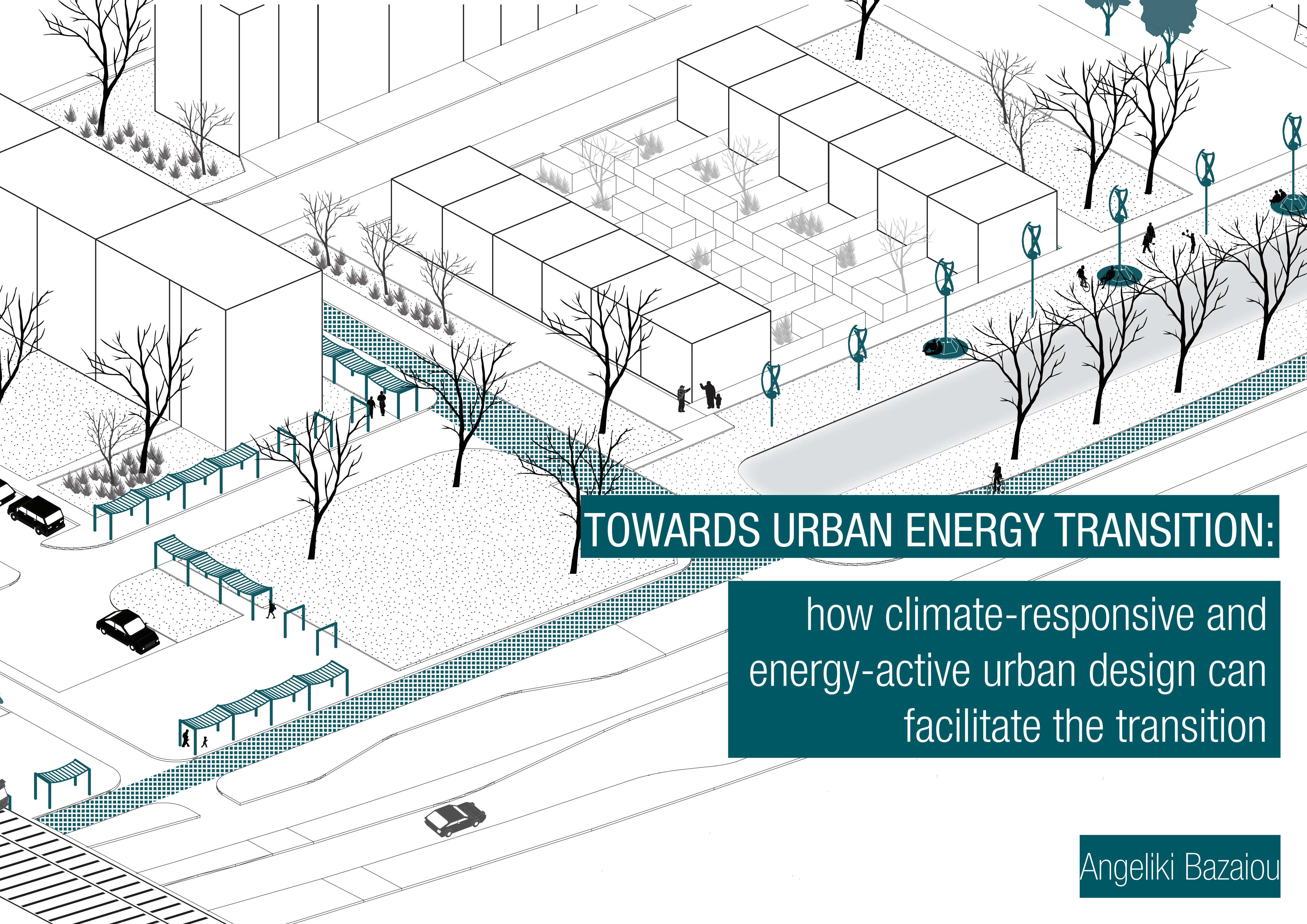


TOWARDS URBAN ENERGY TRANSITION:

how climate-responsive and energy-active urban design can facilitate the transition

Angeliki Bazaiou

STRUCTURE OF THE PRESENTATION

¬ Stating the problem

¬ Energy & climate Matrix

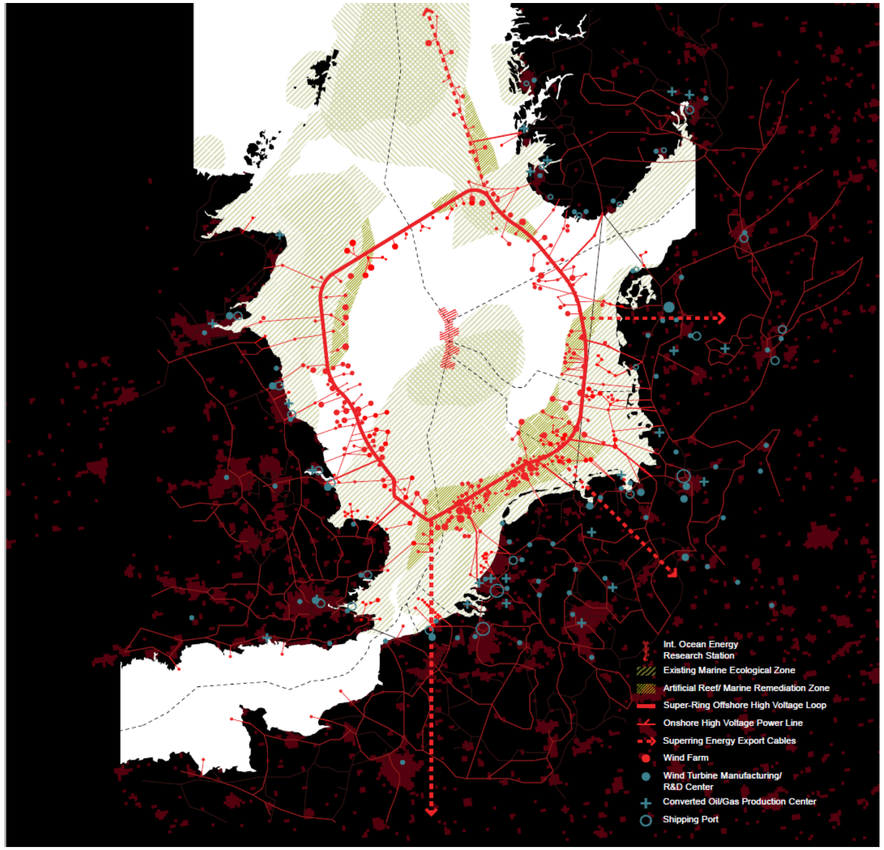
¬ Typology

→ Design Patterns →

¬ Case study

¬ Design method

Saudi Arabia (down) & North Sea's SuperRing proposal by OMA (right)



Beyond large scale energy production; living with(in) the local climate

¬	*Acknowledge it*	⟶	*knowledge*
¬	*Build with(in) it*	⟶	*energy use*
¬	*Harness it*	⟶	*energy production*

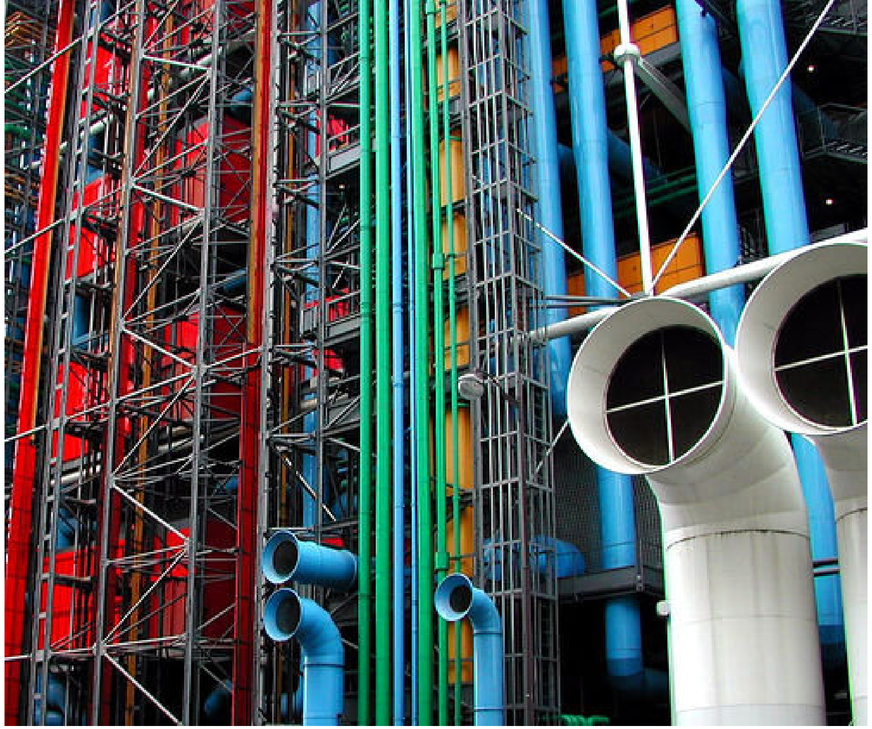
"In this bright future you can't forget your past."

\- Bob Marley

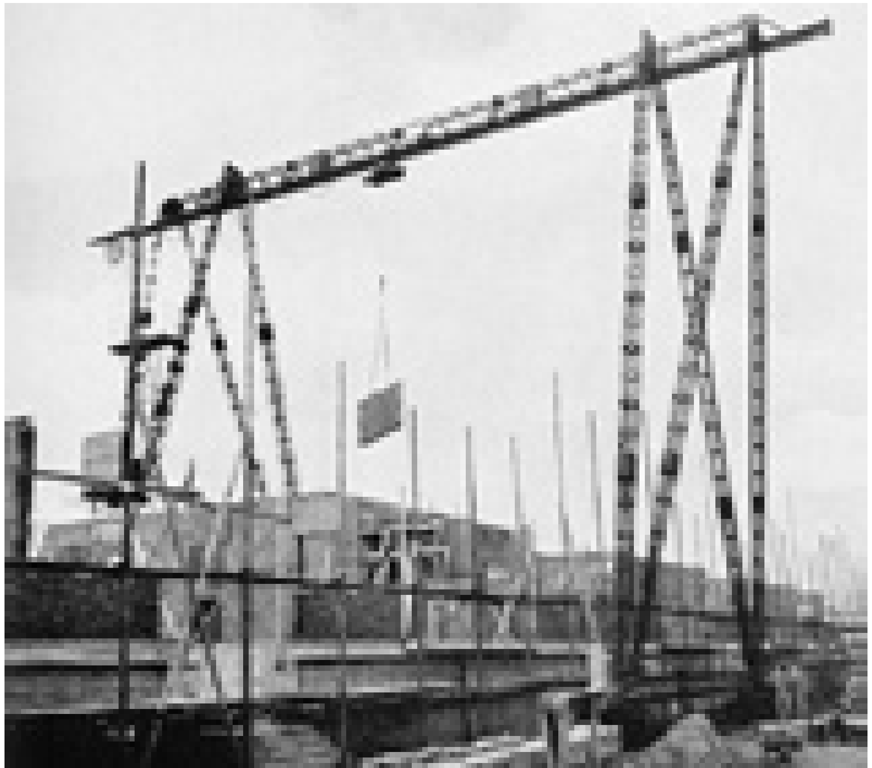
Gas & oil

the abundant and 'invisible' energy

A skin of infrastructure; Centre Pompidou

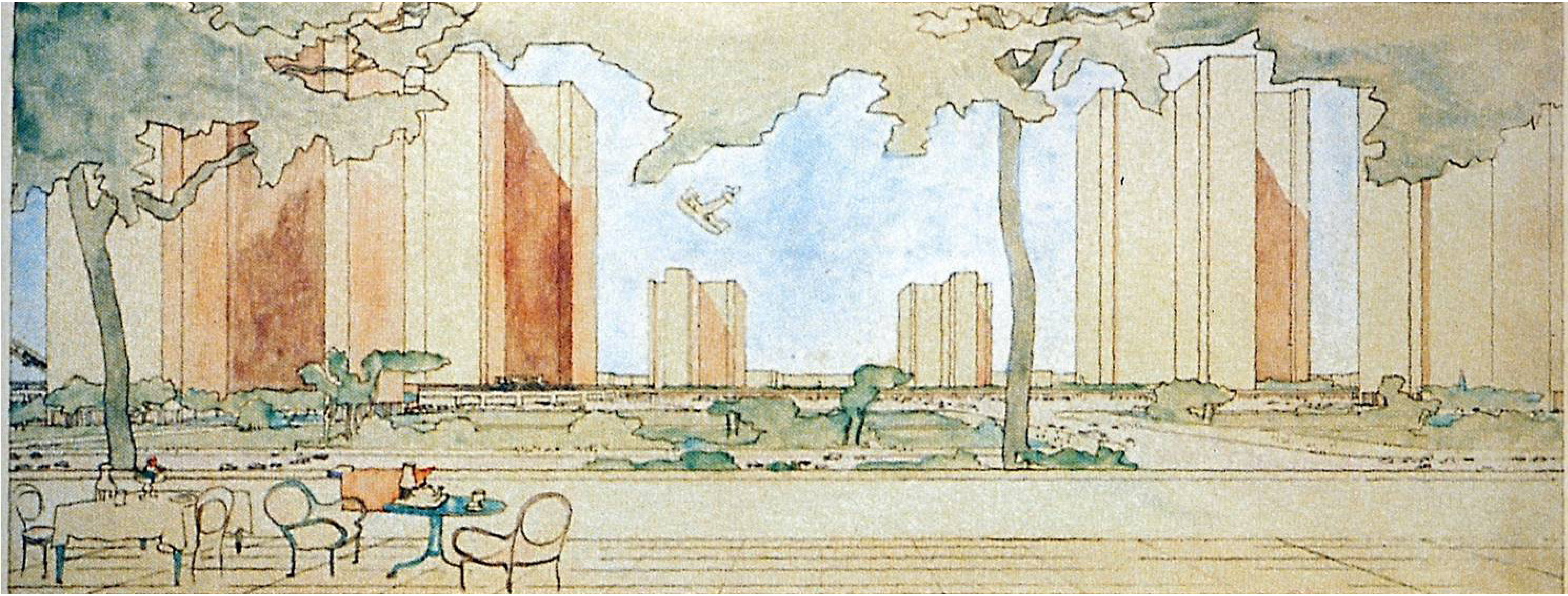


Crane determining the length of the building



<u>Mechanical systems & technology</u>

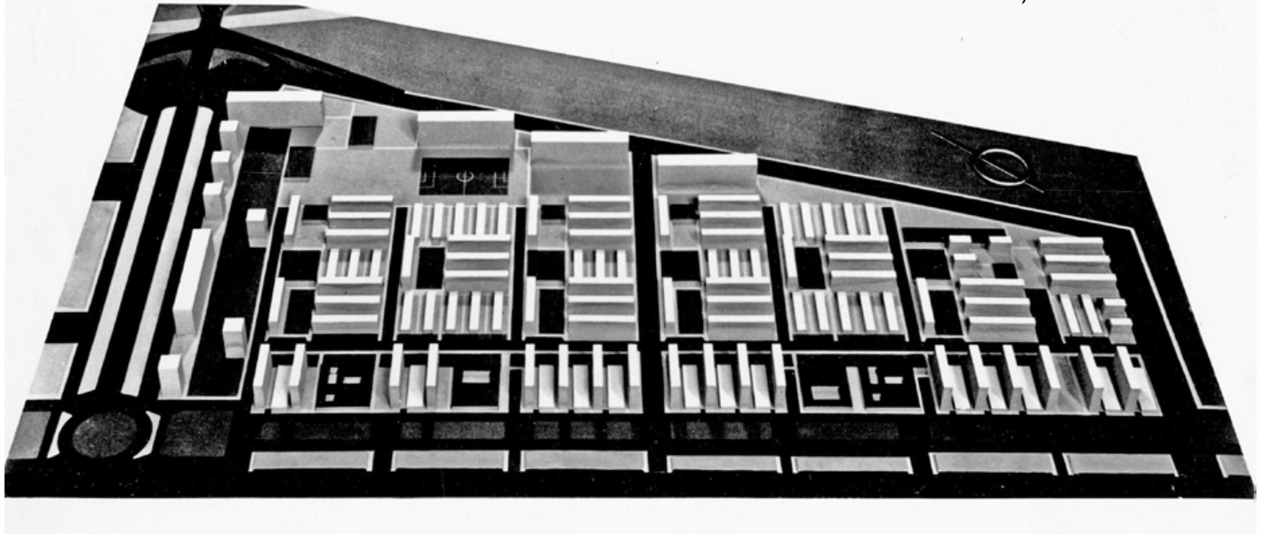
artificial climates & industrialization of construction



Modernism

embraced & preached openess

Model of Sudoeste del Besós, Barcelona



New Belgrade, Former Yugoslavia

Pendrecht, Rotterdam

Sarcelles Locheres, near Paris

PAST	FUTURE
Gas & oil	Renewables
Mechanical systems & technology	Designing with climate
Modernism	Respect but densify

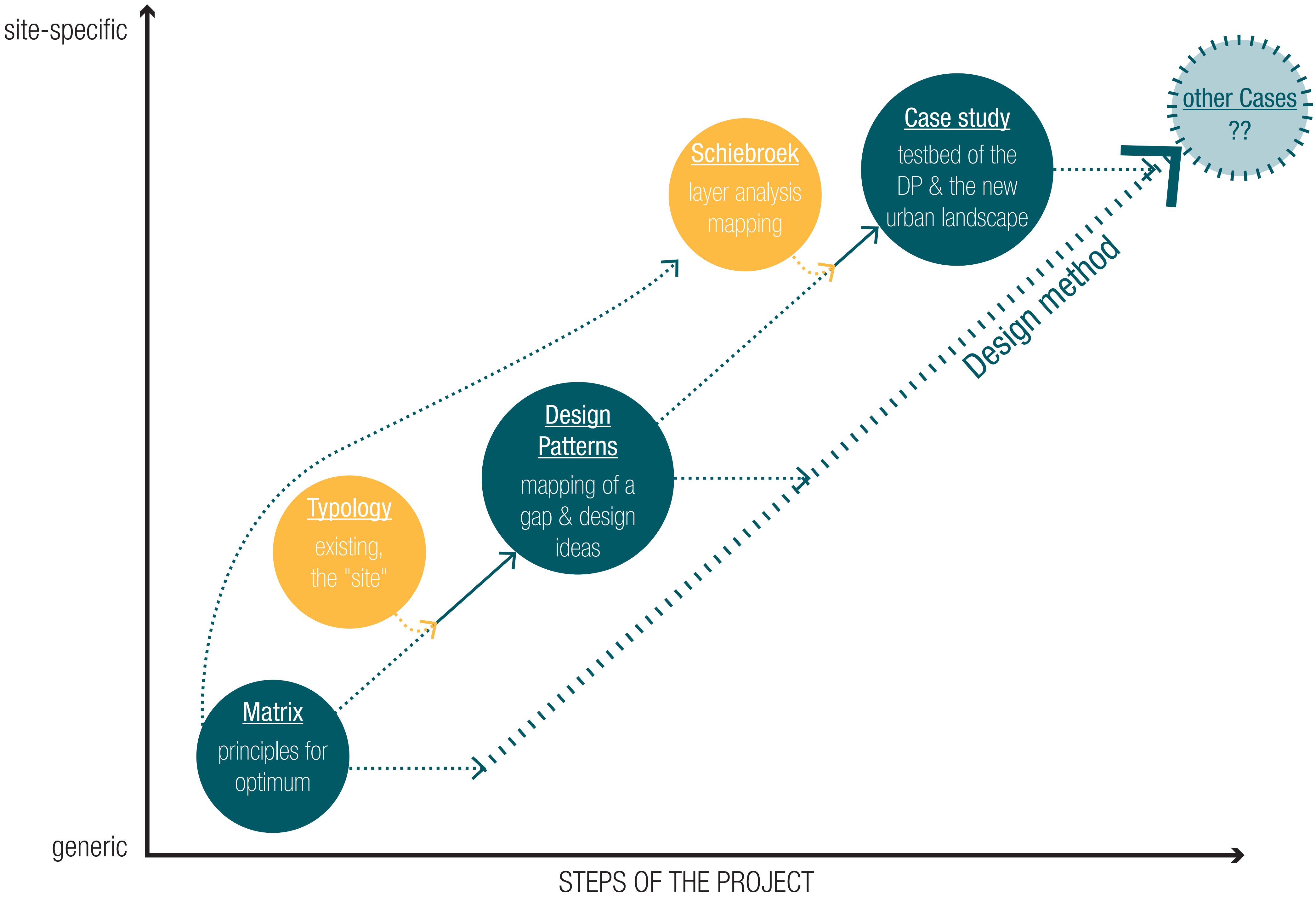
RESEARCH QUESTION

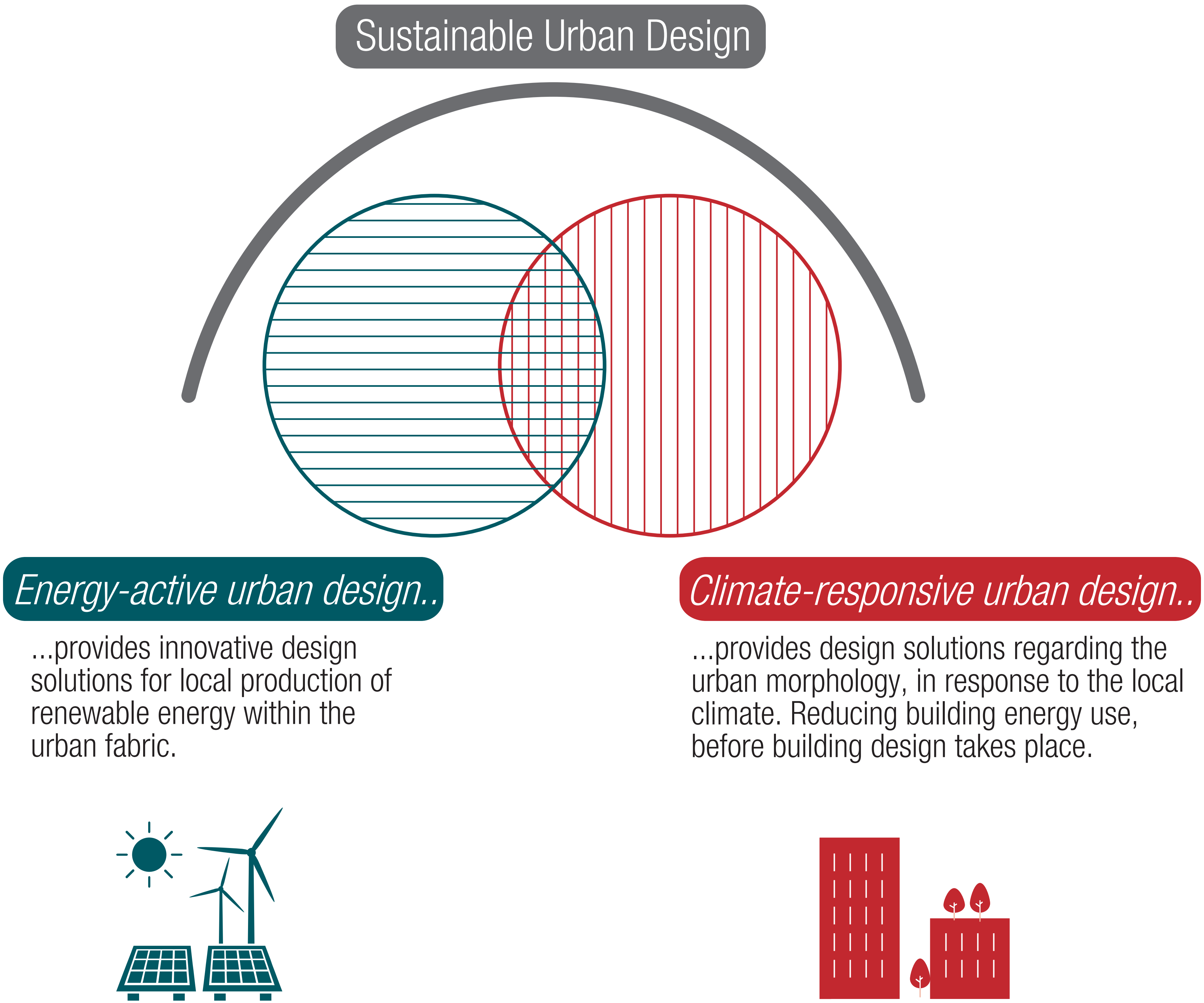
On our way to the urban energy transition, what are the spatial interventions needed in dutch post-war neighbourhoods that, based on principles of climate responsiveness and energy active design, can reduce building energy use and increase sustainable energy production?

energy and climate Matrix

Typology of dutch post-war neighbourhoods

Design Patterns & Case study


site-specific
generic
STEPS OF THE PROJECT
Matrix
principles for optimum
Typology
existing, the "site"
Design Patterns
mapping of a gap & design ideas
Schiebroek
layer analysis mapping
Case study
testbed of the DP & the new urban landscape
other Cases
??
Design method


Sustainable Urban Design
Energy-active urban design..
...provides innovative design solutions for local production of renewable energy within the urban fabric.
Climate-responsive urban design..
...provides design solutions regarding the urban morphology, in response to the local climate. Reducing building energy use, before building design takes place.

