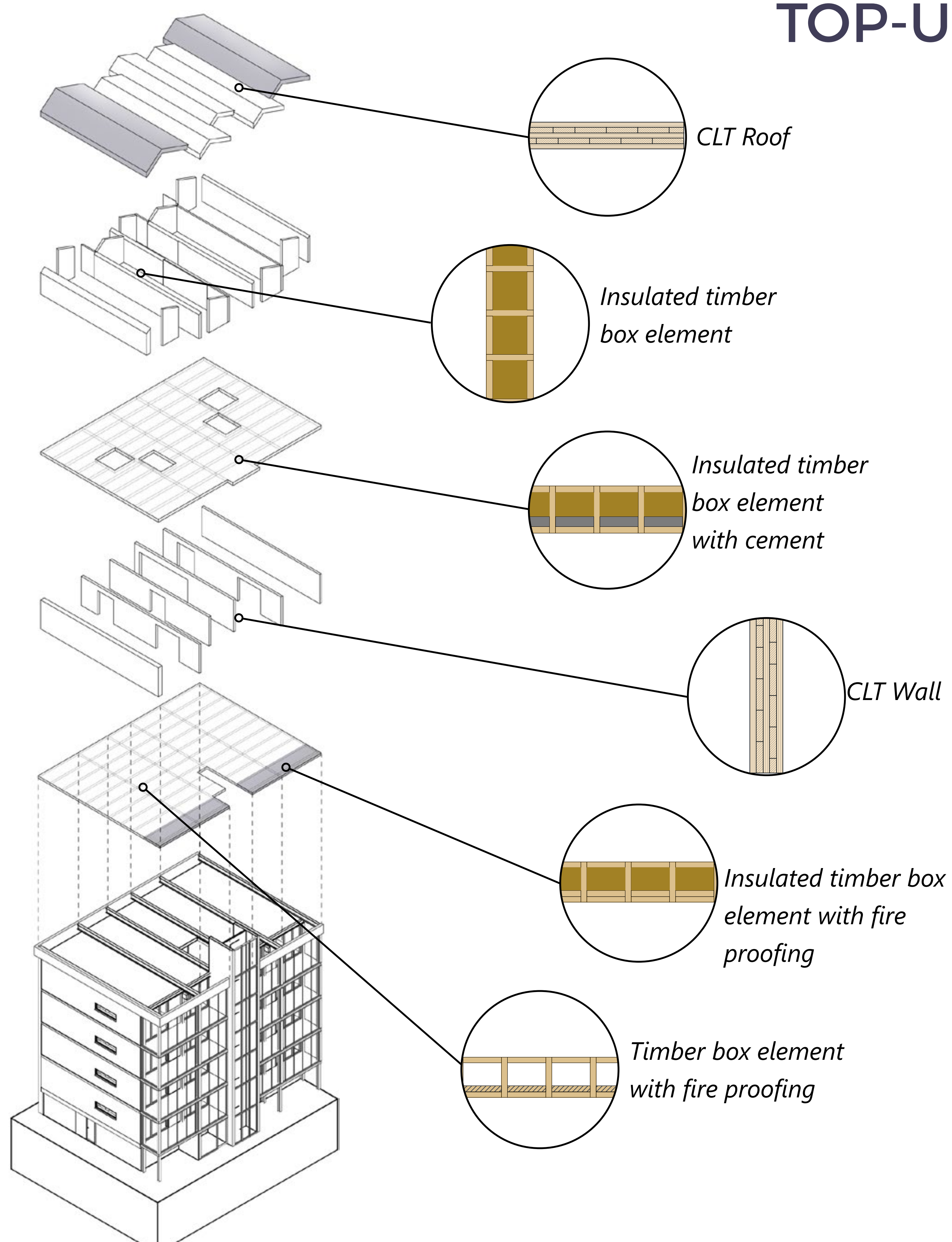
TOP-UP PLAN

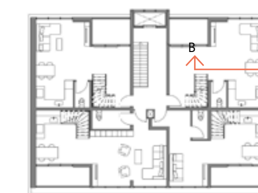


Top-up 1st Level 1:400

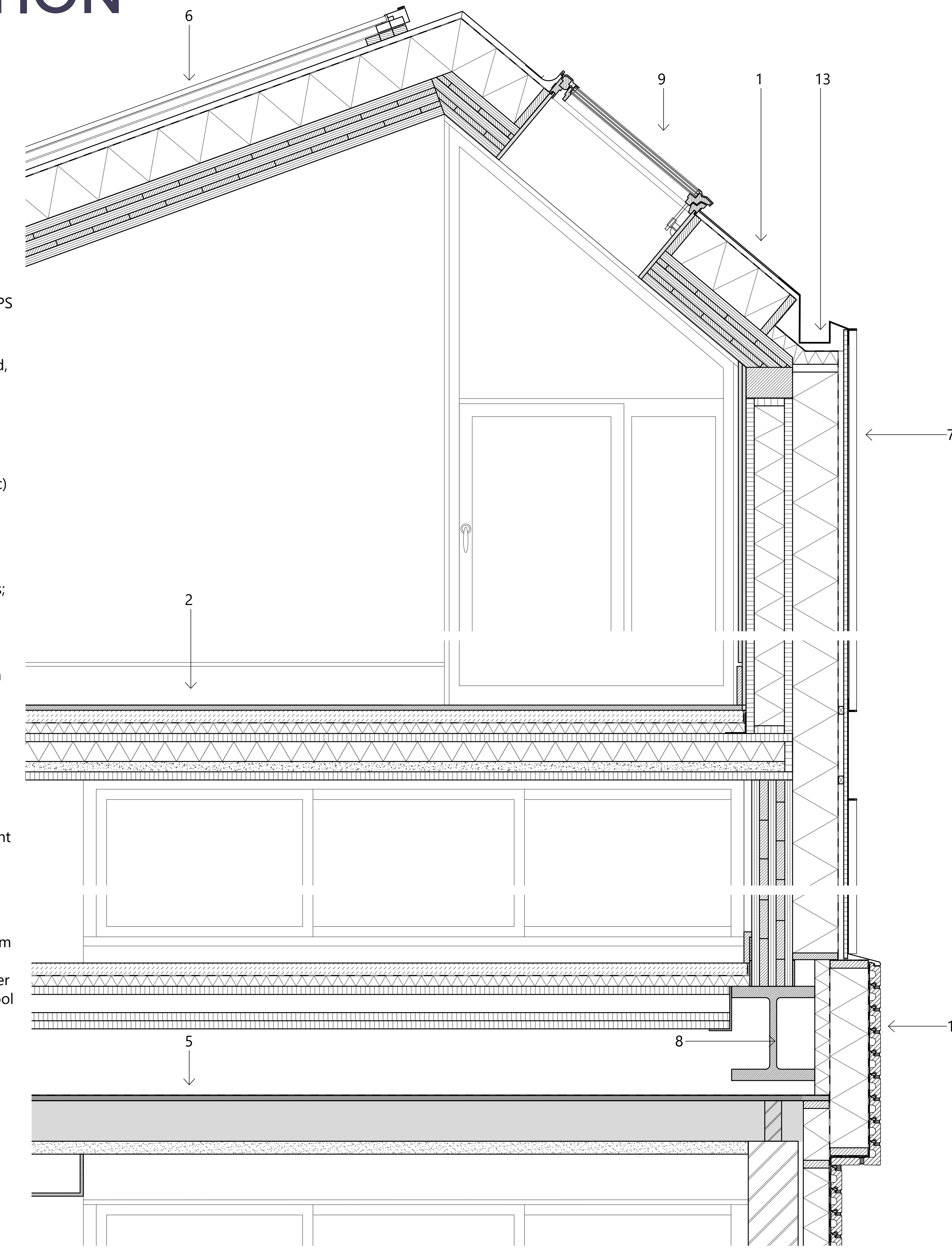
Top-up 2nd Level

TOP-UP CONSTRUCTION





1. Roof construction: zinc cladding; 20mm timber battens; damp proof membrane (DPM); 180mm EPS insulation; CLT roof panel.
2. Top-up Floor construction: 20mm parquet, 50mm screed, 40mm acoustic insulation; 180mm timber box element; 30mm acoustic insulation; 2x12.5mm plasterboard
3. Lignatur box element with 50kg/m2 of cement (acoustic)
4. RE60 fire safe timber box element.
5. Existing roof construction: bitumen layer, 20mm wood board; 150mm timber beams; 50mm cement-wool board
6. Solar panel
7. External wall construction: profiled zinc cladding; 15mm OSB board; 20mm timber battens; DPM; 175mm EPS insulation; 180 timber box element with mineral fibre insulation; 2x15mm gypsum board
8. Steel beam 320x360mm
9. Triple glazed operable skylight in aluminium frame
10. Top-up parapet: 45mm slip-brick cladding system; DPM; 150 EPS insulation
11. Internal wall: 2x15mm gypsum board; 30 acoustic insulation (mineral wool); 180mm timber box element with mineral wool
12. Exposed 158mm CLT panel.
13. Rain gutter