DENSIFICATION OF DUTCH POST-WAR NEIGHBOURHOODS

Why?

- built expression of fossil era
- space for densification
- existing plans for transformation
- represent 36% of dutch residential stock

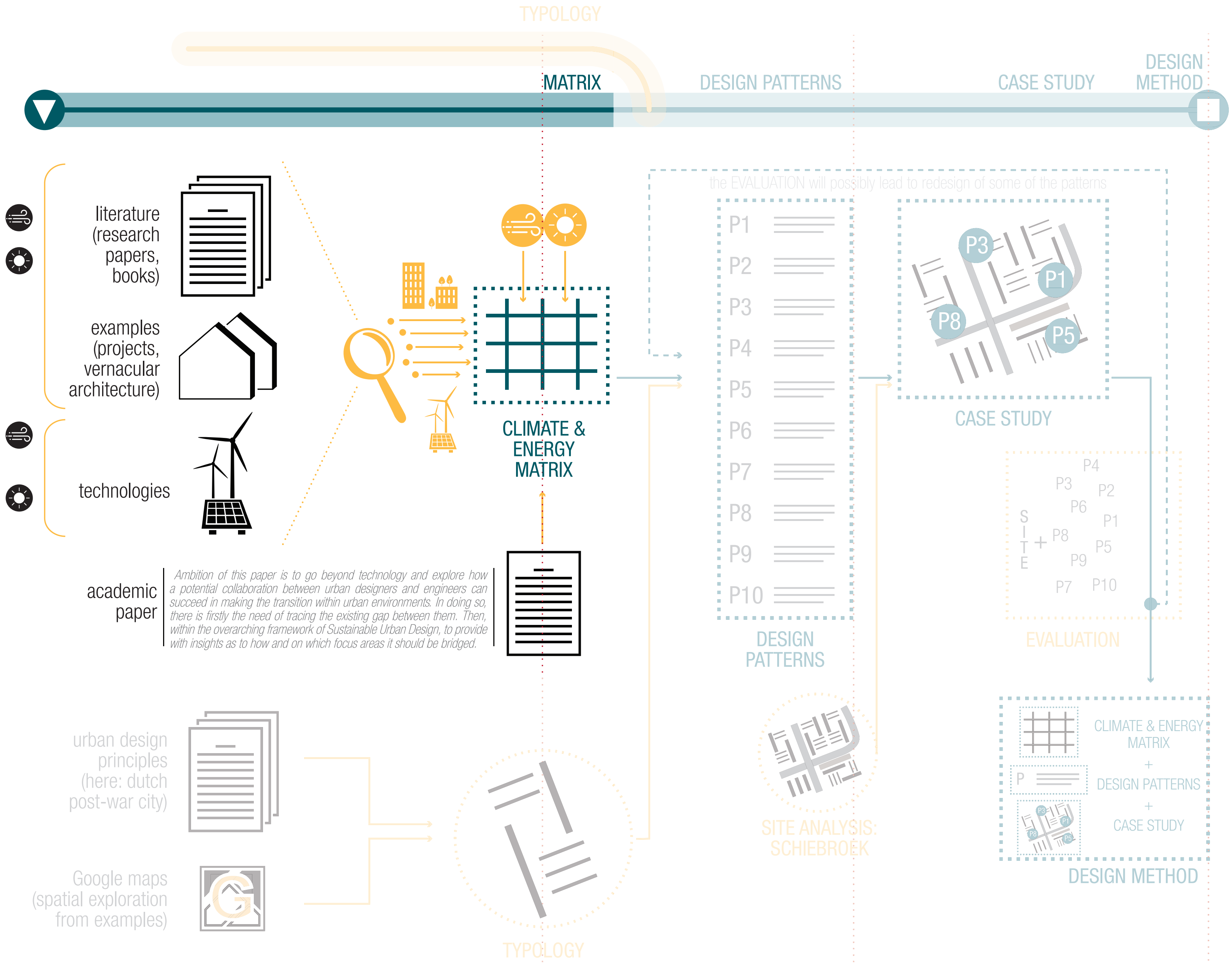
Table 1 The Dutch building stock in numbers (source:Platform31, 2013).

	Total residential stock	Post-war residential stock (1946-1974)	Total apartment flats	Post-war apartment flats	Industrialised systems (all dwelling types
no. dwellings	7300000	2600000	878000	381000	450000
% of the total stock in the NL	**36%**		**12%**	**5%**	**6%**

"(...)if we consider that cities and buildings are some of the most impactful sectors in our global economy, and over 90% of the Dutch population lives in cities, urban housing is a smart place to intervene."

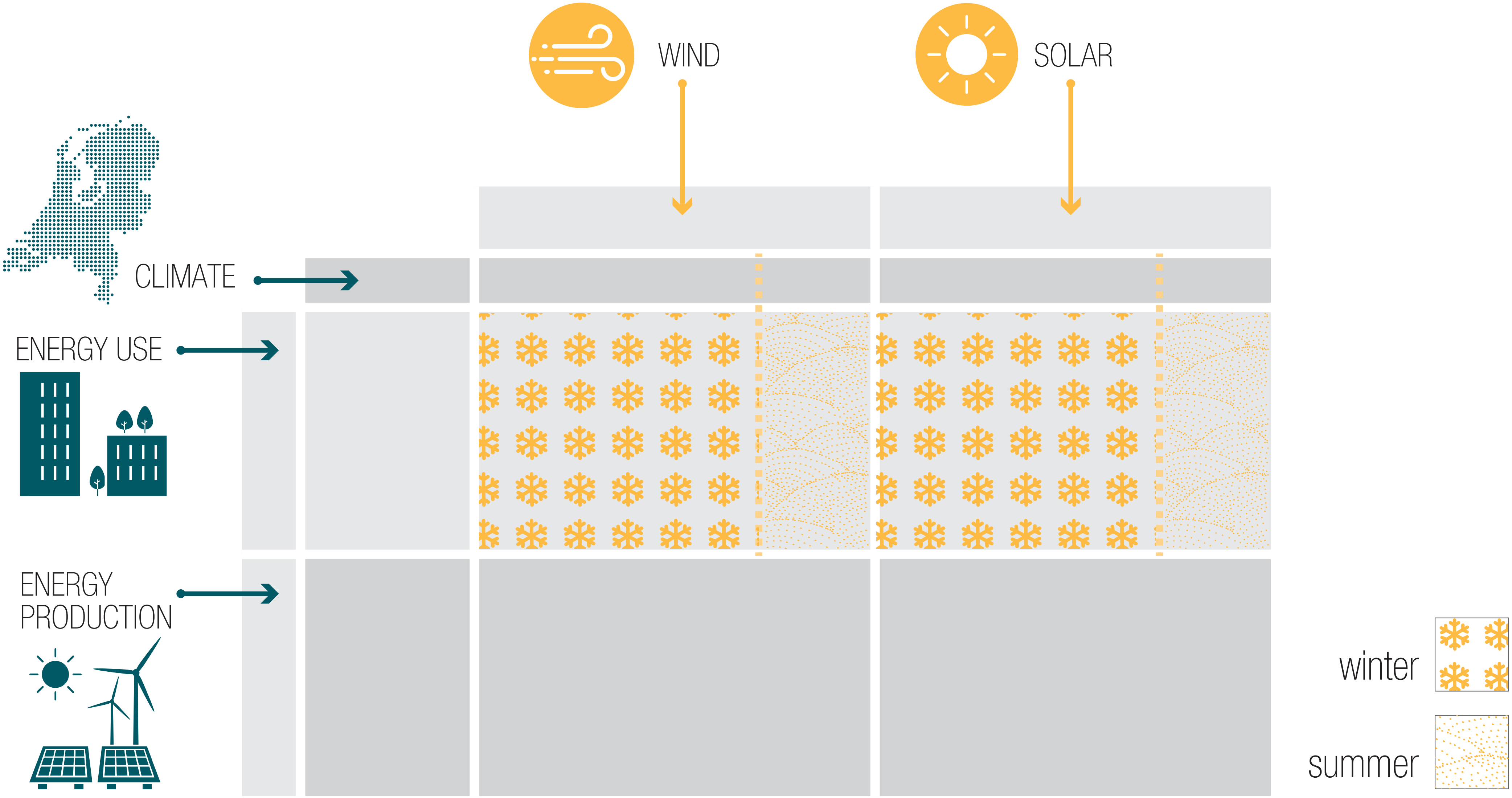
Metabolic, 2018

Climate-responsive & energy-active urban design: **a matrix**



PREMISES

- Climate: Temperate maritime climate highly influenced by the North Sea
- Energy use and energy production
- Climatic conditions: wind & solar
- Focus: winter season



1. ENERGY USE – URBAN MORPHOLOGY

Table 3. The sustainable urban design framework matrix.

SCALES

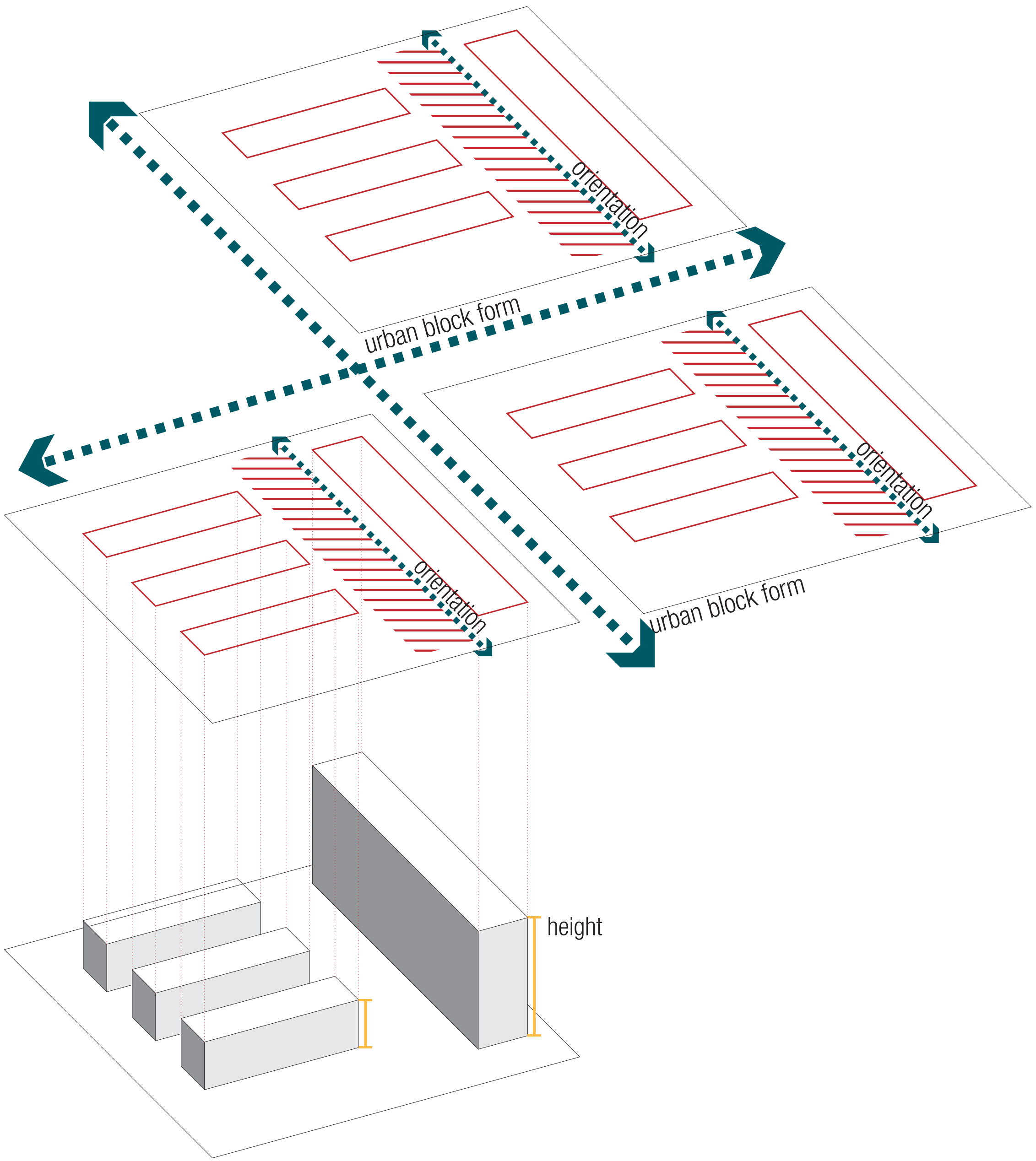
	Regional	District/ neighbourhood	Block/street	Project/parcel
Energy use/GHG (transp./land use)	Robust transit network Robust bicycle networks Vehicular networks High land use mix (Macro scale) Compact development (for density/proximity)	Small and defined blocks High building/housing density High network connectivity Macro parking mgmt/design High land use mix (micro scale)	Multimodal street design Engaging pedestrian realm Robust bicycle infrastructure Design for transit Limiting auto impact Dense and street activating building typologies Micro parking mgmt/design Platting for density	Engaging public realm design Dense and street activating building typologies Engaged building/street relationship High internal and external connectivity Micro parking mgmt/design
Water	Avoid flood prone areas Compact development (for limited impact on nat. systems)	Robust stormwater mgmt. network (distributed/on-site recharge)	High surface permeability Extensive green stormwater infrastructure (GSI) Extensive urban forest canopy	High surface permeability Extensive green stormwater infrastructure (GSI) Extensive urban forest canopy Rainwater capture/re-use
Ecology/habitat	Avoid ecol. sensitive areas Robust and connected macro ecological systems and networks Compact development (for limited impact on nat. systems)	Avoid ecol. sensitive areas Ecological corridors/pockets High urban forest continuity/diversity Daylight/restore waterways	High surface permeability Micro-habitat creation High vertical complexity Native vegetation Mitigating habitat disruption Robust ecological area buffers Non-polluting lighting design	High surface permeability Micro-habitat creation High vertical complexity Native vegetation Mitigating habitat disruption Robust ecological area buffers Non-polluting lighting design
Energy use/production (non-transp.)	Compact development (for limited embodied energy in infrastructure)	Block size/street orientation for microclimate mitigation High building/housing density	Dense/energy efficient building typologies Microclimate mitigation Low albedo surface materials Urban forest and robust vegetation High street ht./width ratio Efficient street lighting design Platting for density and solar exposure	Infill development Dense/energy efficient building typologies Increase local energy production (solar/wind)
Equity and health		[Maximize accessibility and ped/bike safety (see energy use/GHG in transportation and land use)]		
	Equitable distribution of employment, housing, human services, open space, education facilities, and healthy food options	Equitable distribution of employment, housing, human services, open space, education facilities, and healthy food options Limit location of point source pollution and toxins	Active/attractive open space (for activity and quality of life) Lighting for safety Site design for ownership and surveillance Affordable housing typologies Complete streets for ped safety Urban forest and robust veg. (for pollution sequestration)	Mix of unit types Active/attractive open space Lighting for safety Site design for ownership and surveillance Affordable housing typologies

PARAMETERS

B. Parameters per scale

District/neighbourhood

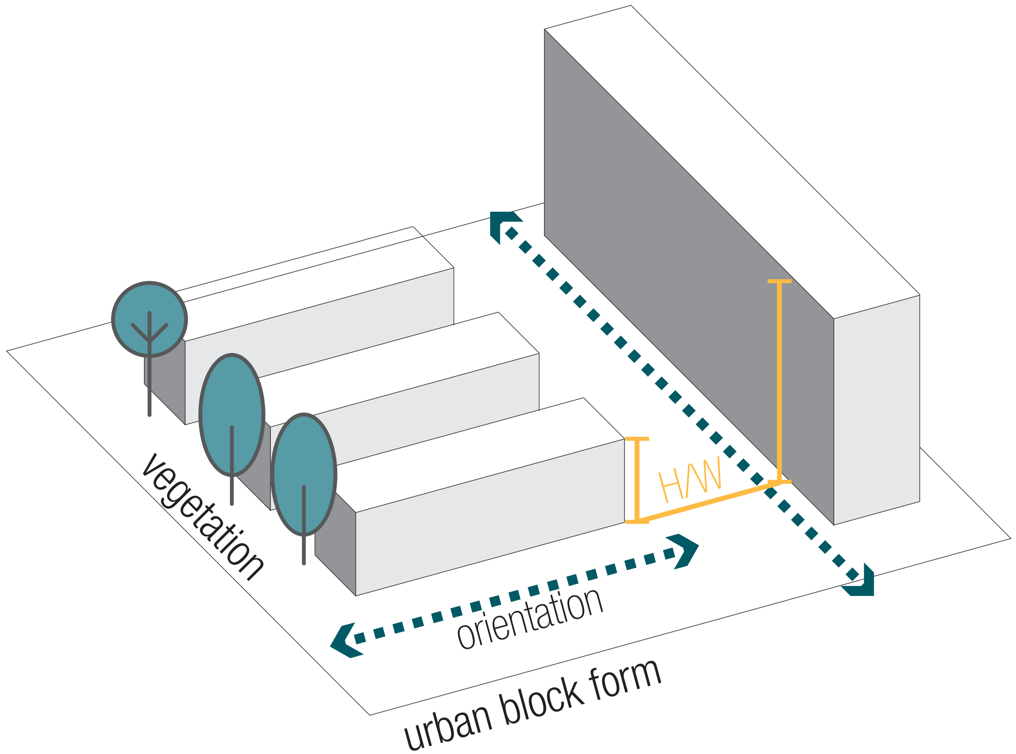
- Heights (irregularities)
- Orientation (of streets & open spaces)
- Urban forest



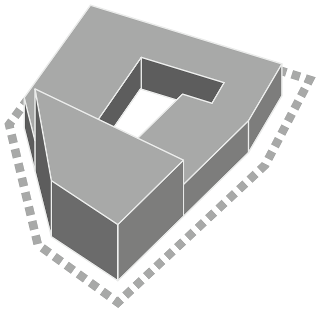
B. Parameters per scale

Urban block/street

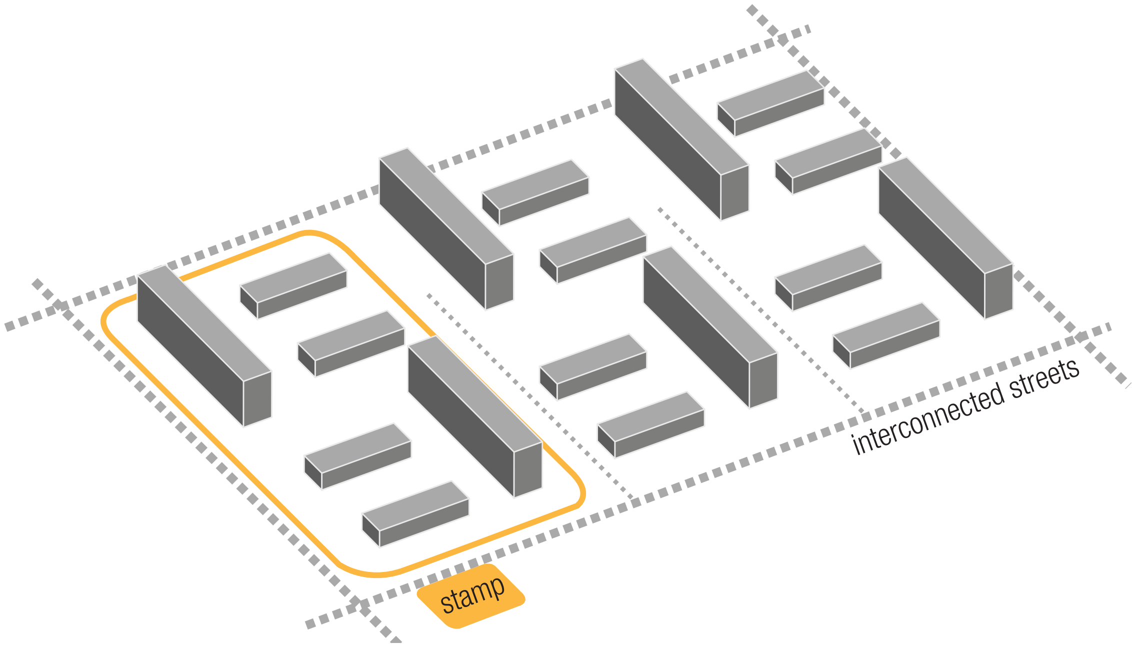
¬ Form
¬ Vegetation
¬ Orientation (of buildings)
¬ H/W ratio



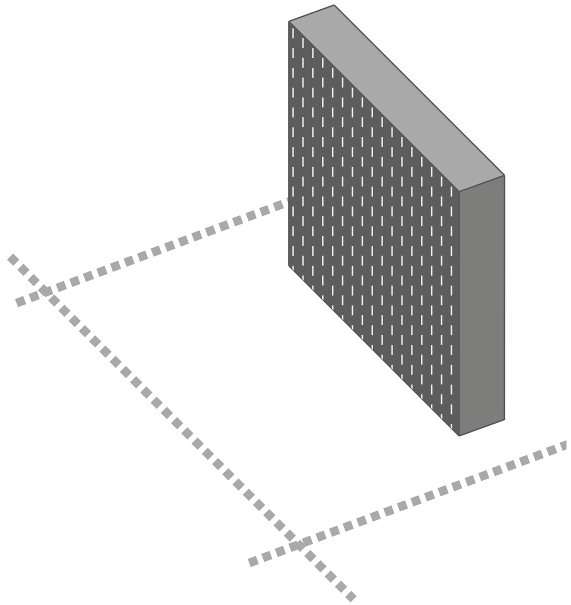
<u>Traditional 'old' city</u>
traditional urban block



<u>Post-war neighbourhoods</u>
new urban block
(influenced by the Garden City & Modernism)



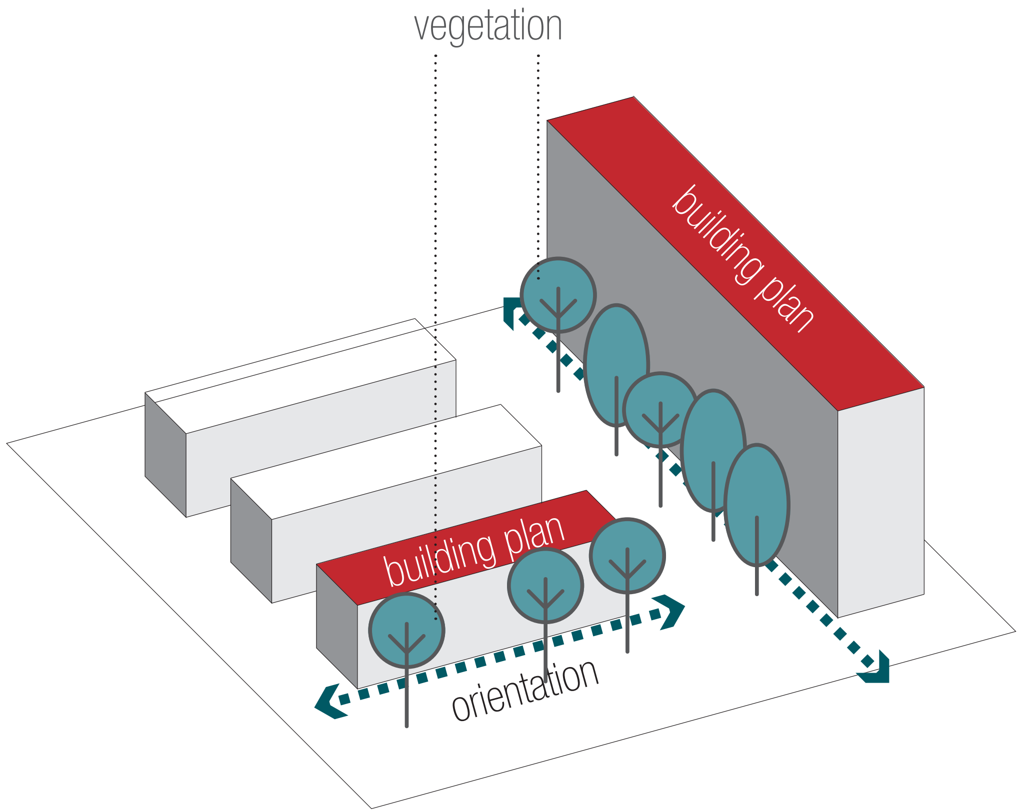
<u>Late post-war neighbourhoods</u>
urban block unit
(influenced by Le Corbusier)



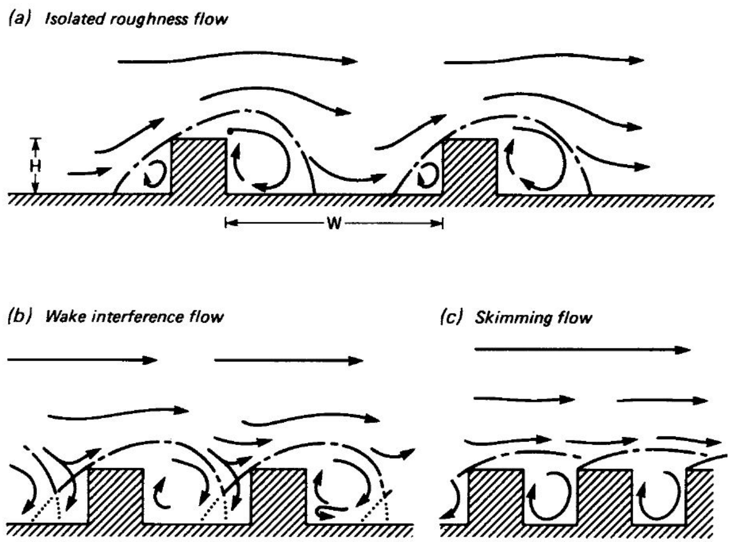
B. Parameters per scale

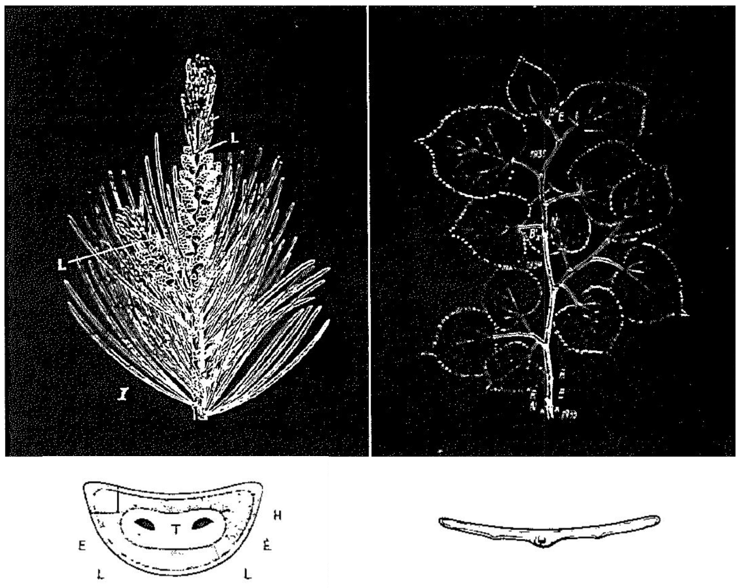
Building/parcel

¬ orientation
¬ vegetation
¬ building plan (envelope)



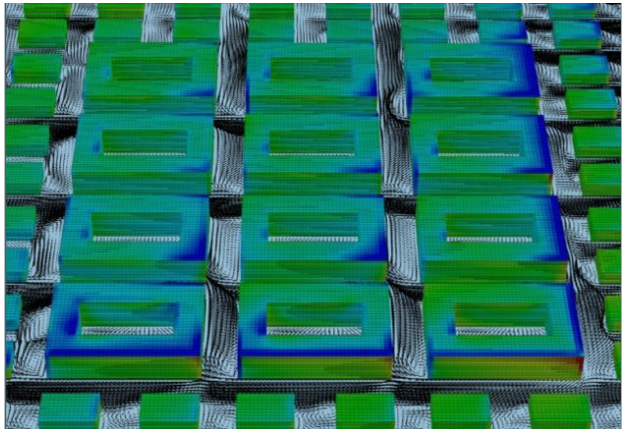
1. ENERGY USE

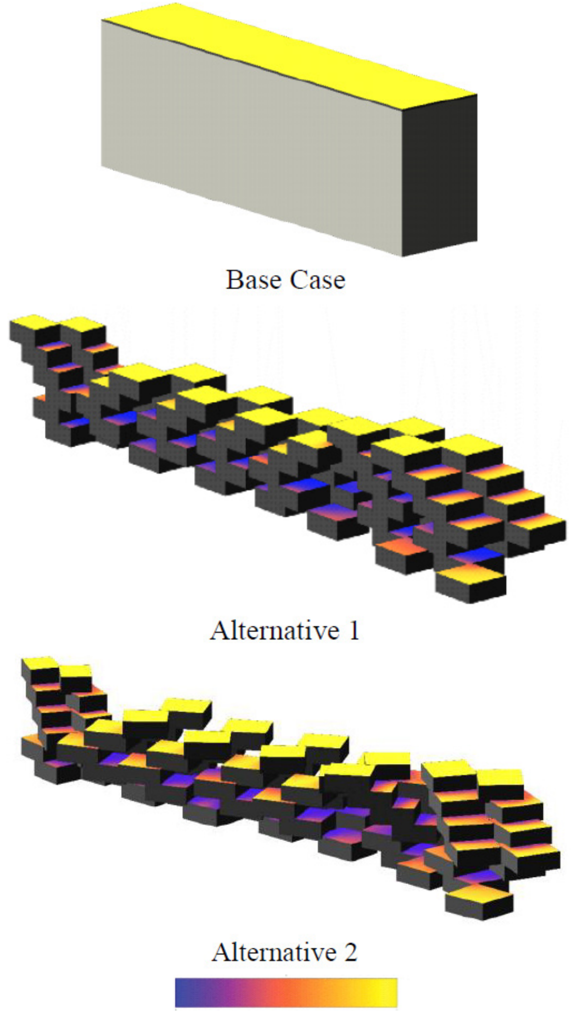




COOL ZONE

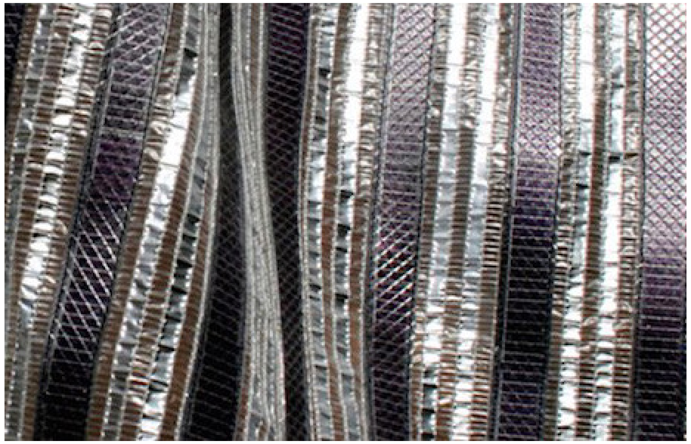
TEMPERATE ZONE

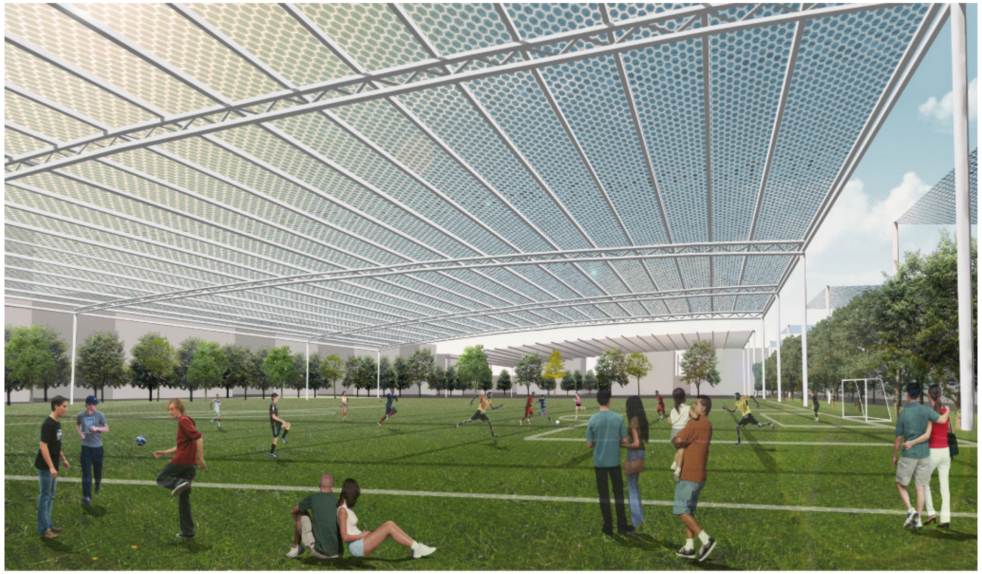


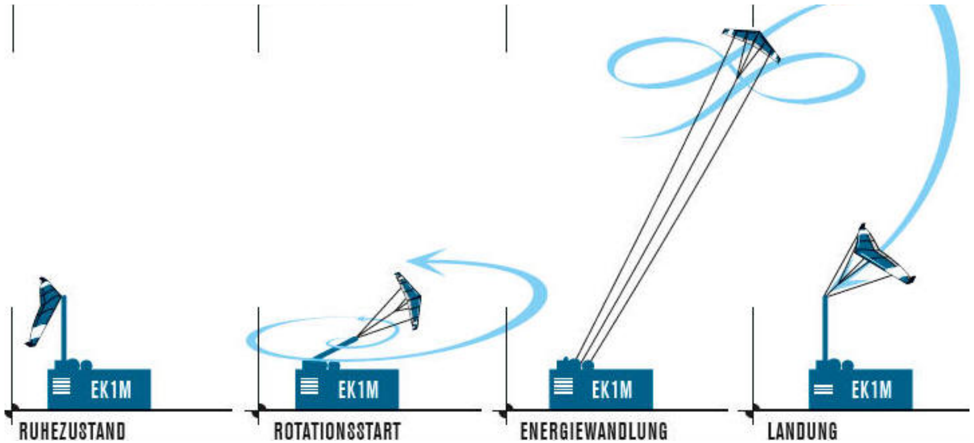


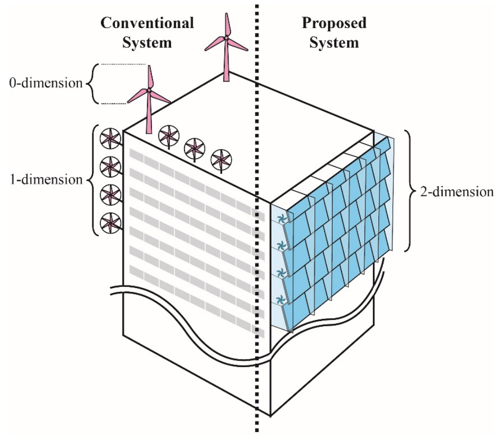
CLIMATE & ENERGY MATRIX

2. ENERGY PRODUCTION









3. ENERGY USE & PRODUCTION – CLIMATE & ENERGY MATRIX

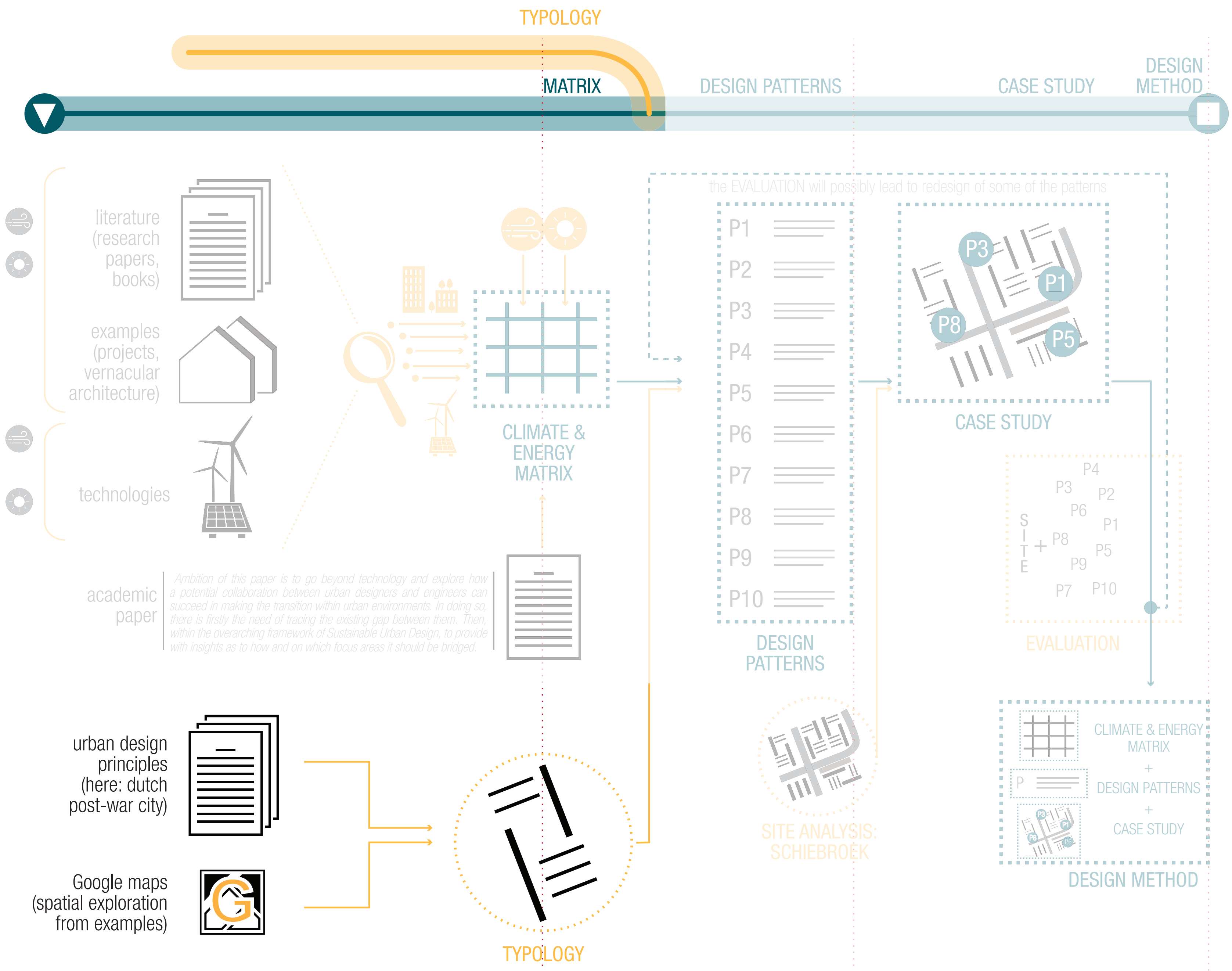
	WIND PATTERNS			SOLAR RADIATION		
CLIMATIC CONDITIONS FOR DUTCH CLIMATE (temperate maritime climate influenced by the North Sea)	WINTER [MAIN FOCUS] moderate winters -cold & strong wind from North Sea	SUMMER [ACCOUNTED FOR] cool summers -sea breeze	SOURCES	WINTER [MAIN FOCUS] moderate winters -cloudy; less solar radiation	SUMMER [ACCOUNTED FOR] COOL SUMMERS	SOURCES
URBAN MORPHOLOGY [QUALITIES] – ENERGY USE						
-district/neighbourhood			[1]Oke, 1987;			
urban block morph.: heights	min. height irregular., avoid tall buildings		[2]Jurelionis, Bouris, 2016;			
urban forest	urban forest (for fully exposed blocks)[I]	not perpendicular to summer breeze	[3]Eumorfopoulou, Kontoleon, 2009;			
street & open sp. orientation	perpendicular or sidewards to the wind		[4]Salat, 2014			
high housing density						
-urban block/street						
urban block morph.: form	(1) paral. rows of linear blocks/elong.forms			(1) free arr. of linear blocks/elong. forms		
	(2) perimeter blocks			(4) T-shaped/cross forms		
	(3) compact form					
vegetation	evergreen rows of trees, perpend. to wind[I]	summer breeze direction: no vegetation		deciduous trees: solar access for winter, shadow for summer	tree rows parall. to W faces	
orientation	perpendic. or sidewards (45º) to the wind					
width street ratio: Height/Width	H/W ≥0.65[1]	parallel or sidewards (45º)		H/W≤2 (traditional deep canyon), by densif. keep H/W as low as possible; blocks facing E-W, united with atrium	high dens. in open spaces; blocks facing E-W, united with atrium	
density & solar exposure	infill where H/W≤0.65 (to achieve skimming flow and avoid wake interfer.)					
-building (parcel)						
orientation	wind perpendicular to long surface			East-West (length), pref. unilateral plan[IV]	west side closed[IV]	
vegetation	trees & plant-covered walls (cavities)[II]	summer breeze: no veg.		S&E surfaces: no/deciduous trees	trees W surf. & green roofs[V]	
bulding plan (envelope)		depth <6m; for nat.ventilat.[4]		depth<6m; for solar access[4]		
infill development AND dense & energy efficient h.typ.	open spaces (no tall buildings & ideallly in low H/W) & protected from wind effect			on west, north or without solar access building faces & sunrooms (building's facades with insufficient solar access)	minimum increase of roof surface	
URBAN MORPHOLOGY [QUALITIES] – ENERGY PRODUCTION						
1 technology	HAWT (Horizontal Axis Wind Turbines)		[5]Wang et al., 2017;	PV panels & parabolic		
orientation	windward (WT adjustable)			South to East		
location	mid- & high-rise build., towers open sp.		[6]Bell et al.,n.d.;	mid- & high-rise build.		
morphology	roof (optimum type: curved)		[7]Guzzetta et al., 2007;	unshaded and spaciou[s] non-residential build.)		
2 technology	VAWT or micro-wind turbines or IRWES[13]		[8]Smith et al., 2012;	solar roads & paths		
orientation	windward (only for micro-wind)			---		
location	high- & mid-rise build. (possible for low)		[9]Micallef et al., 2016	infrastructure & public space		
morphology	flat roof, corners & facades			away from buildings (low dens. vegetation)		
3 technology	ducted wind turbines		[10]Park et al., 2015	thin-film solar (textile)	thin-film solar (textile)	
orientation	windward (fixed position)			South to East (120-degree range)	South to West	
location	high-rise build.		[11]Ledo et al., 2011;	mid- & high-rise build.	build. & open spaces	
morphology	flat roof			large vertical blind facades	rooftops (summer terraces)	
4 technology	savonius VAWT or Binopterus VAWT		[12]Korprasertsak & Leephakpreeda, 2015;	see-through transparent solar panels		
orientation	independent of orientation			South to East		
location	bus stops, shelters, roof patios - open sp.		[13]Dekker, 2012	buildings		
morphology	VAWT with wind booster system (vanes) are appropriate for low winds[12]			balconies and windows		
5 technology	Kite power systems					
orientation	independent of orientation					
location	mid- & high-rise build.					
morphology	independent					

ENERGY USE

ENERGY PRODUCTION

DESIGN PATTERN GROUPS

Typology

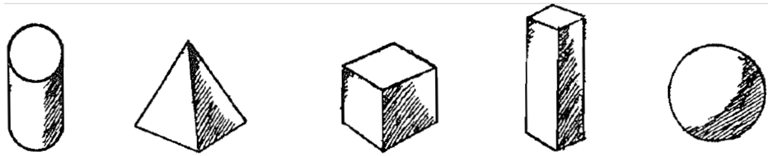


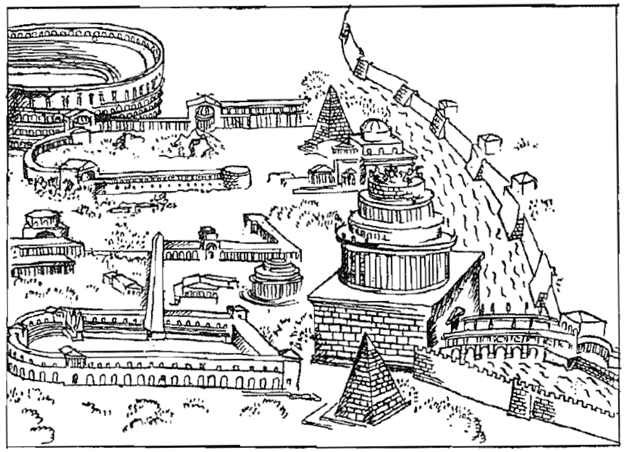
TYPOLOGY
MATRIX
DESIGN PATTERNS
CASE STUDY
DESIGN METHOD
literature (research papers, books)
examples (projects, vernacular architecture)
technologies
CLIMATE & ENERGY MATRIX
academic paper
Ambition of this paper is to go beyond technology and explore how a potential collaboration between urban designers and engineers can succeed in making the transition within urban environments. In doing so, there is firstly the need of tracing the existing gap between them. Then, within the overarching framework of Sustainable Urban Design, to provide with insights as to how and on which focus areas it should be bridged.
the EVALUATION will possibly lead to redesign of some of the patterns
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
DESIGN PATTERNS
P3
P1
P8
P5
CASE STUDY
S I T E
+
EVALUATION
SITE ANALYSIS: SCHIEBROEK
CLIMATE & ENERGY MATRIX
+
DESIGN PATTERNS
+
CASE STUDY
DESIGN METHOD
urban design principles (here: dutch post-war city)
Google maps (spatial exploration from examples)
TYPOLOGY

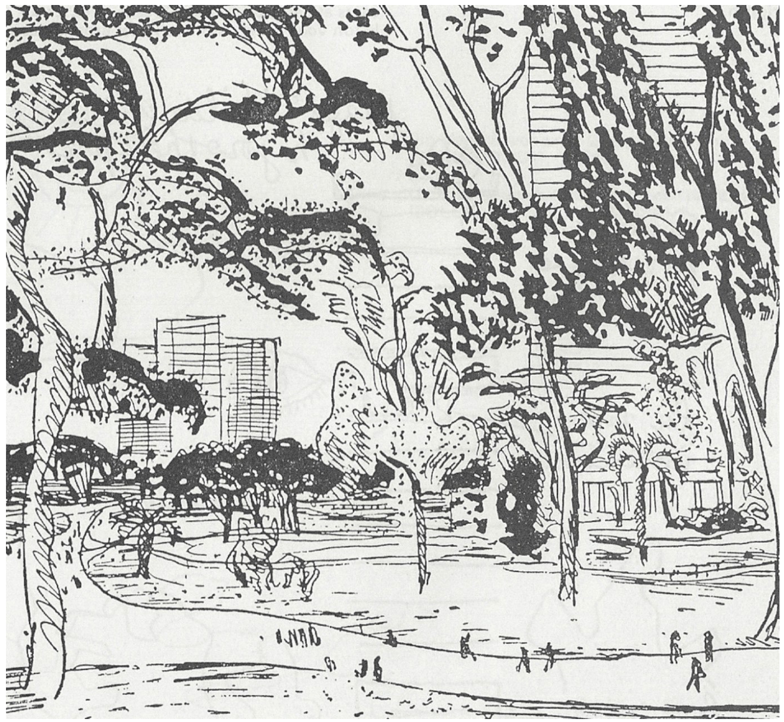

DUTCH POST-WAR NEIGHBOURHOODS

1. MODERNISM PRINCIPLES

- rythmic game of forms
- importance of nature
- openness, light and air





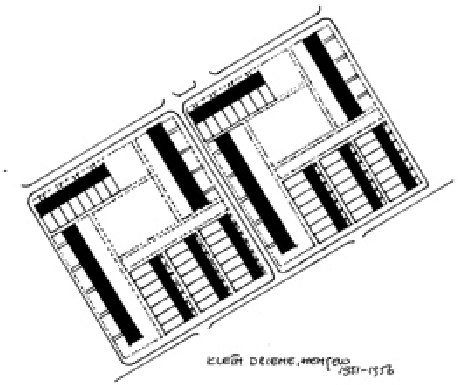


TYPOLOGY

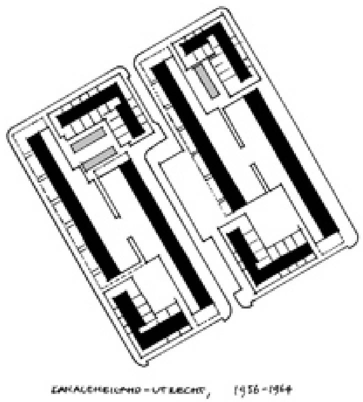
2. TECHNOLOGY

- industrialization
- prefabrication and assembly on site
- cranes and long linear buildings
- 'stamps'