RETROFIT DESIGN

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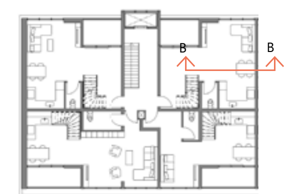
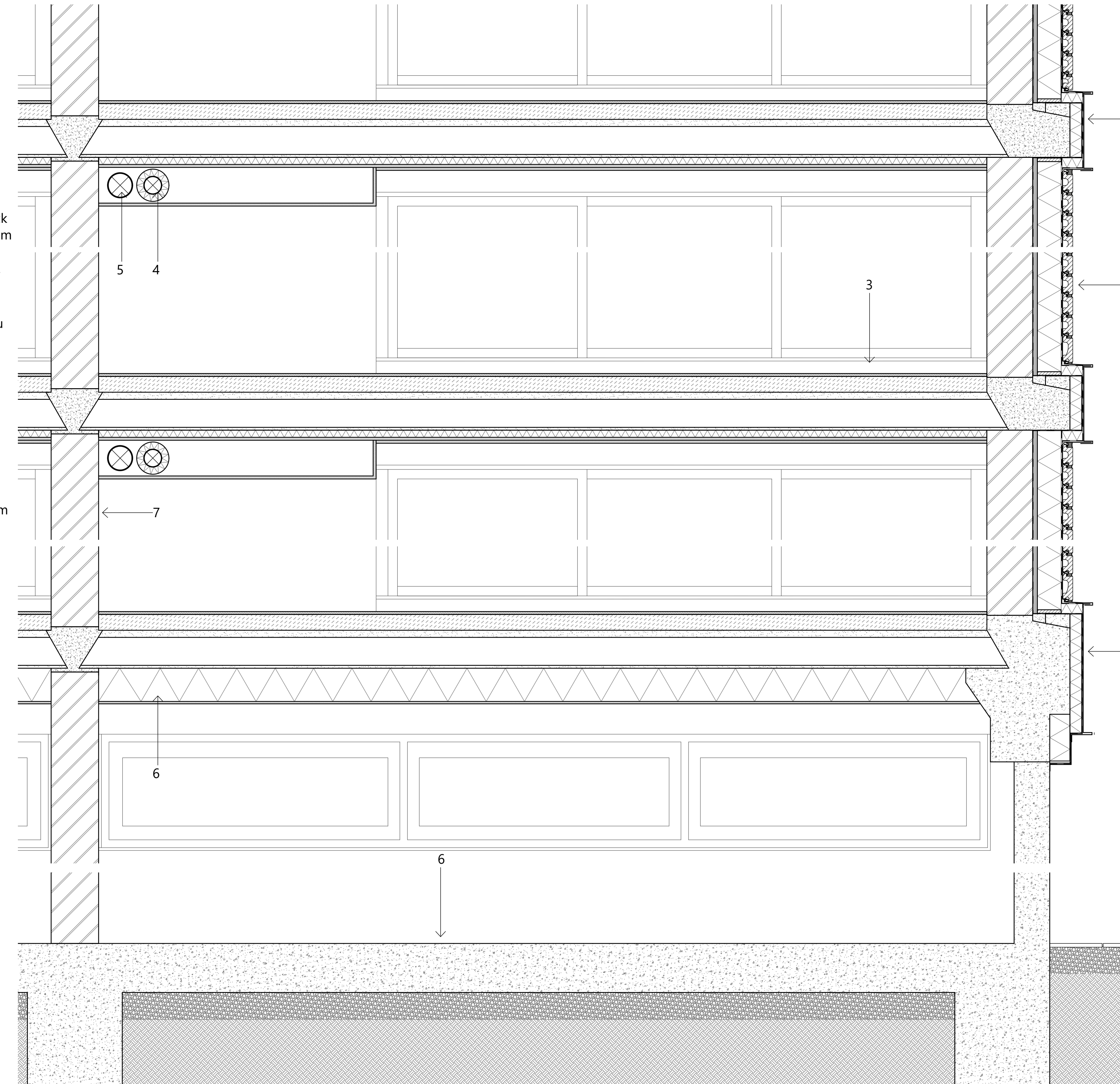
DETAIL B



1. External Wall: 45mm slip-brick cladding system; DPM; 100mm EPS insulation; 20mm OSB board; Existing concrete wall.
2. External wall-floor junction; zinc cladding; DPM; 50mm EPS insulation; existing in situ concrete.
3. Floor construction: 12mm new flooring; 65mm new screed; 160mm existing floor construction; 40mm acoustic insulation; 2x12mm plasterboard.
4. Incoming air duct
5. Exhaust air duct
6. 12mm gypsum board; 150mm fibre wool insulation
7. 200mm existing internal concrete wall
8. 200mm in situ concrete floor slab



BEFORE

AFTER

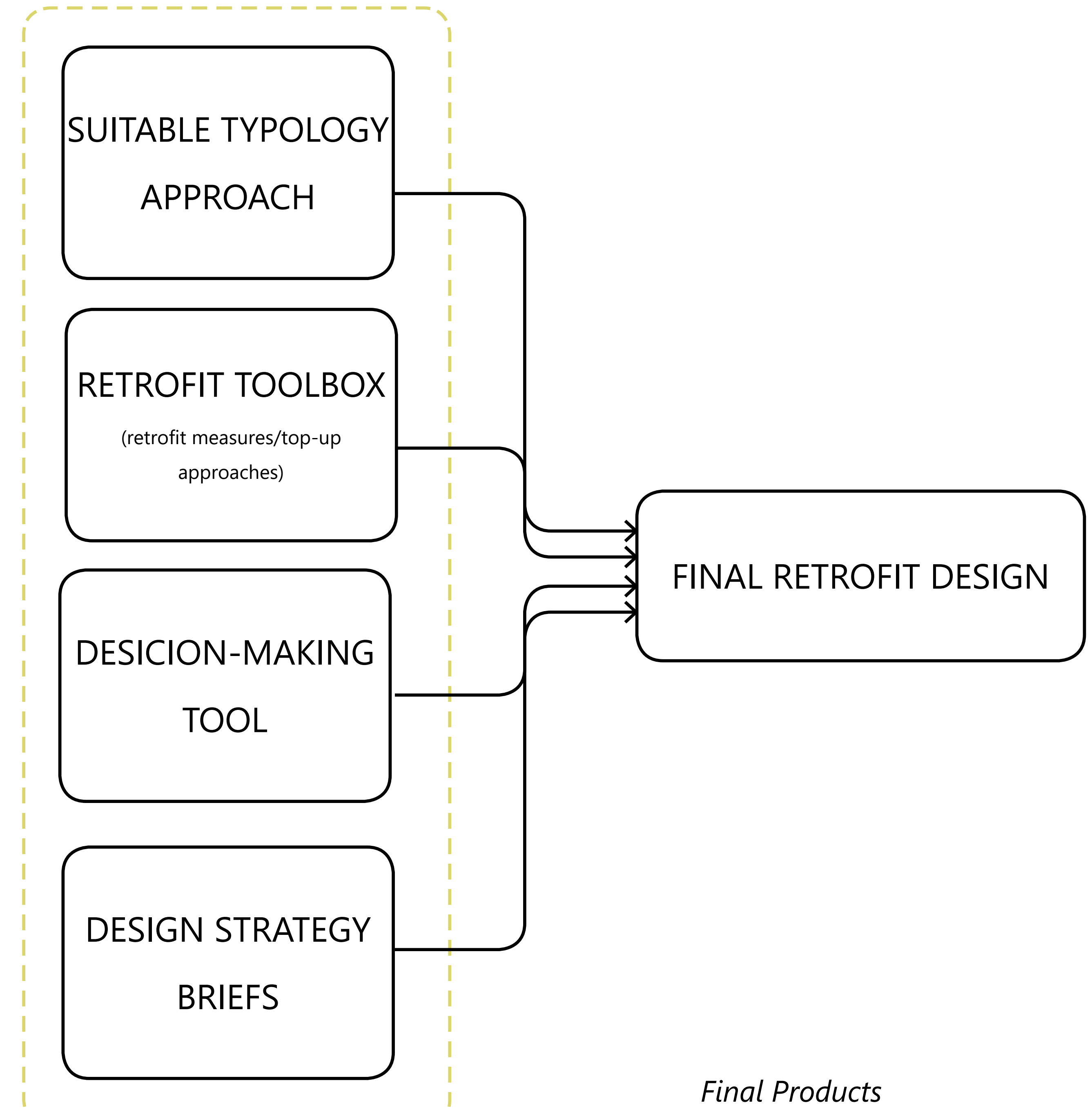
BEFORE

CONCLUSION

RQ: How can the design of a retrofit measure provide integrated solutions to energy reduction and densification for a suitable residential building typology in Amsterdam Nieuw-West?