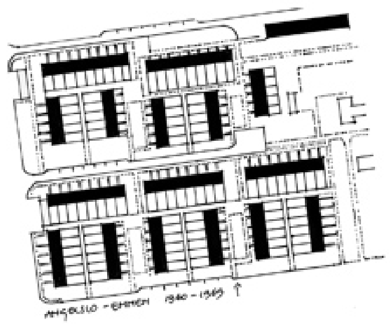
Hengelo - Klein Driene



Utrecht - Kanaleneiland



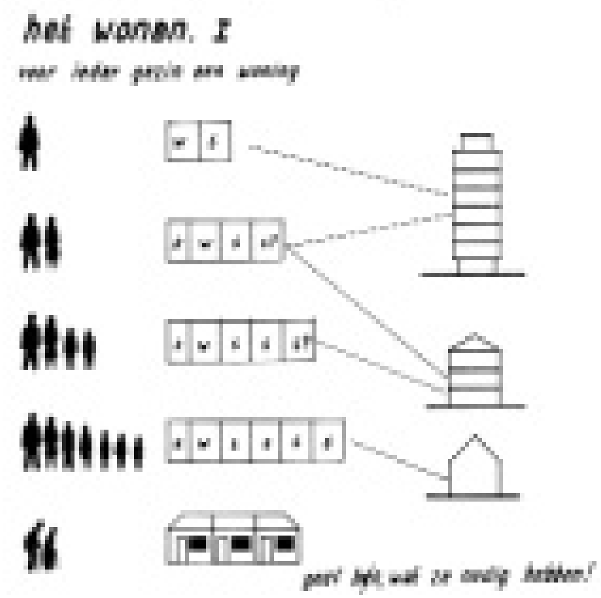
Emmen - Angelslo

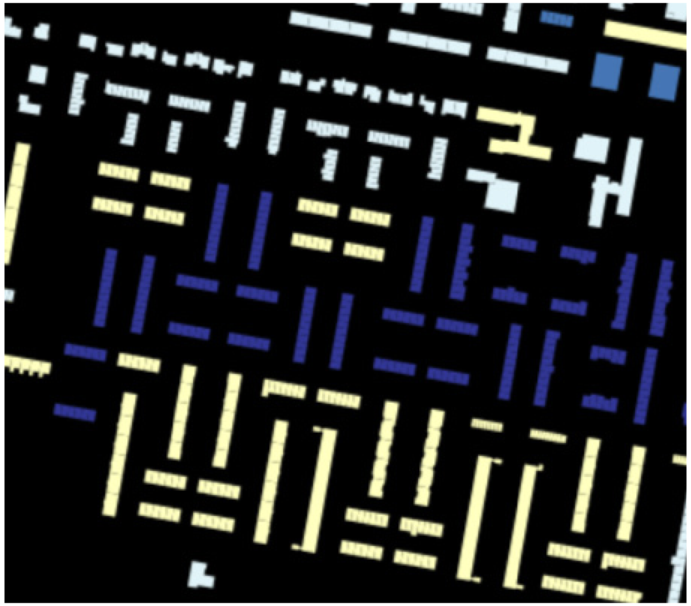


TYPOLOGY

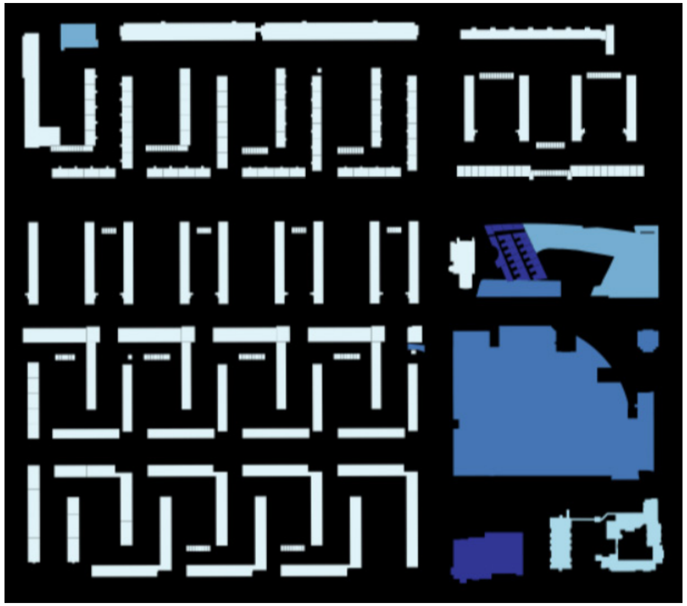
DUTCH POST-WAR PERIOD

- influence by garden city movement
- 'wijkgedachte': varying housing typologies
- housing association: commonalities across the country



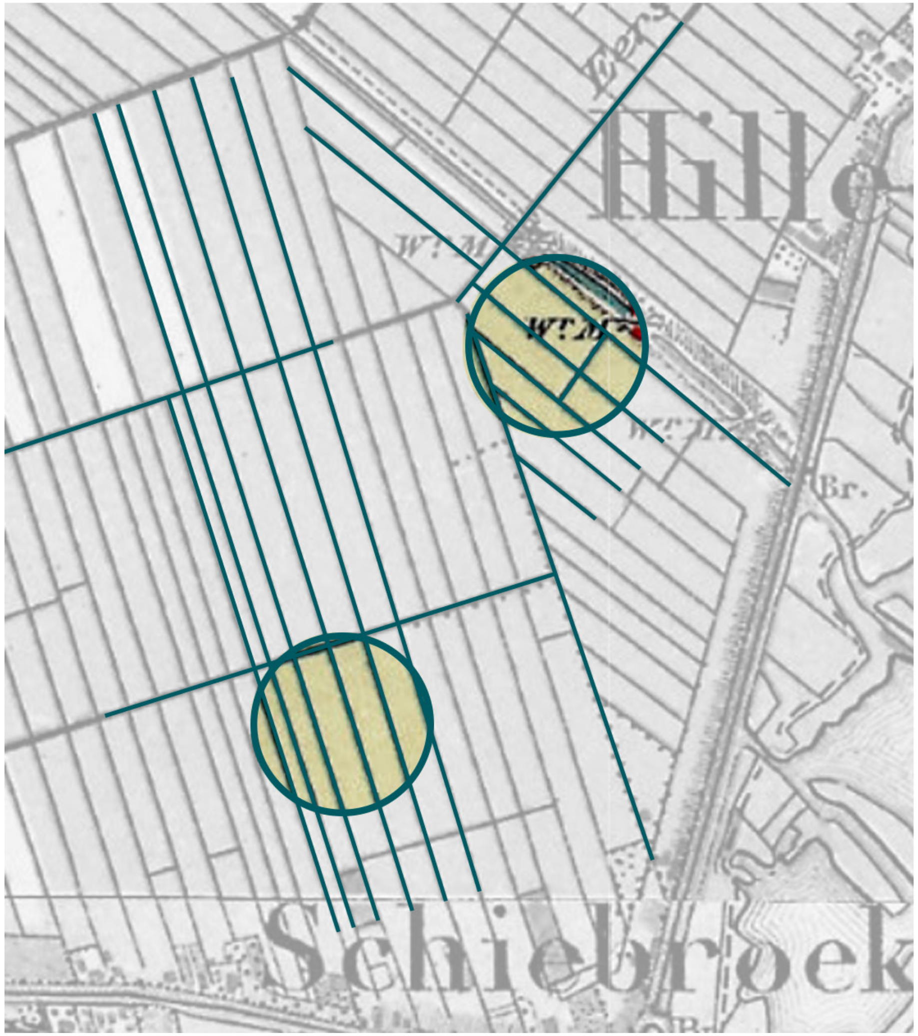


Pendrecht, Rotterdam

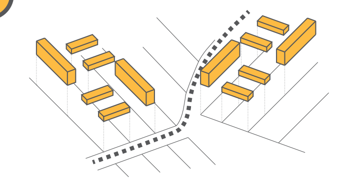
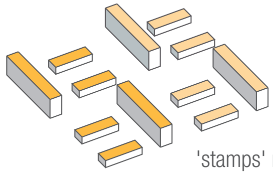
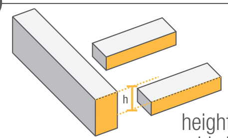
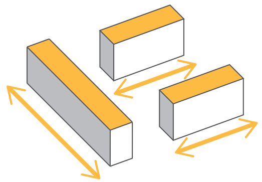
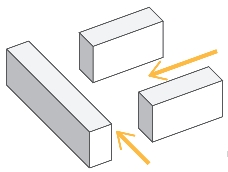
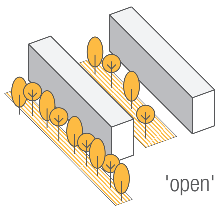
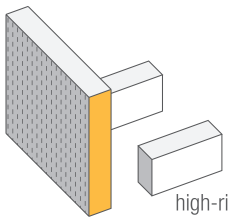


Amsterdam Zuid, Amsterdam

INHERENT UNSUSTAINABILITY



TYPOLOGY

scales	Morphological qualities	Modern city principles	Dutch post-war principles	Connection with Matrix
neighbourhood	 roads & existing infrastr. defined planning	¬ streets dominated the structure of the city as cars became the main transportation	¬ polders located on the outskirts of cities as the main structures for new residential areas	ENERGY USE
	 'stamps' repetition	¬ steep housing needs after the war ¬ prefabricated materials/building elements ¬ expansion to outskirts of cities - a lot of free space to be planned and built	¬ stamps included different housing types ¬ therefore, height irregularities and interchange of blocks and garden houses ¬ aim: social mixing of neighbourhoods	
urban block	 height irregularities: mid-rise blocks & low-rise row houses	¬ from the art of the facade to the art of space	¬ wijkgedacht ¬ idea of social mixing ¬ living in the same neighbourhood all your life ¬ 'ritme' - 'ruimtekunst'	ENERGY USE DENSIFICATION (POTENTIAL)
	 built linear blocks of different orientations	¬ from the art of the facade to the art of space ¬ simple geometries rhythmically arranged in open space	¬ post-war residential areas planned on polder land and according to their structure ¬ therefore, mostly two orientations, perpendicular to each other	ENERGY USE DENSIFICATION (POTENTIAL)
	 'openess'	¬ (again) reaction to unhealthy cities ¬ more air and sun		ENERGY USE DENSIFICATION (POTENTIAL)
	 'open' green spaces	¬ nature as initiator of urban form ¬ reaction to unhealthy medieval cities ¬ more air and sun		ENERGY USE DENSIFICATION (POTENTIAL)
stamp	 high-rise buildings - towers	¬ Le Corbusier's idea of cities on towers to give space to nature ¬ central heating and elevators (late post-war period: late 60s, early 70s)	¬ gas in Slochteren ¬ gas pipelines through the country (60s)	ENERGY USE ENERGY PRODUCTION

CONNECTING WITH THE MATRIX

URBAN MORPHOLOGY [QUALITIES]	CLIMATIC CONDITIONS FOR DUTCH CLIMATE (temperate maritime climate influenced by the North Sea)	WIND PATTERNS: Winter [main focus] moderate winters -cold & strong wind from North Sea	WIND PATTERNS: Summer [accounted for] cool summers -sea breeze	WIND PATTERNS: Sources	SOLAR RADIATION: Winter [main focus] moderate winters -cloudy; less solar radiation	SOLAR RADIATION: Summer [accounted for] cool summers	SOLAR RADIATION: Sources
ENERGY USE	-district/neighbourhood			[1]Oke, 1987; [2]Jurelionis, Bouris, 2016; [3]Eumorfopoulou, Kontoleon, 2009; [4]Salat, 2014			
	urban block morph.: heights	min. height irregular., avoid tall buildings					
	urban forest	urban forest (for fully exposed blocks)[I]	not perpendicular to summer breeze				
	street & open sp. orientation	perpendicular or sidewards to the wind					
	high housing density						
	-urban block/street						
	urban block morph.: form	(1) paral. rows of linear blocks/elong.forms			(1) free arr. of linear blocks/elong. forms		
		(2) perimeter blocks			(4) T-shaped/cross forms		
		(3) compact form					
	vegetation	evergreen rows of trees, perpend. to wind[I]	summer breeze direction: no vegetation		deciduous trees: solar access		
	orientation	perpendic. or sidewards (45º) to the wind			shadow for summer		
	width street ratio: Height/Width	H/W ≥0.65[1]	parallel or sidewards (45º)		H/W≤2 (traditional deep canyo		
	density & solar exposure	infill where H/W≤0.65 (to achieve skimming flow and avoid wake interfer.)			by densif. keep H/W as low as blocks facing E-W, united wit		
	-building (parcel)						
	orientation	wind perpendicular to long surface			East-West (length), pref. unilateral plan[IV]	west side closed[IV]	
	vegetation	trees & plant-covered walls (cavities)[II]	summer breeze: no veg.		S&E surfaces: no/deciduous trees	trees W surf. & green roofs[V]	
	bulding plan (envelope)		depth <6m; for nat.ventilat.[4]		depth<6m; for solar access[4]		
	infill development AND dense & energy efficient h.typ.	open spaces (no tall buildings & ideallly in low H/W) & protected from wind effect			on west, north or without solar access building faces & sunrooms (building's facades with insufficient solar access)	minimum increase of roof surface	
ENERGY PRODUCTION	1 technology	HAWT (Horizontal Axis Wind Turbines)		[5]Wang et al., 2017; [6]Bell et al.,n.d.; [7]Guzzetta et al., 2007; [8]Smith et al., 2012; [9]Micallef et al., 2016 [10]Park et al., 2015 [11]Ledo et al., 2011; [12]Korprasertsak & Leephakpreeda, 2015; [13]Dekker, 2012	PV panels & paral		
	orientation	windward (WT adjustable)			South to East		
	location	mid- & high-rise build., towers open sp.			mid- & high-rise b		
	morphology	roof (optimum type: curved)			unshaded and spa non-residential bu		
	2 technology	VAWT or micro-wind turbines or IRWES[13]			solar roads & path		
	orientation	windward (only for micro-wind)			---		
	location	high- & mid-rise build. (possible for low)			infrastructure & public space		
	morphology	flat roof, corners & facades			away from buldings (low dens. vegetation)		
	3 technology	ducted wind turbines			thin-film solar (textile)	thin-film solar (textile)	
	orientation	windward (fixed position)			South to East (120-degree range)	South to West	
	location	high-rise build.			mid- & high-rise build.	build. & open spaces	
	morphology	flat roof			large vertical blind facades	rooftops (summer terraces)	
	4 technology	savonius VAWT or Binopterus VAWT			see-through transparent solar panels		
	orientation	independent of orientation			South to East		
	location	bus stops, shelters, roof patios - open sp.			buildings		
	morphology	VAWT with wind booster system (vanes) are appropriate for low winds[12]			balconies and windows		
	5 technology	Kite power systems					
	orientation	independent of orientation					
	location	mid- & high-rise build.					
	morphology	independent					

ENERGY USE

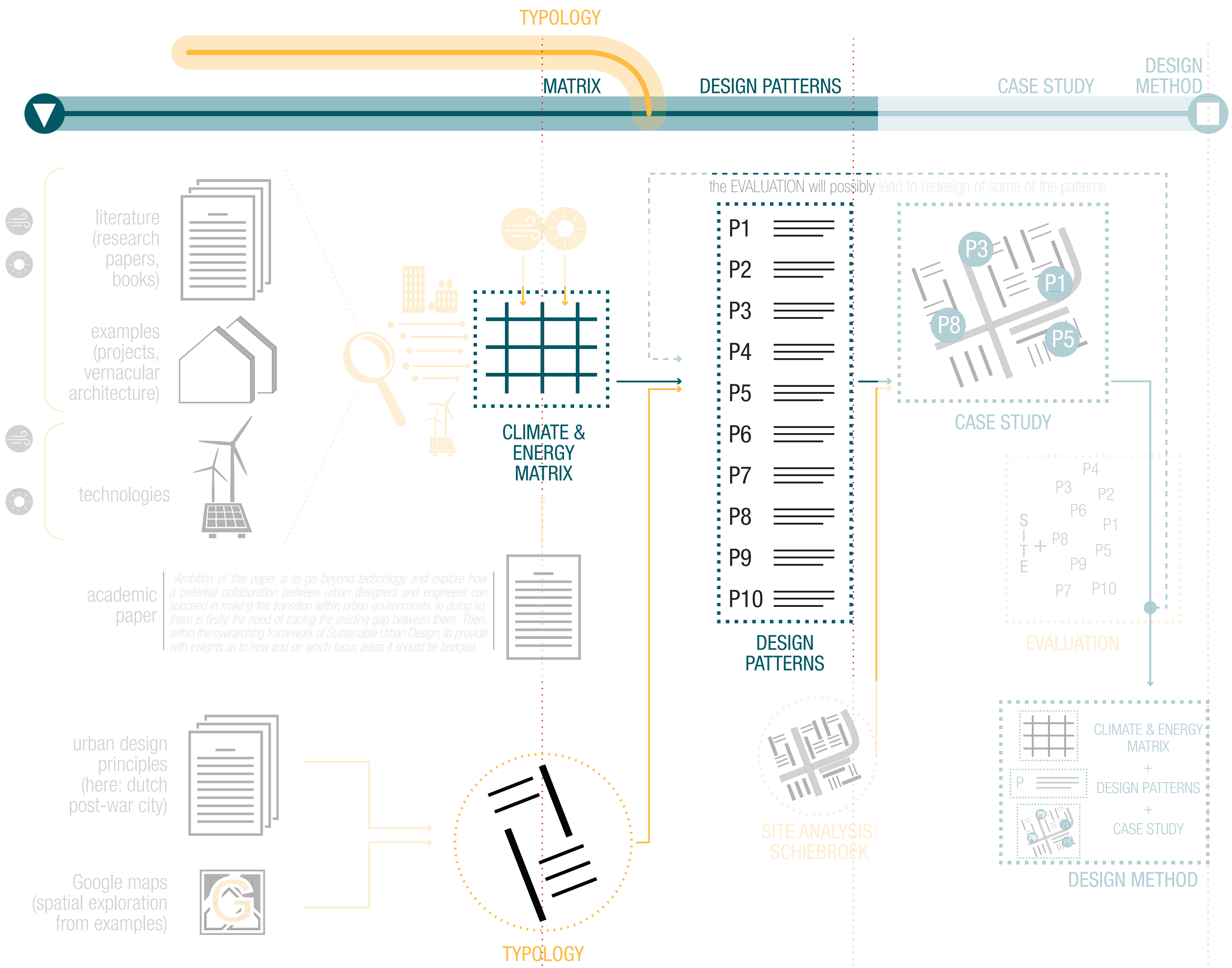
DENSIFICATION (POTENTIAL)

ENERGY PRODUCTION

DESIGN PAATTERN GROUPS

TYPOLOGY

Design patterns



"The design pattern describes a problem that occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice."

Christopher Alexander

DESIGN PATTERN GROUPS:

ENERGY USE

ENERGY PRODUCTION

DENSIFICATION

DESIGN PATTERNS STRUCTURE

Design pattern GROUP

Design PATTERN

title of design pattern

problem statement of design pattern

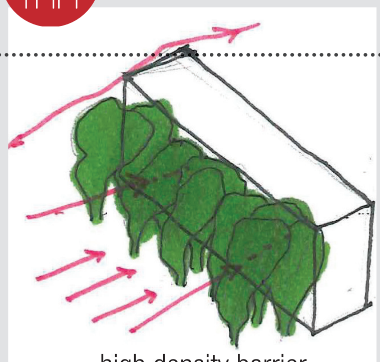
Design SUB-PATTERN

reference project/ design idea

FACADES EXPOSED TO PREVAILING WINTER WIND

Problem statement
Sides of building exposed to wind during winter have as a result significant loss of building energy especially in the case of the poorly insulated post-war buildings. No or insufficient (deciduous) protection from vegetation is also a common phenomenon. Therefore high density barriers should be placed in the presence of main flow (full speed). Low density barrieres are more appropriate in cases of wake interference or lee eddys.

URBAN FOREST



high density barrier

Reference
left: Azelia Residence (Bandar Sri Damansara, PJ)
right: The Court Square Press (Landworks Studio)

DESIGN PATTERNS

A. FACADES EXPOSED TO PREVAILING WINTER WIND

Problem statement

Sides of building exposed to wind during winter have as a result significant loss of buildings' heat especially in the case of the poorly insulated post-war buildings. No or insufficient (deciduous) protection from vegetation is a common reason for exposure to wind. Also low H/W ratio for parallel rows results in wind's acceleration regaining. Meanwhile, parallel linear blocks with large open spaces inbetween them are common in dutch post-war neighbourhoods. Therefore high density barriers should be placed in the presence of main flow (full speed). Low density barriers are more appropriate in cases of wake interference or lee eddys.

B. WIND SPEED ACCELERATION DUE TO TUNNEL EFFECT

Problem statement

Parallel rows of buildings when oriented in parallel to the prevailing wind direction create an acceleration of the wind which in turn intensifies the negative impact of wind on building energy consumption. Therefore barriers should be placed to decrease, if not to block it entirely, the wind speed.

C. LACK OF PASSIVE HEATING

Problem statement

The optimum orientation of living spaces is facing south for solar passive heating. Indeed in some of the post war buildings the entrance is north so that living spaces can freely face the south. However it is also common for a 'stamp' to consist of different – often perpendicular to each other – orientated buildings. Therefore some buildings face E-W which is disadvantageous both for winter and summer moths. Therefore, where possible glazed spaces should be created to maximize passive heating during winter months and at the same time provide for cooling opportunities during summer. Where not possible or desireable, the possibility is given for infill development since there is already no solar exposure and densification is considered desireable.

D. UNUSED AND ENERGY-LACKING **ROOFTOPS OF RESIDENTIAL BUILDINGS**

Problem statement

M

Rooftops on residential buildings are under- or unused. In mid-rise buildings a combination of energy production and active use by residents is both desireable and possible.The height of mid-rise buildings shows lower wind speeds which means, on the hand specific technologies can only be productive, on the other hand they can be actively used by residents. Elements such as orientation, position, visual impact and combination with other uses, need to be taken into account for design decisions.

E. UNUSED AND ENERGY-LACKING **HIGH-RISE BUILDINGS' SURFACES**

Problem statement

L

In many post-war neighbourhoods there is a significant number of high rise buildings. The wind speeds at these heights are higher and unblocked by surrounding buildings, the same applies for sun on the higher floors.

F. UNDERUSED AND ENERGY-LACKING **PUBLIC SPACES**

Problem statement

PS

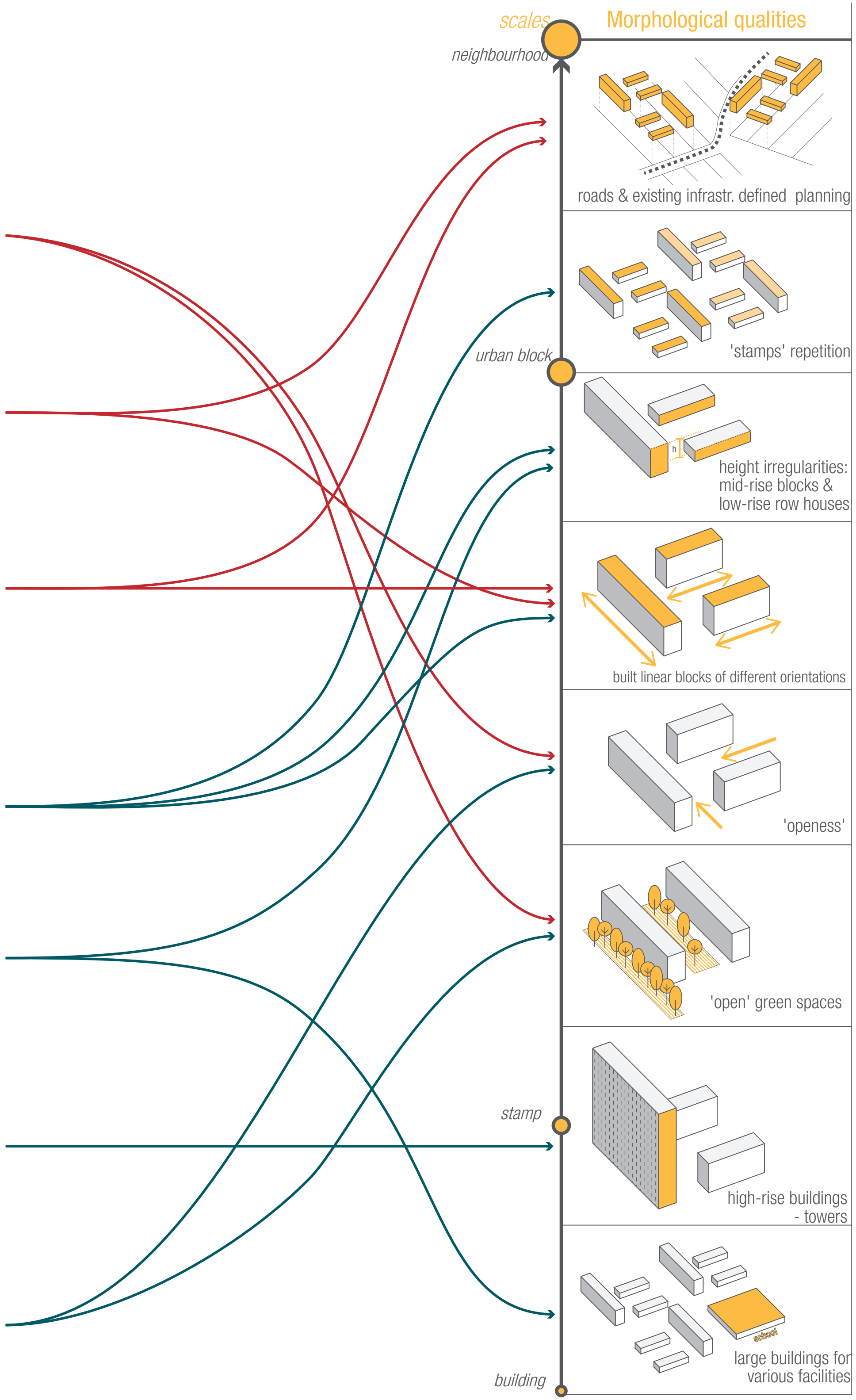
The result of openess and zoning has been an abundance of public spaces for green or activities but are currently largely underused. These large and undefined spaces have the potential with the implementaion of various innovative technologies to be revitalized while contributing in lowering energy demand of buildings or more importantly in energy production.

G. SMALL OR UNPRODUCTIVE RESIDENTIAL ROOFTOPS

Problem statement

NR

Rooftops on residential buildings can often be too small to produce enough energy or the circumastances might be unfavourable, such as shadow on single-family houses from blocks of flats. Public or commercial buildings located usually in the centre or orderly in relation to houses, usually have large rooftops appropriate for large installations of PV panels. Their location in relation to houses can serve well in connecting the houses to this more central installations.



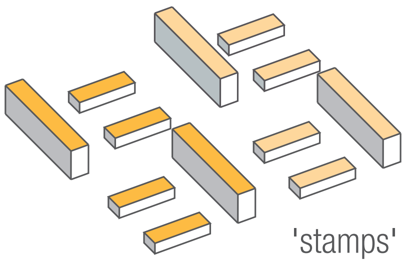
DESIGN PATTERNS

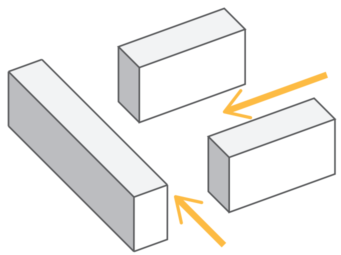
CLIMATIC CONDITIONS FOR DUTCH CLIMATE (temperate maritime climate influenced by the North Sea)	WIND PATTERNS: WINTER [MAIN FOCUS] moderate winters -cold & strong wind from North Sea	WIND PATTERNS: SUMMER [ACCOUNTED FOR] cool summers -sea breeze	SOURCES	SOLAR RADIATION: WINTER [MAIN FOCUS] moderate winters -cloudy; less solar radiation	SOLAR RADIATION: SUMMER [ACCOUNTED FOR] COOL SUMMERS	SOURCES
ENERGY USE						
-district/neighbourhood			[1]Oke, 1987; [2]Jurelionis, Bouris, 2016; [3]Eumorfopoulou, Kontoleon, 2009; [4]Salat, 2014			[14]McPherson et al., 1988; [15]Olygay et al., 2015; [16]Scott, Ben-Joseph, 2012; [4]Salat, 2014
urban block morph.: heights	min. height irregular., avoid tall buildings					
urban forest	urban forest (for fully exposed blocks)[1]	not perpendicular to summer breeze				
street & open sp. orientation	perpendicular or sidewards to the wind					
high housing density						
-urban block/street						
urban block morph.: form	(1) paral. rows of linear blocks/elong.forms			(1) free arr. of linear blocks/elong. forms		
	(2) perimeter blocks			(4) T-shaped/cross forms		
	(3) compact form					
vegetation	evergreen rows of trees, perpend. to wind	sum… …ze direction: no vegeta…		deciduous trees: solar access for winter, shadow for summer		
orientation	perpendic. or sidewards (45º) to the w…				tree rows parall. to W faces	
width street ratio: Height/Width	H/W ≥0.65[1]	parallel or sidew… …5º)		H/W≤2 (traditional deep canyon),	high dens. in open spaces;	
	infill where … /≤0.65 (to achieve			by densif. keep H/W as low as possible;	blocks facing E-W, united	
density & solar exposure	skimming f… and avoid wake interf…			blocks facing E-W, united with atrium	with atrium	

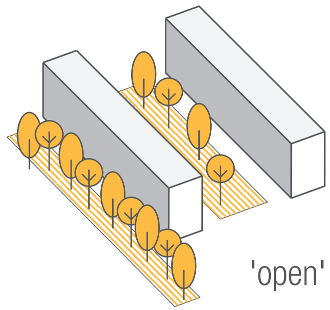
FACADES EXPOSED TO … REVAILING … VINTER WIND

Problem statement

Sides of building exposed to … nd during wi… r have as a result significant loss of buildings … t especially in the case of the poorly insulated post-wa… uildings. No or insufficient (deciduous) protection from vegetation … common reason for exposure to wind. Also low H/W ratio for parallel rows results in wind's acceleration regaining. Meanw… parallel linear blocks with large open spaces inbetween them are common in dutch post-war neighbourhoods. Therefore high density barriers should be placed in the presence of main flow (full speed). Low density barriers are more appropriate in cases of wake interference or lee eddys.


'stamps' repetitio


'openess'

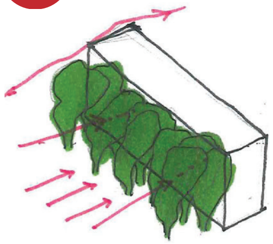

'open' green spaces

FACADES EXPOSED TO PREVAILING WINTER WIND

Problem statement

Sides of building exposed to wind during winter have as a result significant loss of buildings' heat especially in the case of the poorly insulated post-war buildings. No or insufficient (deciduous) protection from vegetation is a common reason for exposure to wind. Also low H/W ratio for parallel rows results in wind's acceleration regaining. Therefore high density barriers should be placed in the presence of main flow (full speed). Low density barriers are more appropriate in cases of wake interference or lee eddys.

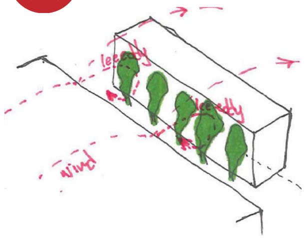
P1_URBAN FOREST



high density barrier

Reference
left: Azelia Residence (Bandar Sri Damansara, PJ)
right: The Court Square Press (Landworks Studio)

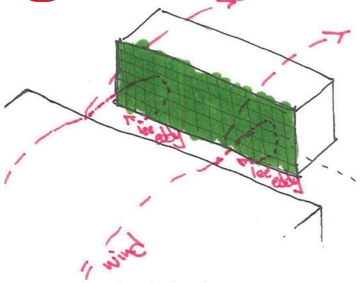
P2_EVERGREEN TREE ROW



low density barrier

Reference
Nieuw Leyden (MVRDV)

P3_'GREEN' WALLS



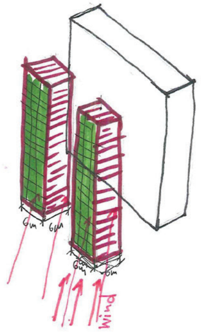
low density barrier

Reference
The greenscreen® trellis system of engineered mounting accessories is designed to hold greenscreen® trellis panels off the building surface, protecting the building's waterproof membrane from direct plant attachment and transferring the weight of the plants to the screen structure and the wall. Panels can be stacked side to side or top to bottom to cover larger areas.
Fishers Place Parking Structure Facade, Rockville MD (greenscreen)

P17_COMPACT FORM

Problem statement

Compact form – aka structure with minimum exterior surface and a planar analogy of 1: 1.1-1.3 elongated on E-W axis – can sustain its inner heat better and if the width or legth remains under 10m it is easily heated. Therefore, and given current insulation systems and the incorporation of green walls, a line of compact towers can provide shelter for post-war high-rise buildings.



Neubau MFO-Park Zürich (Burckhardt+Partner AG, Raderschall Landschaftsarchitekten)

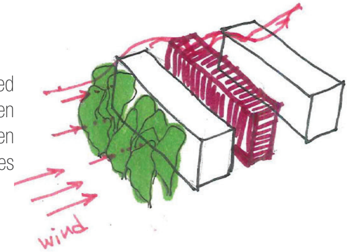
ReGen village vertical farming system (EFFEKT Architects)

Urban Farm at Pasona Tokyo Headquarters is a nine story high corporate office building (KONODESIGNS)

P18_PARALLEL ROWS DENSIFICATION

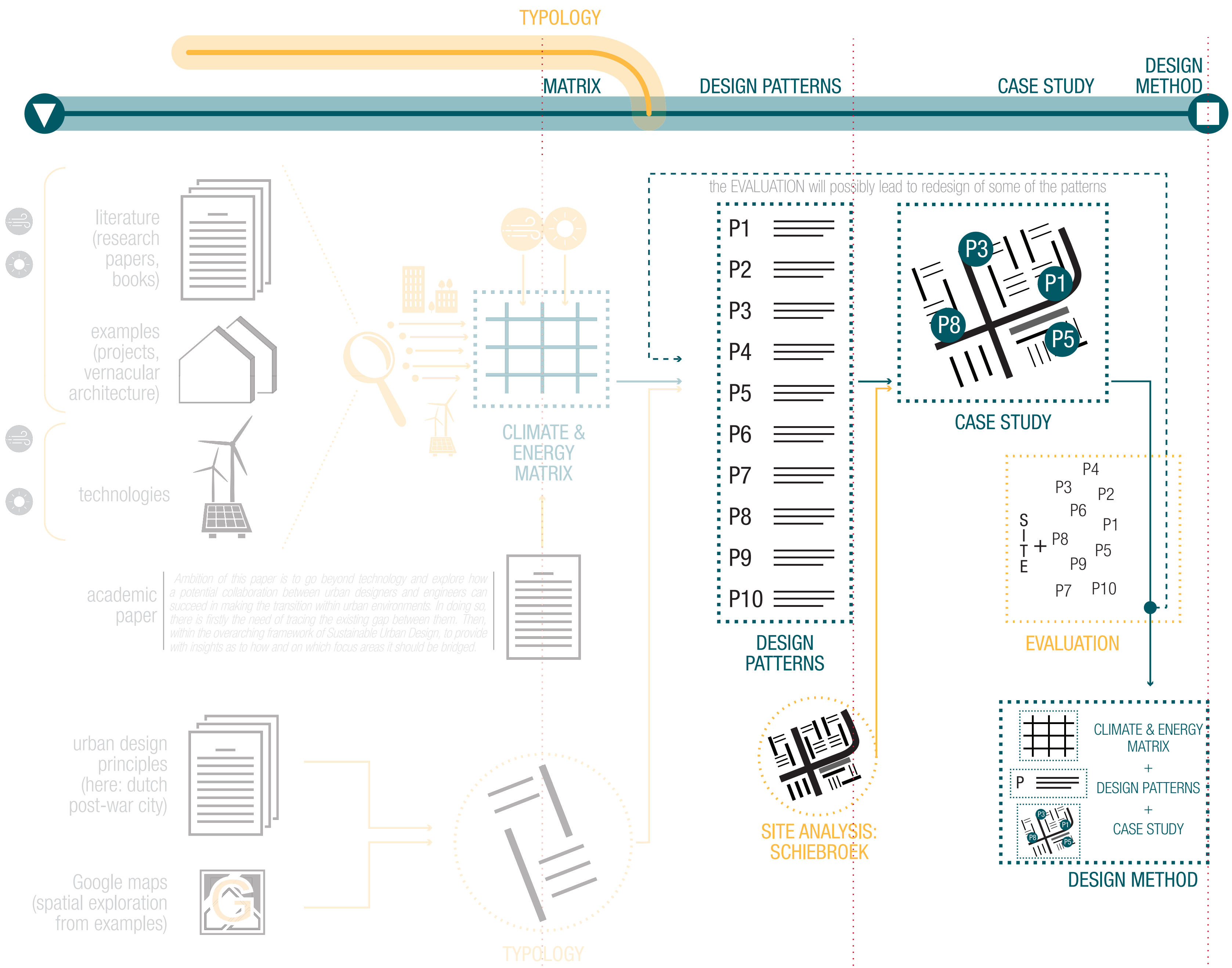
Problem statement

The wind flow when encountering a hard-edged building (flat roof, vertical walls) is displced over the building which then functions as a shelter for succeeding buildings. However when the buildings set in parallel have large spacing in between them (low hight-to-width ratio) then the sheltering effect is lost. Densifying the in between space by adding a new row restores the sheltering effect.

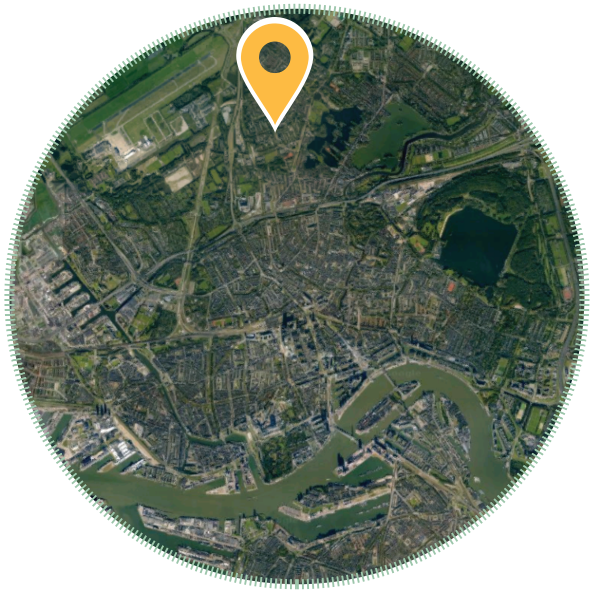


Y:Cube (Rogers Stirk Harbour + Partners, YMCA London South West)

Case study & Design method



LOCATION SELECTION: SCHIEBROEK ZUID, ROTTERDAM



NEIGHBOURHOOD/DISTRICT SCALE

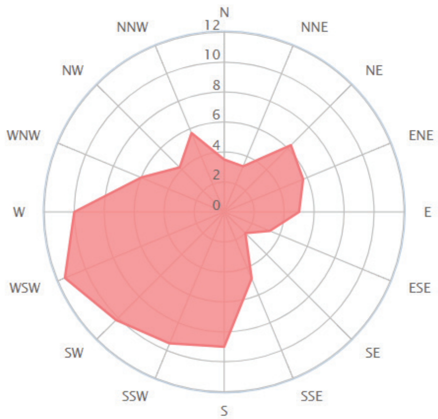
CLIMATIC CONDITIONS FOR DUTCH CLIMATE
(temperate maritime climate influenced by the North Sea)

ENERGY USE

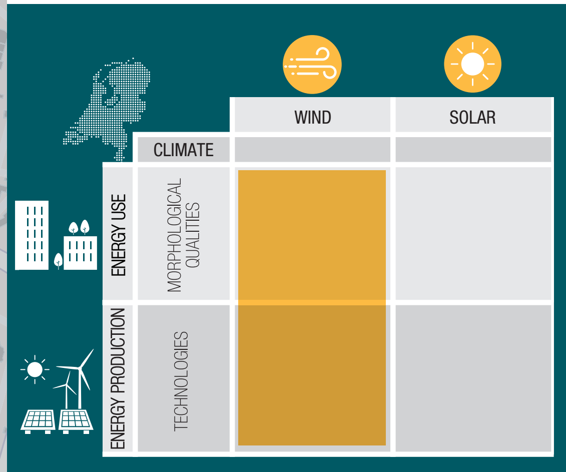
-district/neighbourhood
- urban block morph.: heights
- urban forest
- street & open sp. orientation
- high housing density

-urban block/street
- urban block morph.: form
- vegetation
- orientation
- width street ratio: Height/Width
- density & solar exposure

-building (parcel)
- orientation
- vegetation
- bulding plan (envelope)
- infill development AND dense & energy efficient h.typ.



CASE STUDY - LOCAL CONDITIONS



CASE STUDY - LOCAL CONDITIONS

URBAN BLOCK/STREET SCALE

CLIMATIC CONDITIONS FOR DUTCH CLIMATE
(temperate maritime climate influenced by the North Sea)

ENERGY USE

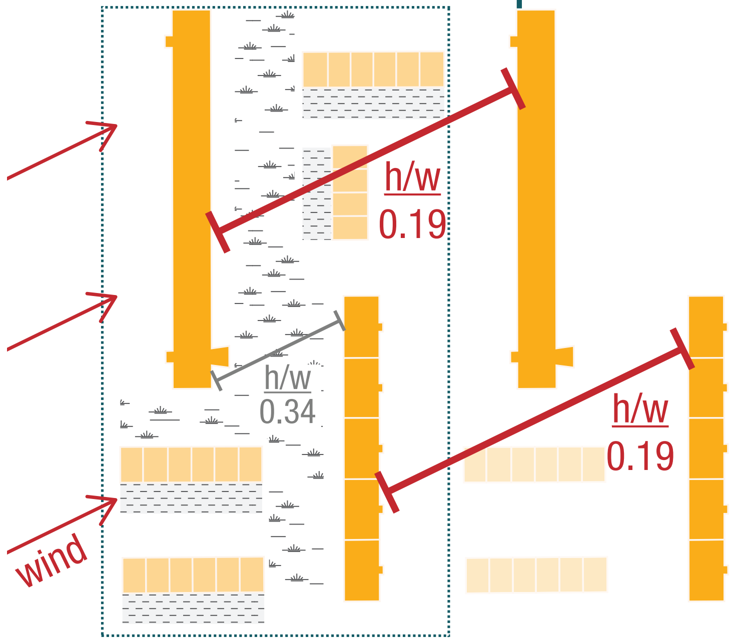
-district/neighbourhood
- urban block morph.: heights
- urban forest
- street & open sp. orientation
- high housing density

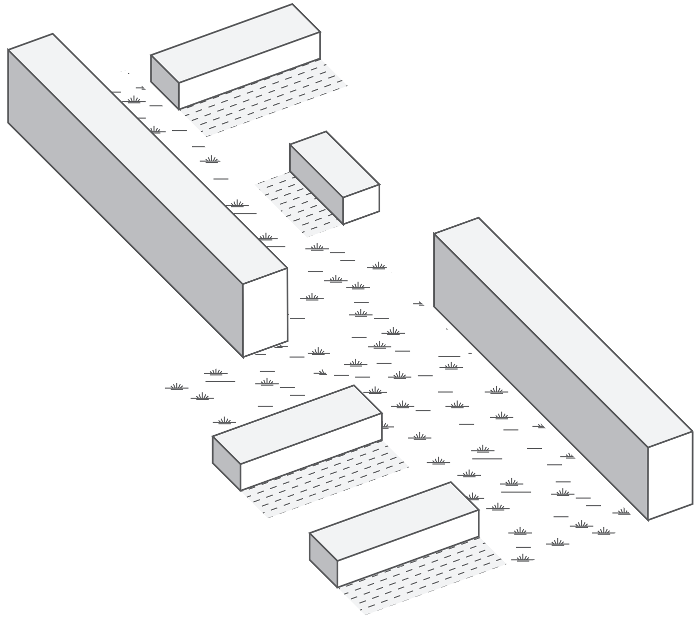
-urban block/street
- urban block morph.: form
- vegetation
- orientation
- width street ratio: Height/Width
- density & solar exposure

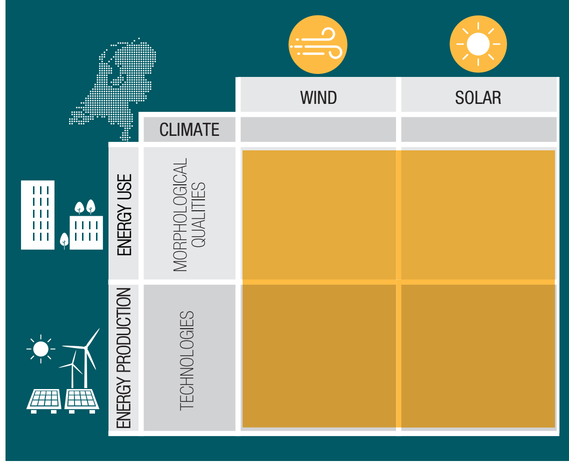
-building (parcel)
- orientation
- vegetation
- bulding plan (envelope)
- infill development AND dense & energy efficient h.typ.

CASE STUDY - LOCAL CONDITIONS

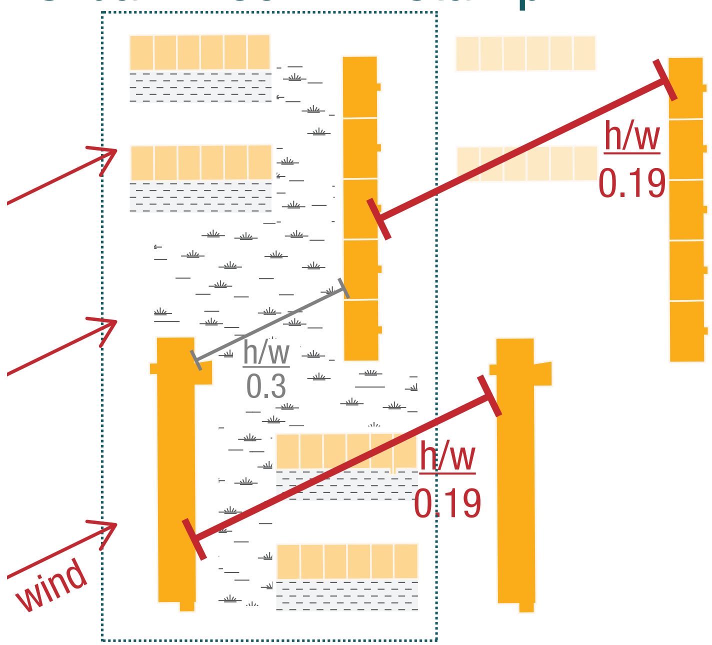
Urban Block A - stamp

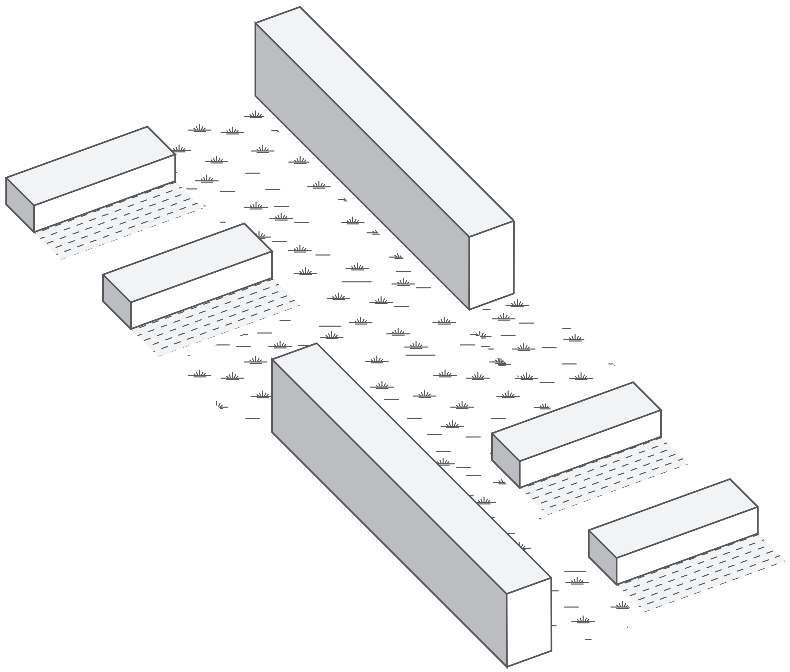


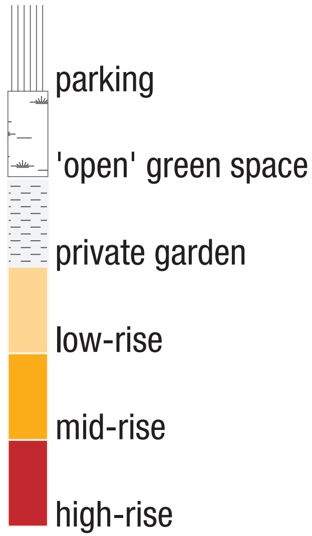




Urban Block B - stamp

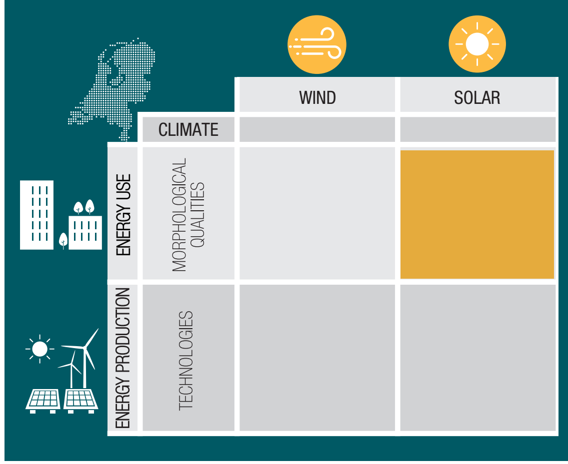






URBAN BLOCK/STREET SCALE

CASE STUDY - LOCAL CONDITIONS



CLIMATIC CONDITIONS FOR DUTCH CLIMATE
(temperate maritime climate influenced by the North Sea)

ENERGY USE

-district/neighbourhood

urban block morph.: heights
urban forest
street & open sp. orientation
high housing density