By isolating the **design aspects** of the retrofit measure, identified through case-study research, to then systematically combine them using a **set of decisions** based on building constraints, site condition and stakeholder interests of the suitable residential building typology to generate a **design strategy(s)** which integrates solutions for energy-reduction and densification on a strategic level and provides the basis for the technical design phase.

- Suitable typology: 1950's Portiekflat
- Energy performance measure of building integrates to a limited amount with Top-up measures.
- Top-up design aspects have overaching influence of design strategy independant of energy performance measure and target.



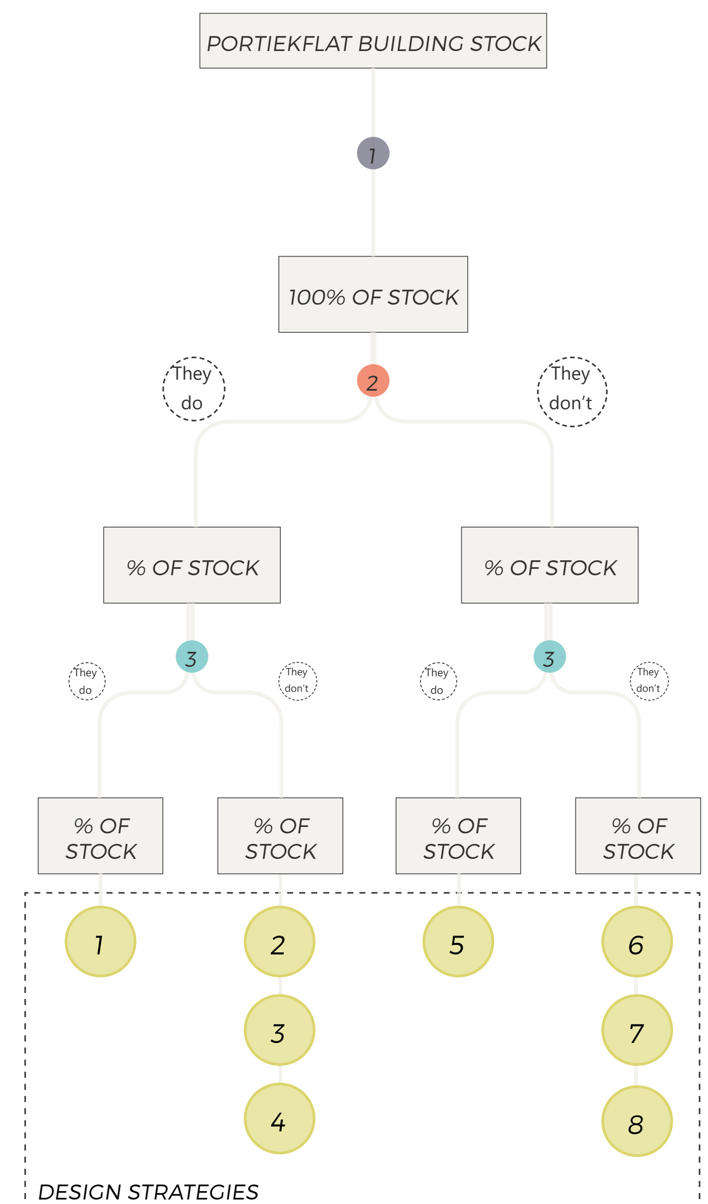
Final Products

FURTHER RESEARCH

1. Apply Desicion-Making Tool and the Design Strategies to 1950's Portiekflat to provide basis for roadmap.

2. Expand Toolbox and Design Strategies to include other typologies. For example, gable roofed portiekflats or flat-roofed rowhouses

3. Evaluate the financial feasibility of the retrofit measure. Can densification (top-up) provide investment for overal energy retrofit of building?



1. Which Portiekflats will be retrofitted?

2. What buildings have foundations with structural bearing capacity?

3. Which buildings have the spatial requirements for accessibility approach 1?

THANKS!

any questions?