-urban block/street

urban block morph.: form

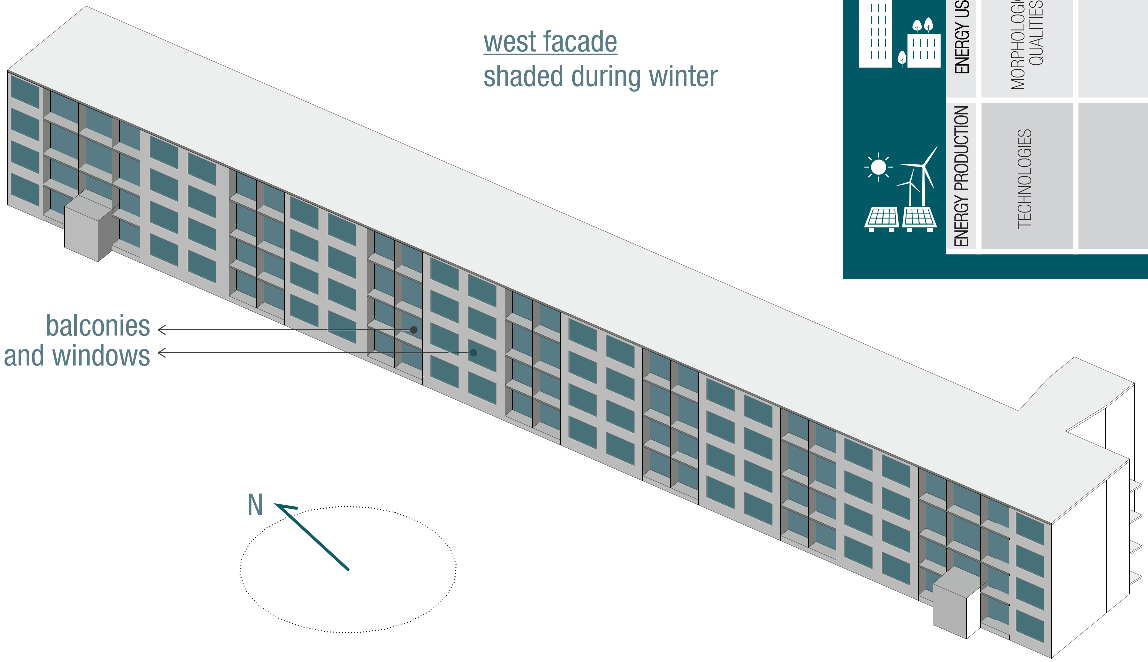
vegetation
orientation
width street ratio: Height/Width

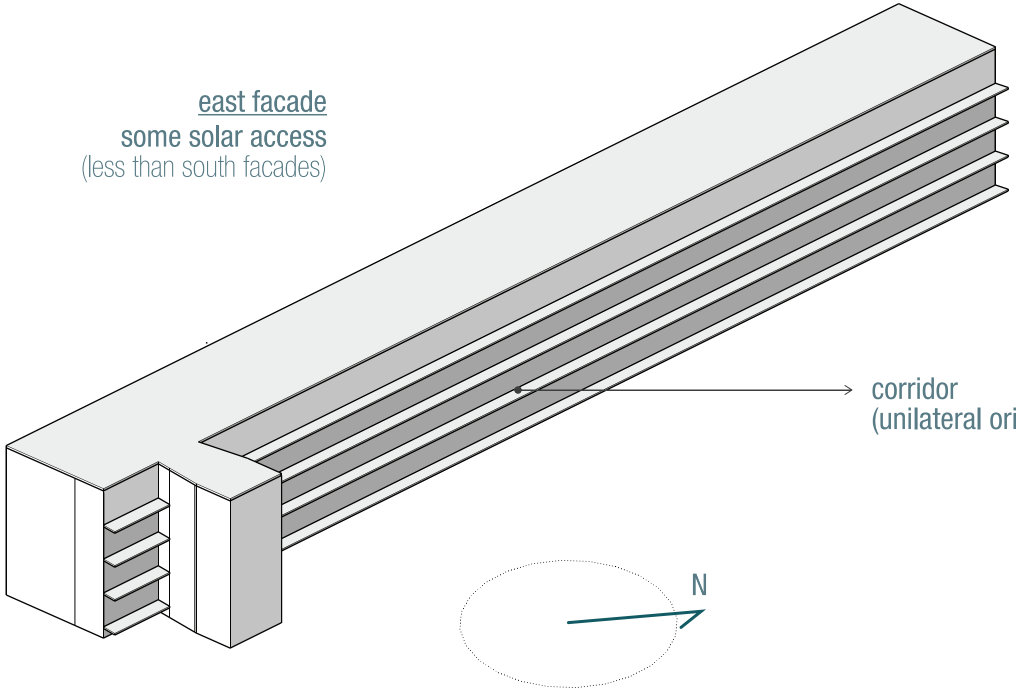
density & solar exposure

-building (parcel)

orientation
vegetation
bulding plan (envelope)

infill development AND
dense & energy efficient h.typ.





CASE STUDY – LAYER ANALYSIS MAPPING

		WIND	SOLAR
ENERGY USE		1. wind's influence on energy use SURFACES/MORPHOLOGY LOCATION residential buildings DESIGN PATTERNS A,B	2. solar exposure and passive heating SURFACES/MORPHOLOGY LOCATION residential buildings DESIGN PATTERNS C
ENERGY PRODUCTION		3. wind energy generation potential SURFACES/MORPHOLOGY LOCATION M L PS DESIGN PATTERNS D, E, F, G	4. solar energy generation potential SURFACES/MORPHOLOGY LOCATION M L NR PS DESIGN PATTERNS D, E, F, G

CASE STUDY – LAYER ANALYSIS MAPPING

WIND

1. wind's influence on energy use

SURFACES/MORPHOLOGY

LOCATION

residential buildings

DESIGN PATTERNS

A,B

3. wind energy generation potential

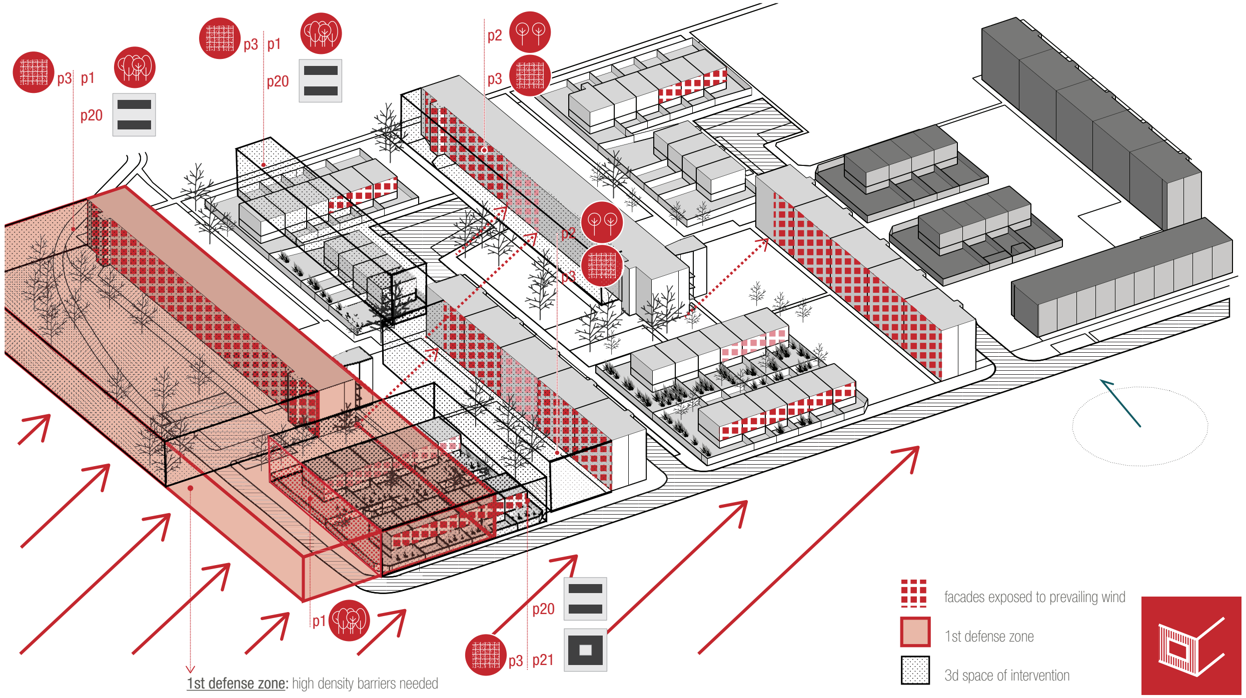
SURFACES/MORPHOLOGY

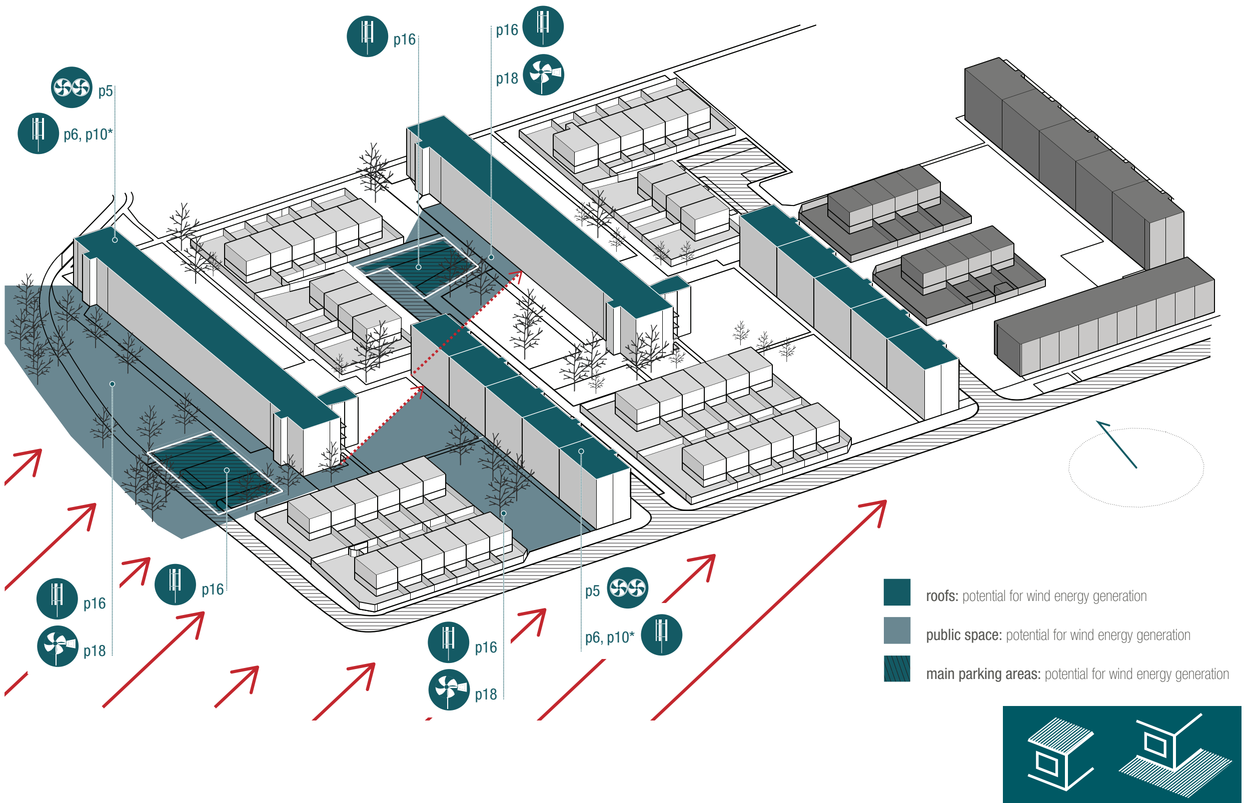
LOCATION

M L PS

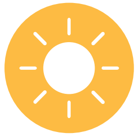
DESIGN PATTERNS

D, E, F, G





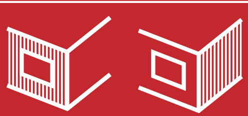
CASE STUDY – LAYER ANALYSIS MAPPING



SOLAR

2. solar exposure and passive heating

SURFACES/MORPHOLOGY



LOCATION

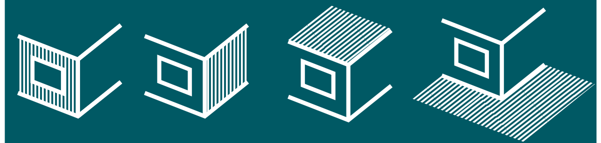
residential buildings

DESIGN PATTERNS

C

4. solar energy generation potential

SURFACES/MORPHOLOGY

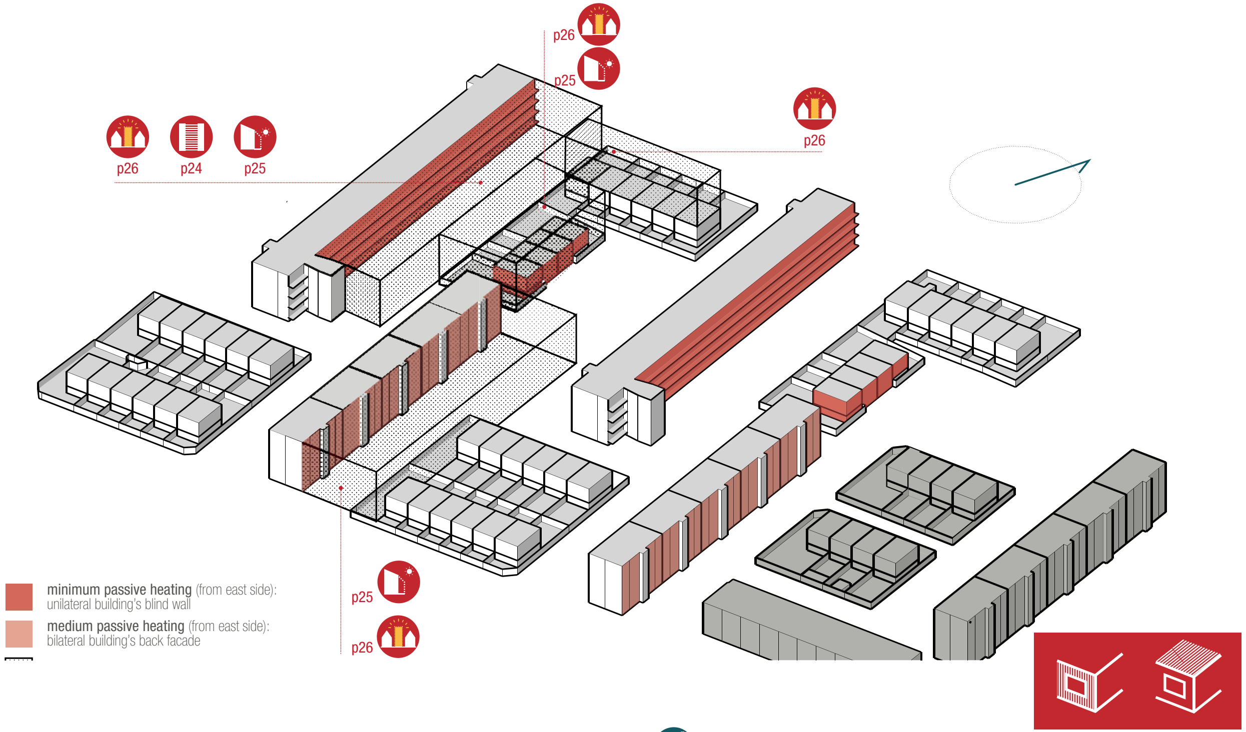


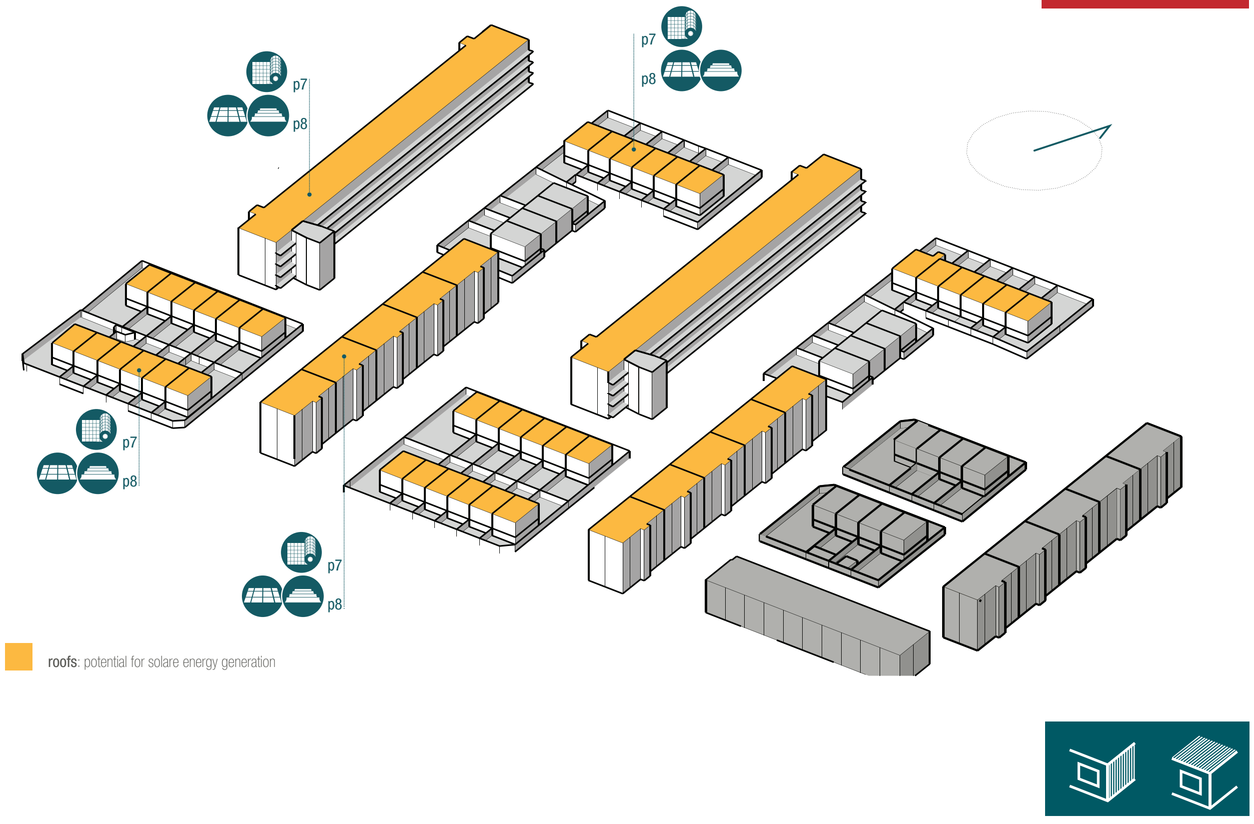
LOCATION

M L NR PS

DESIGN PATTERNS

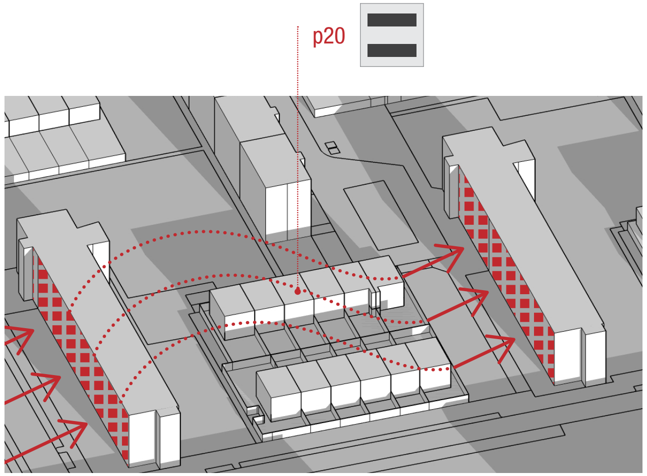
D, E, F, G



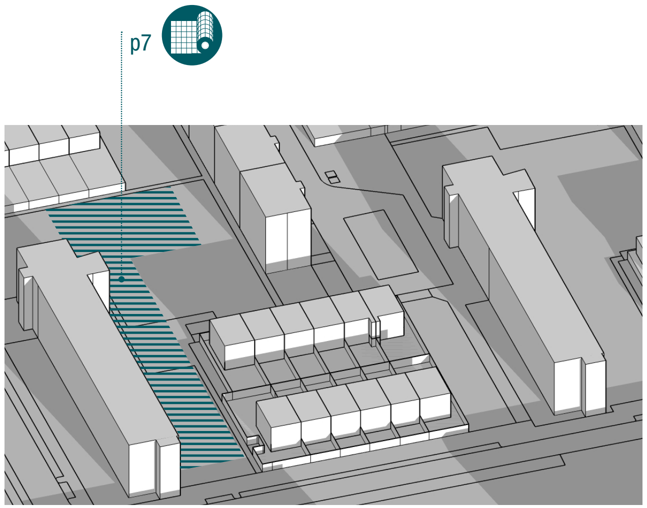


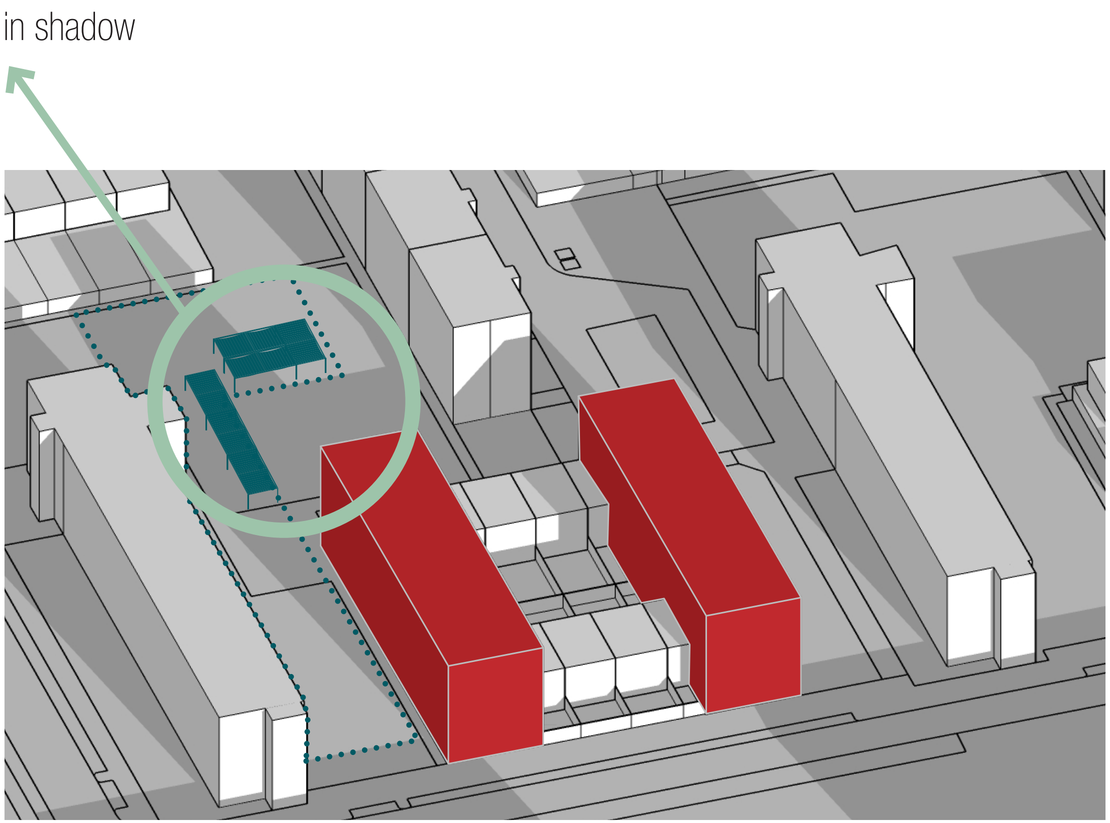
INSIGHT TO THE DESIGN METHOD

WIND PROTECTION



SOLAR ENERGY GENERATION

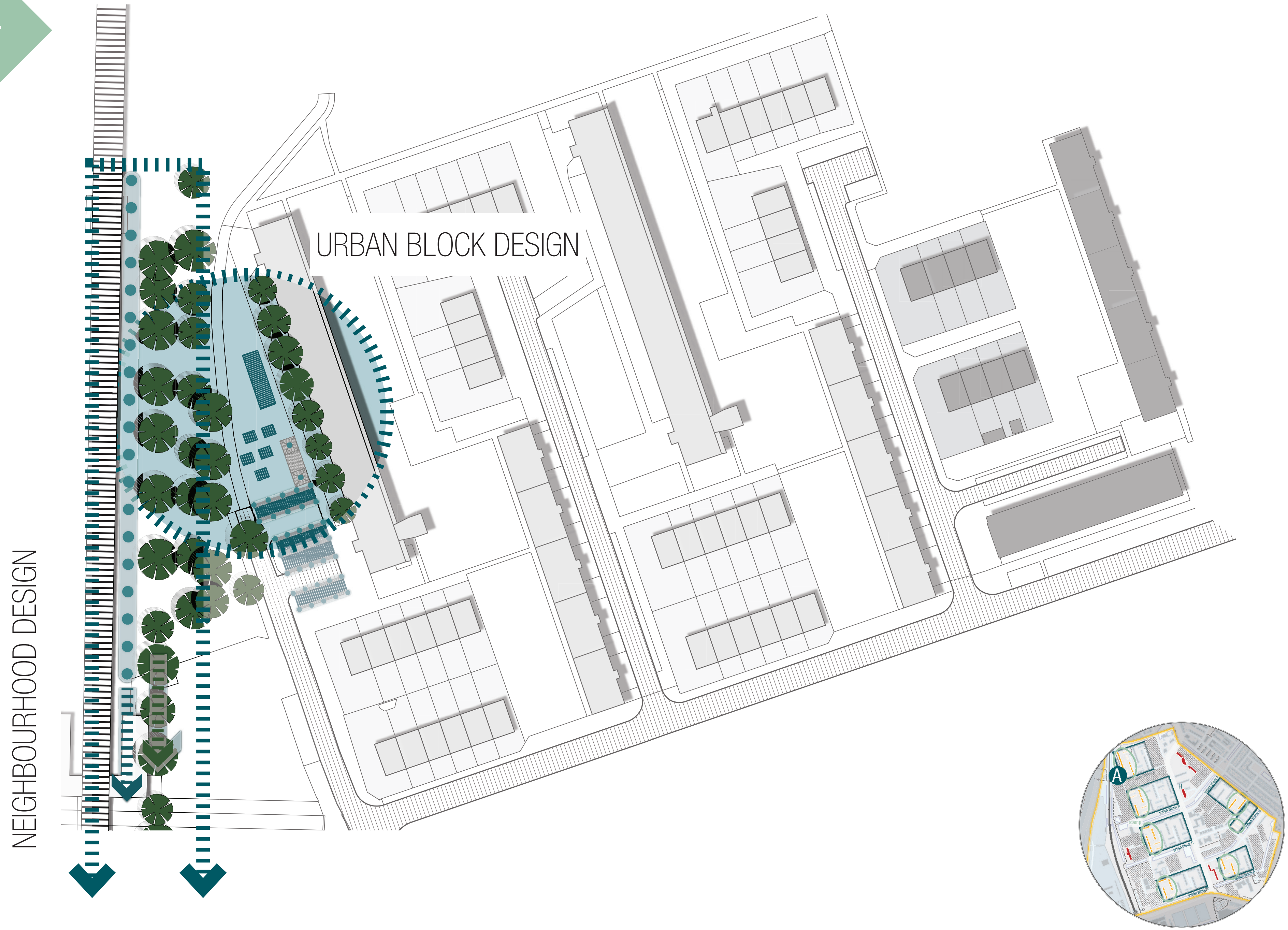




FINAL OUTCOME: CONTRADICTING EFFECTS

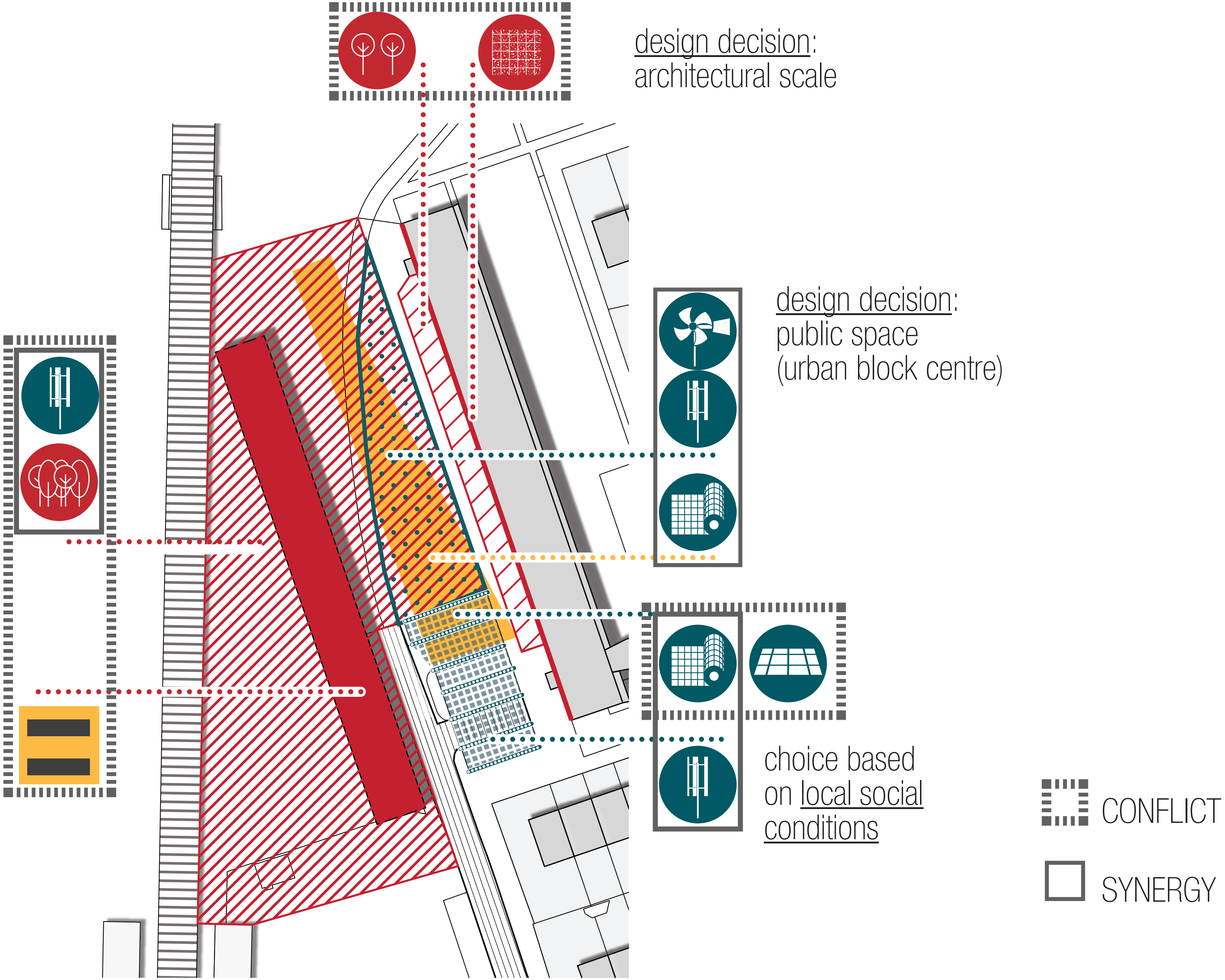
INSIGHT TO THE DESIGN METHOD

EXAMPLE



INSIGHT TO THE DESIGN METHOD

EXAMPLE



NEIGHBOURHOOD ANALYSIS ON DENSIFICATION HOTSPOTS

CASE STUDY – SUB-PATTERN IMPLEMENTATION

	BASIC ELEMENTS			POSITIONING	DESIGN RELATED INFO		EXTRA TECHNICAL INFO		
	energy source	location	morphology/ surface	position/ orientation	combined with uses	visual impact	productivity	cost	embodied energy
P4	solar & wind	M & L		fixed		high	-	-	-
P5	wind	M & L		fixed	works	high	low wind speeds (medium)	high	high
P6	wind	M & L		fixed/free		low	also low & turbulent (medium)	low	low
P7	solar	All & PS		free/120º range	works, works, works	low	low	high	high
P8	solar	M & PS		relatively free	works, works	low	high	low	low
P9	wind	M		fixed	does not work, does not work	low	high	-	-
P10	wind (& solar)	M		fixed	works	high	high	-	-
P11	solar	NR		fixed	does not work, does not work	high	high	low	low
P12	wind	L		fixed/free		low	high	-	-
P13	wind	L		fixed		high	-	-	-
P14	wind	L		free		high	high	-	high
P15	solar	L		fixed		high	high	low	-
P16	wind	PS		free	works	low	low wind (medium)	-	-
P17	solar	PS		free	works, works	high	high	low	low
P18	wind	PS		free	works, works, works	low	- (medium)	high	high

works

does not work

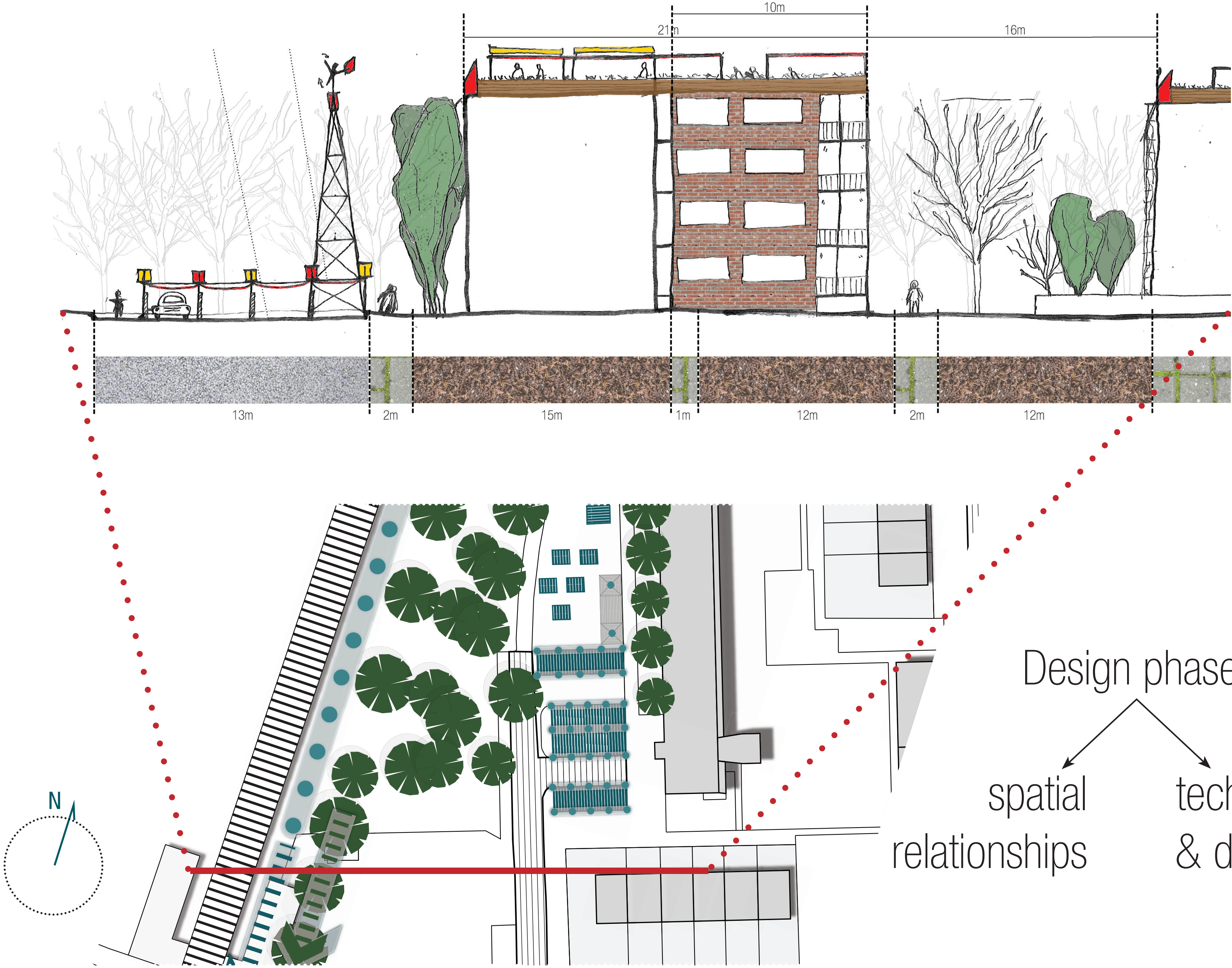
high

medium

low

irrelevant/unknown

CASE STUDY – DESIGN PHASE



Design phase

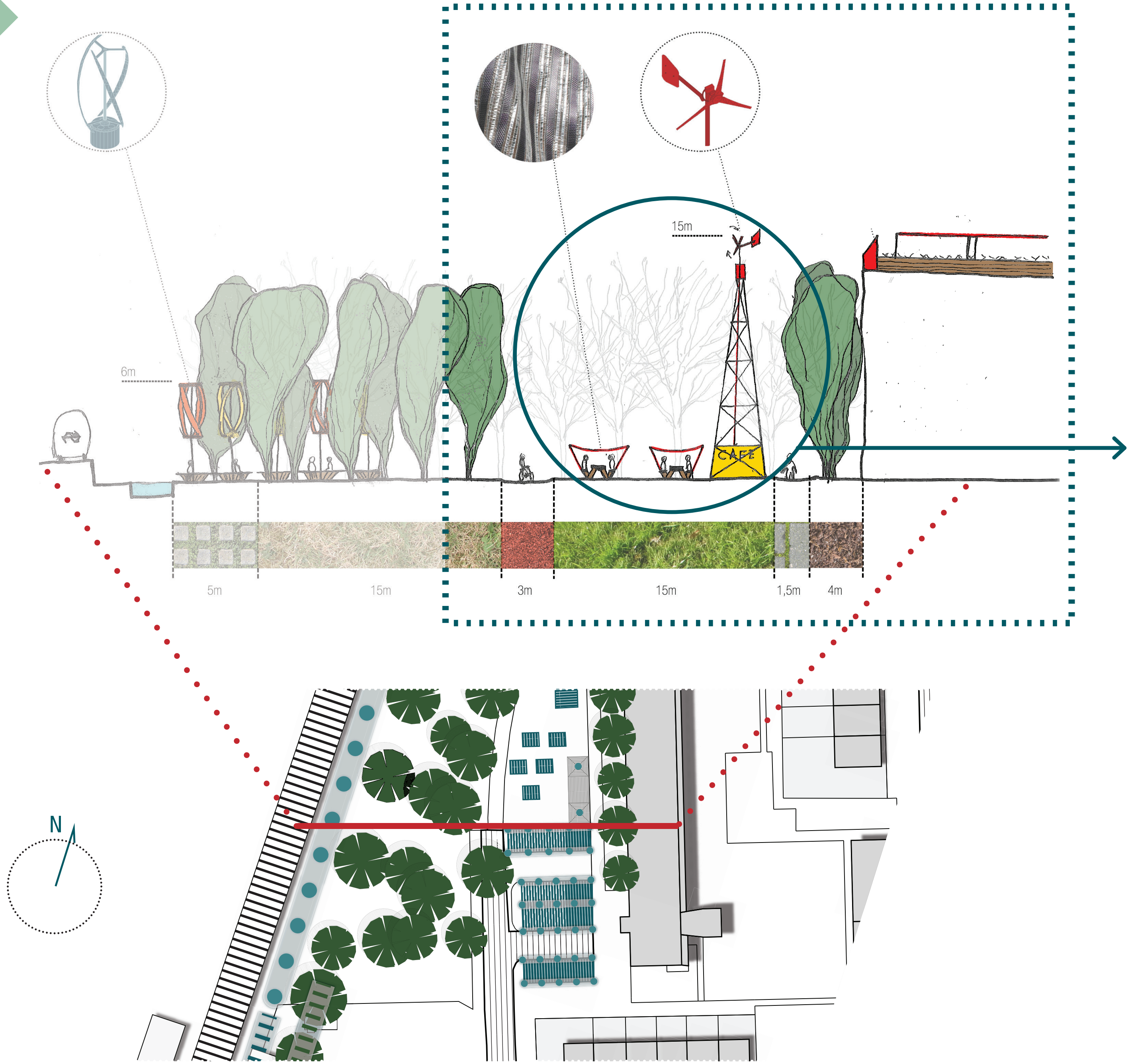
spatial relationships

technologies & design

INSIGHT TO THE DESIGN METHOD

EXAMPLE

URBAN BLOCK DESIGN



Public spaces:
energy generated used for PUBLIC ACTIVITIES

INSIGHT TO THE DESIGN METHOD

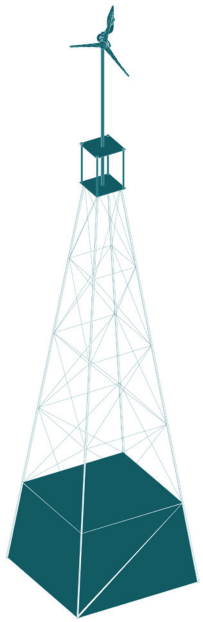
EXAMPLE

P18_HAWT \TOWER

Energy production: 3-5 kWh/day

Cost: 640 €

$\boxed{\text{Average } E \approx 14 \text{ MJ/day}}$



ENERGY CONSUMPTION of an average COFFEE MACHINE

1h= 3,600 s

Average coffee machine: 800 W(J/s) $\boxed{t \approx 5\ h}$

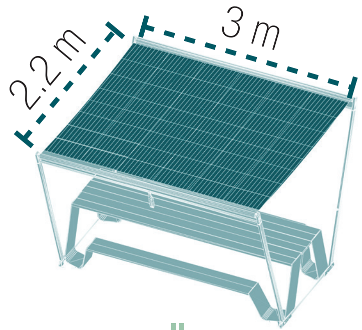
5h

INSIGHT TO THE DESIGN METHOD

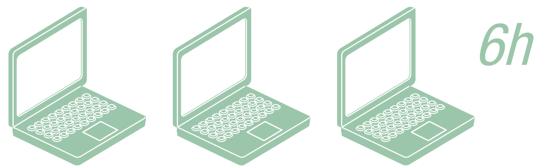
EXAMPLE

P7_SOLAR 'FABRIC'

Energy production: 0.2 kWh/day for $1m^2$ ⋯ 2.2m x 3m ⋯ **1.3 kWh/day** ⋯ $\boxed{E \approx 4.7\ MJ/day}$
(based on dutch sun peak hours for WINTER)



ENERGY CONSUMPTION of an average LAPTOP



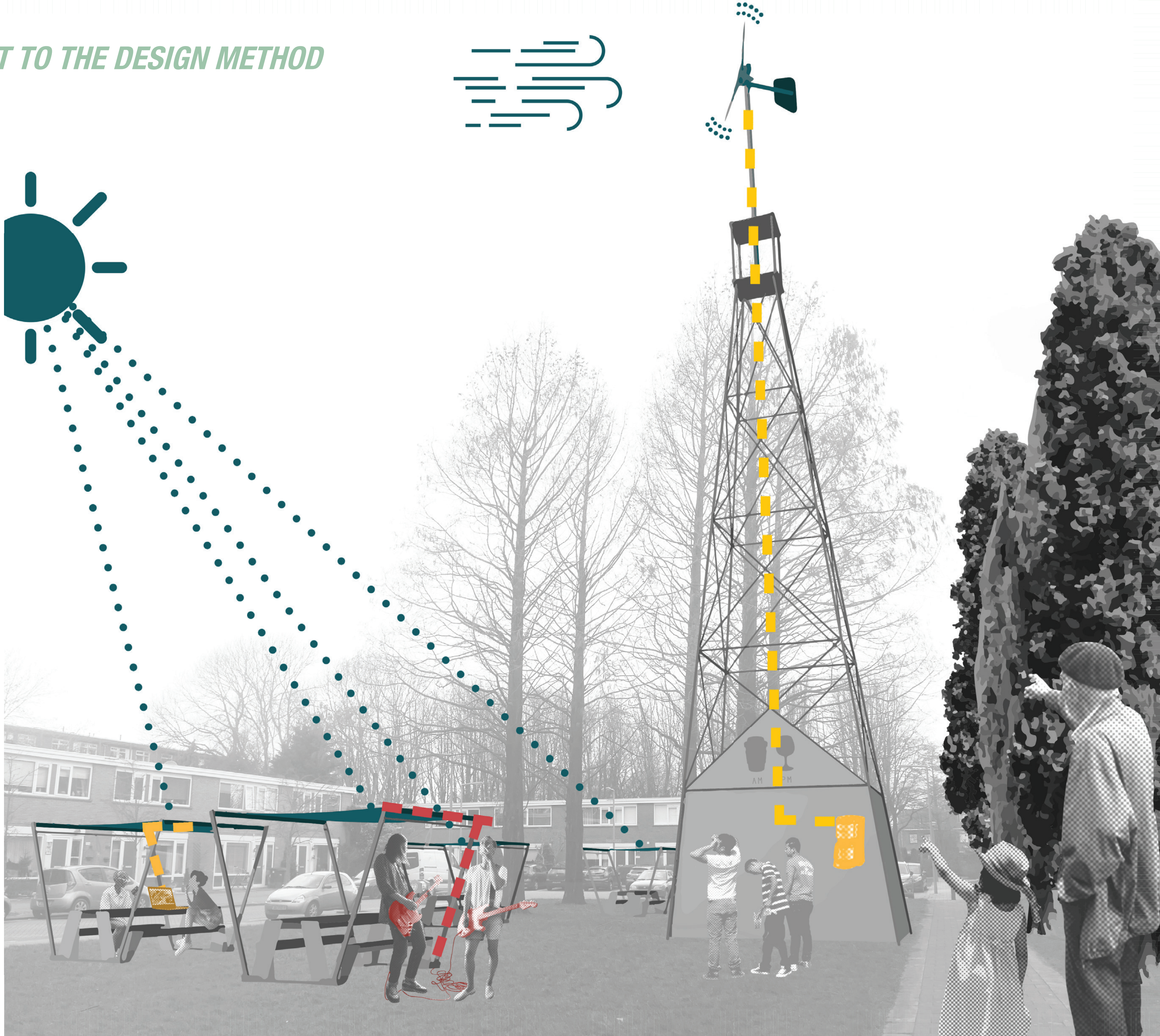
Average laptop: 60 W(J/s) ⋯ *t= 18h* ⋯ $\boxed{\text{or t=6h for 3 laptops}}$

INSIGHT TO THE DESIGN METHOD

EXAMPLE

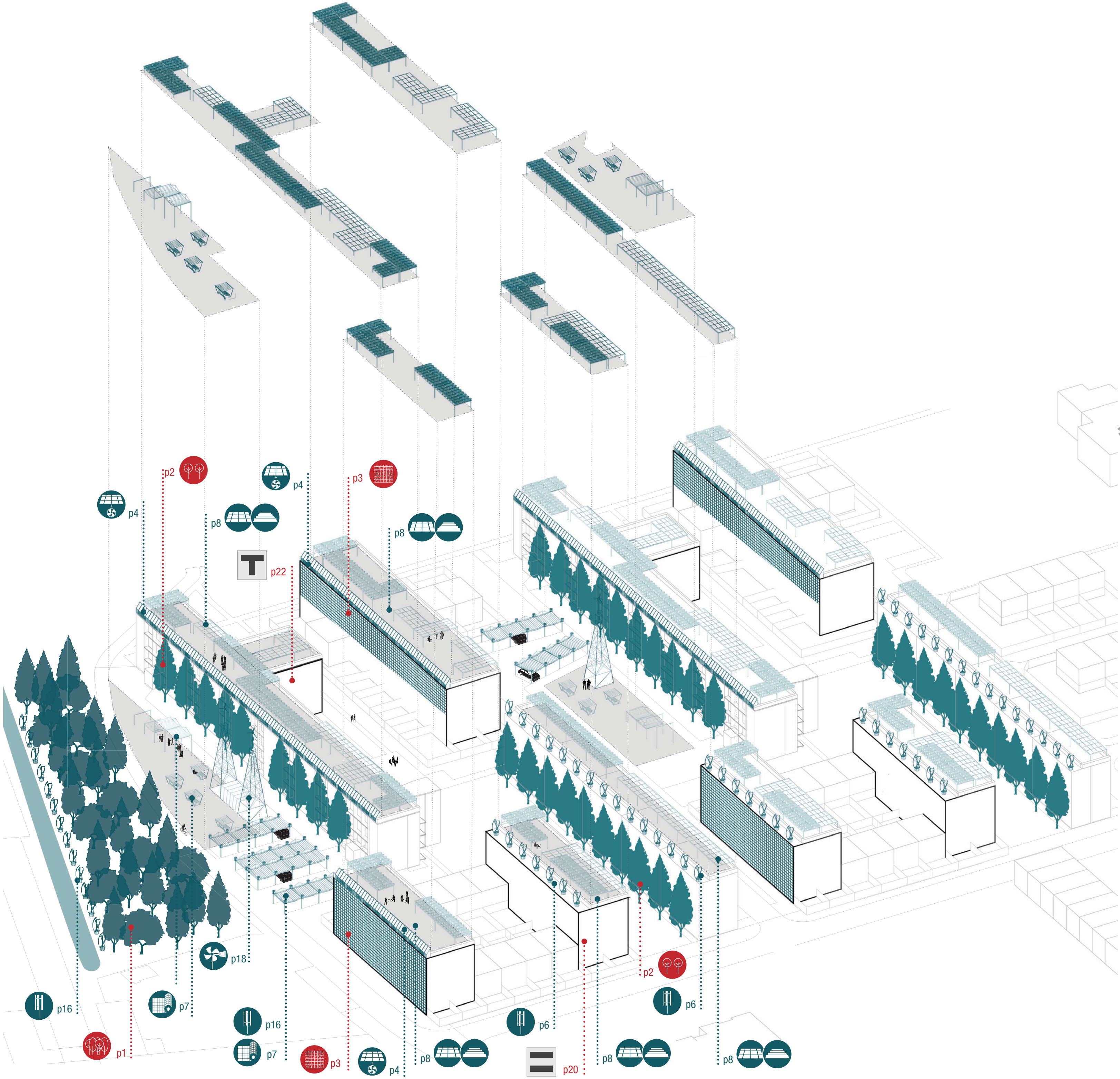
INSIGHT TO THE DESIGN METHOD

EXAMPLE

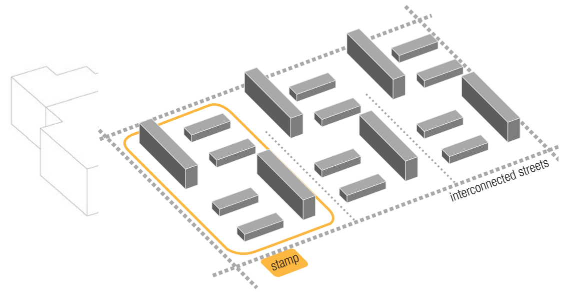


CASE STUDY — URBAN BLOCK DESIGN

URBAN BLOCK A

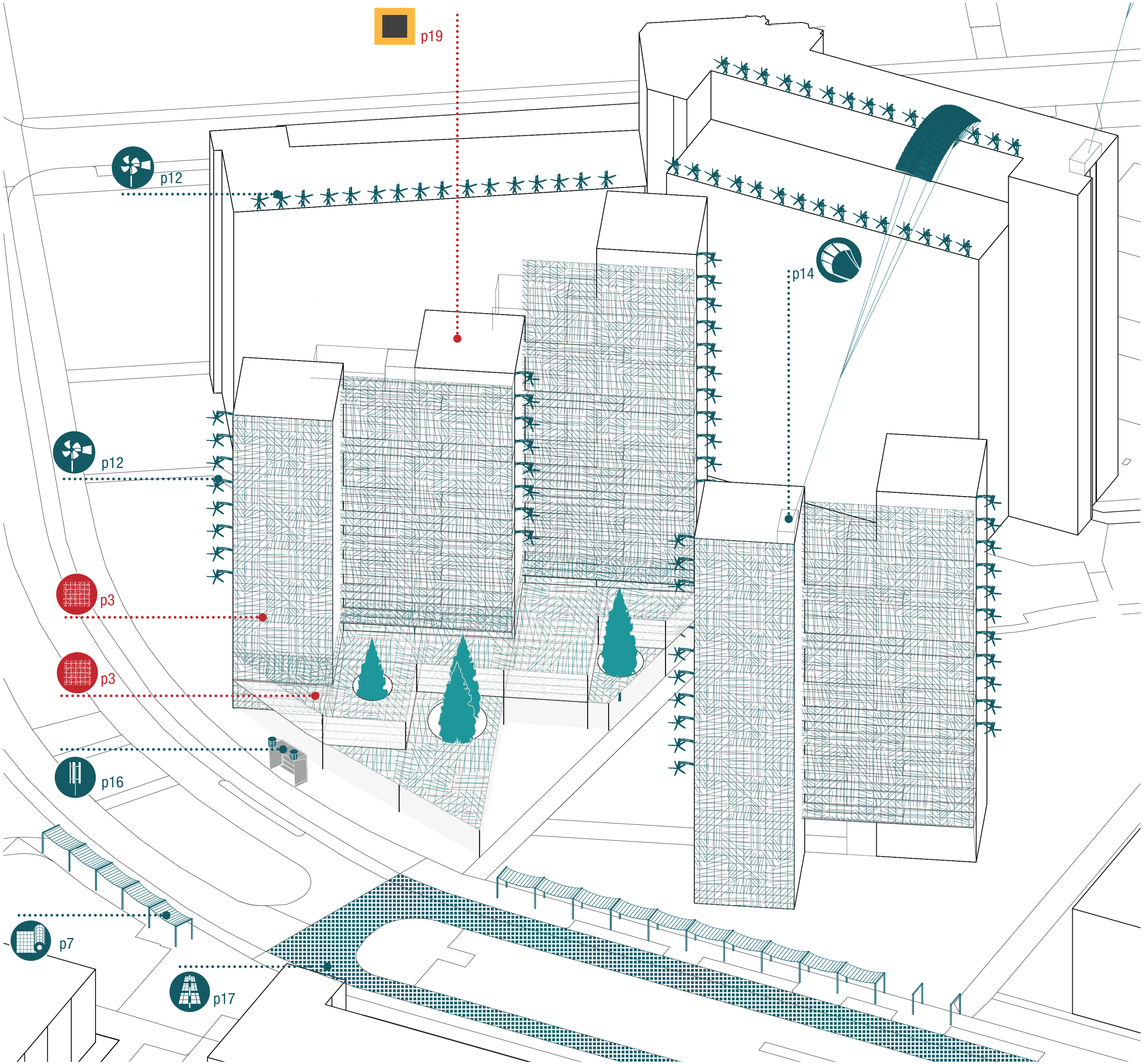


<u>Post-war neighbourhoods</u>
new urban block
(influenced by the Garden City & Modernism)

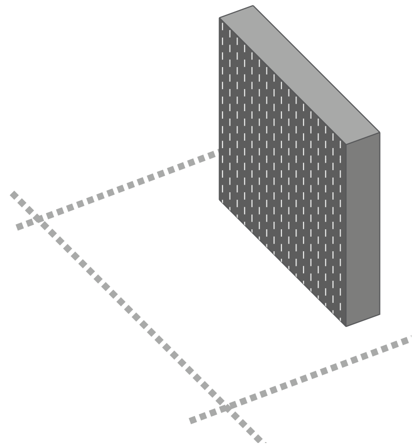


CASE STUDY – URBAN BLOCK DESIGN

TOWER SQUARE

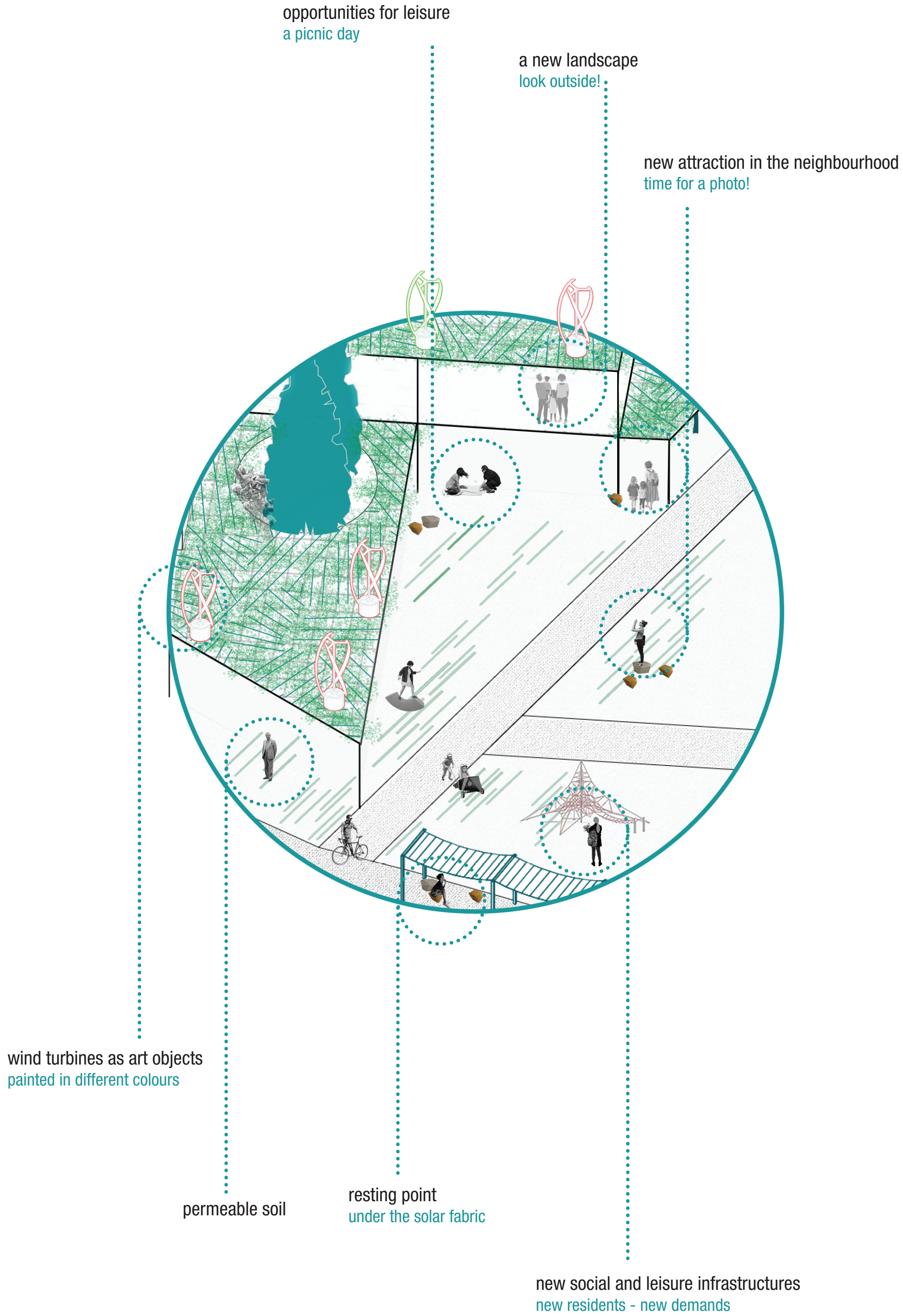


<ins>Late post-war neighbourhoods</ins>
urban block unit
(influenced by Le Corbusier)



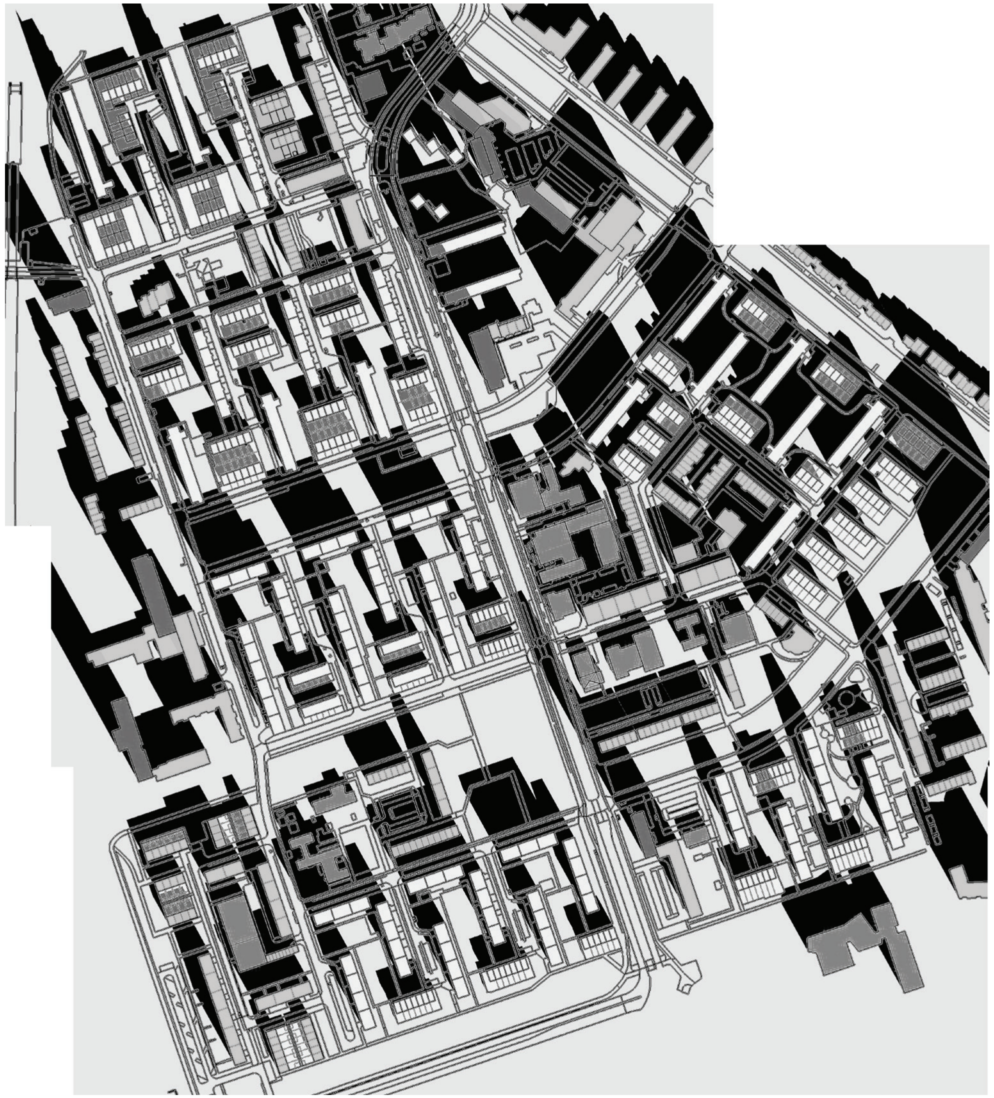
CASE STUDY – **URBAN BLOCK DESIGN**

TOWER SQUARE



CASE STUDY – **NEIGHBOURHOOD DESIGN**

NEIGHBOURHOOD ANALYSIS ON WIND & SOLAR ENERGY GENERATION POTENTIALS



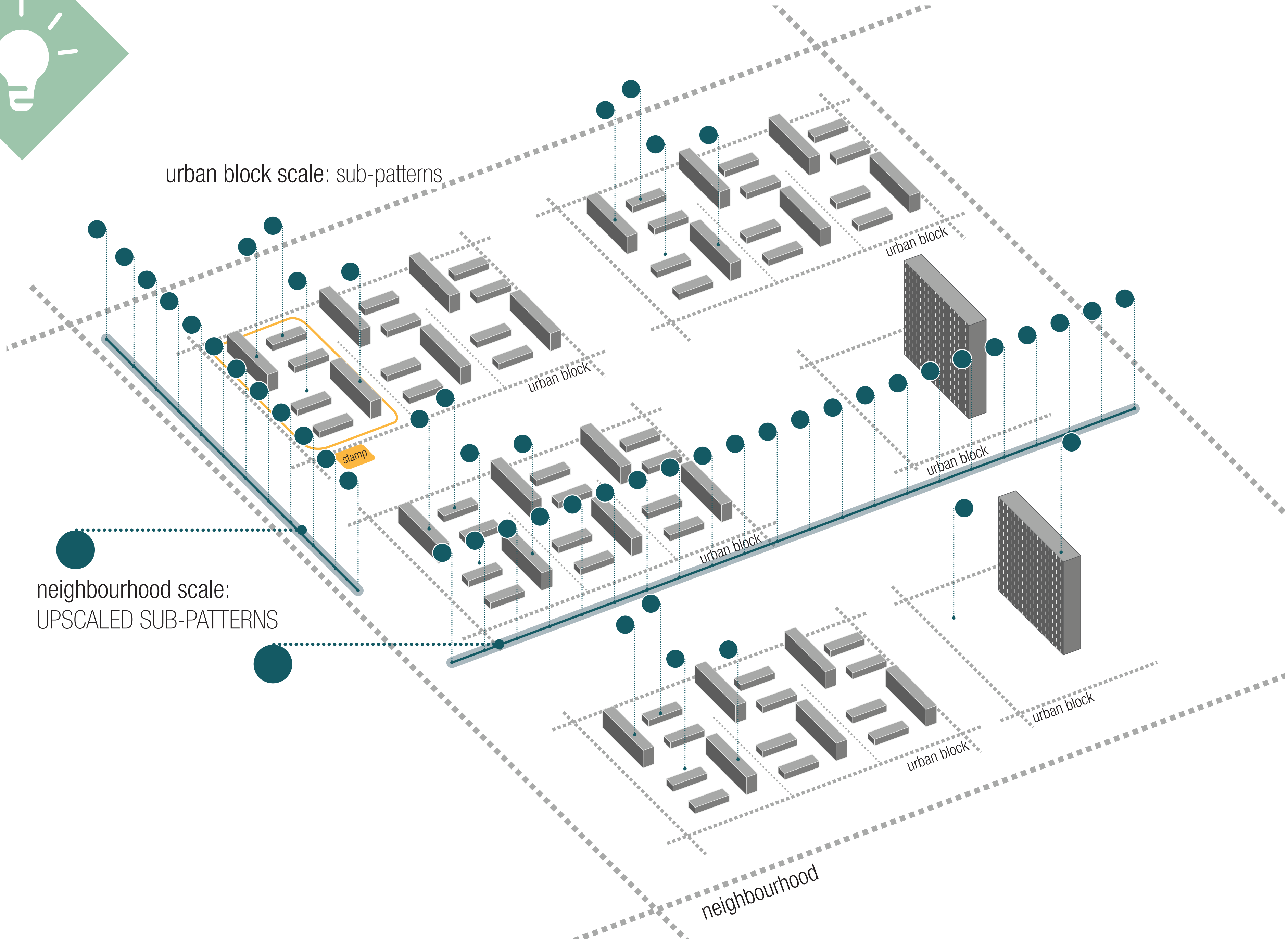
NEIGHBOURHOOD ANALYSIS ON FACILITIES AND CENTRES

- block centres
- neighbourhood subcenters
- neighbourhood centre
- centres to-be-created
- shopping strips
- important facilities (educational, recreational, cultural)

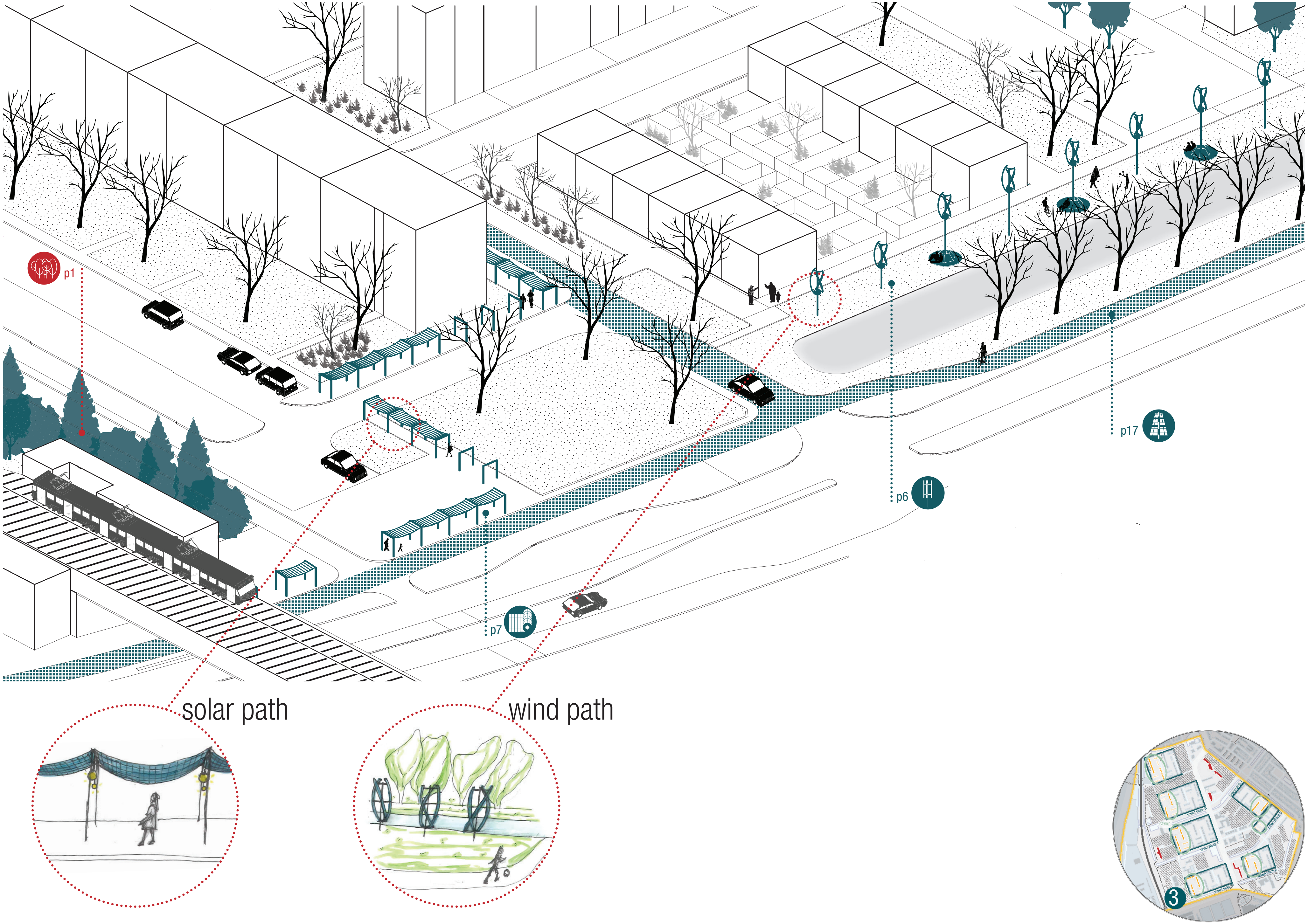
- train station
- tram station
- bus station
- railway
- main street
- tram line
- neighbourhood streets

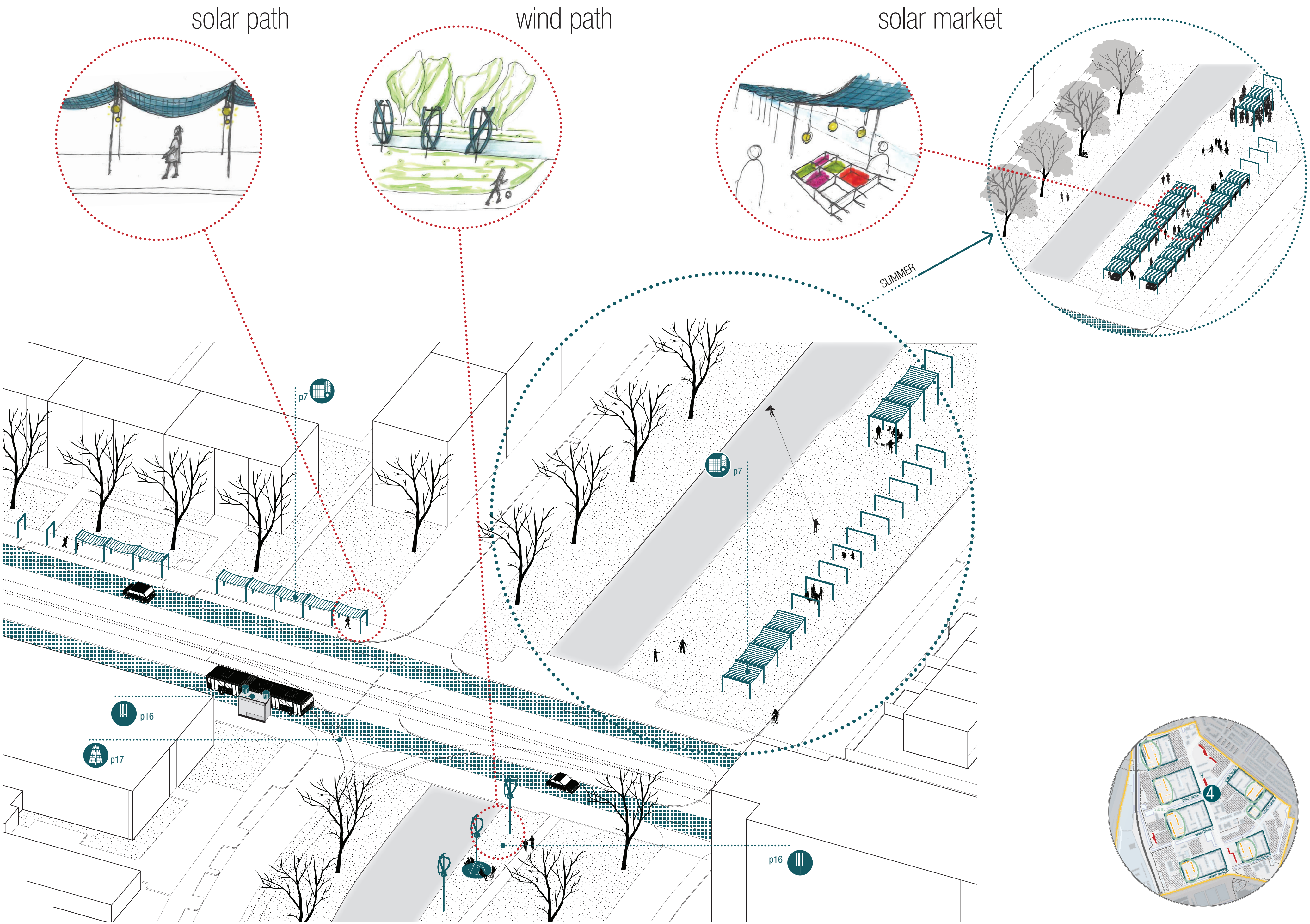
- energy productive strips (tram lines & singels)

INSIGHT TO THE DESIGN METHOD

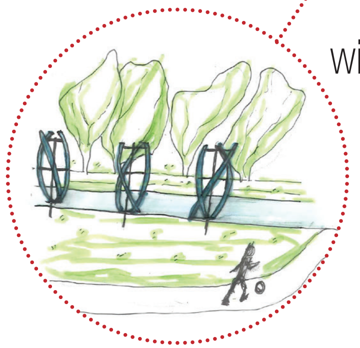


CASE STUDY — NEIGHBOURHOOD DESIGN




solar path
wind path
solar market
SUMMER
p7
p7
p16
p17
p16
4

CASE STUDY – NEIGHBOURHOOD DESIGN

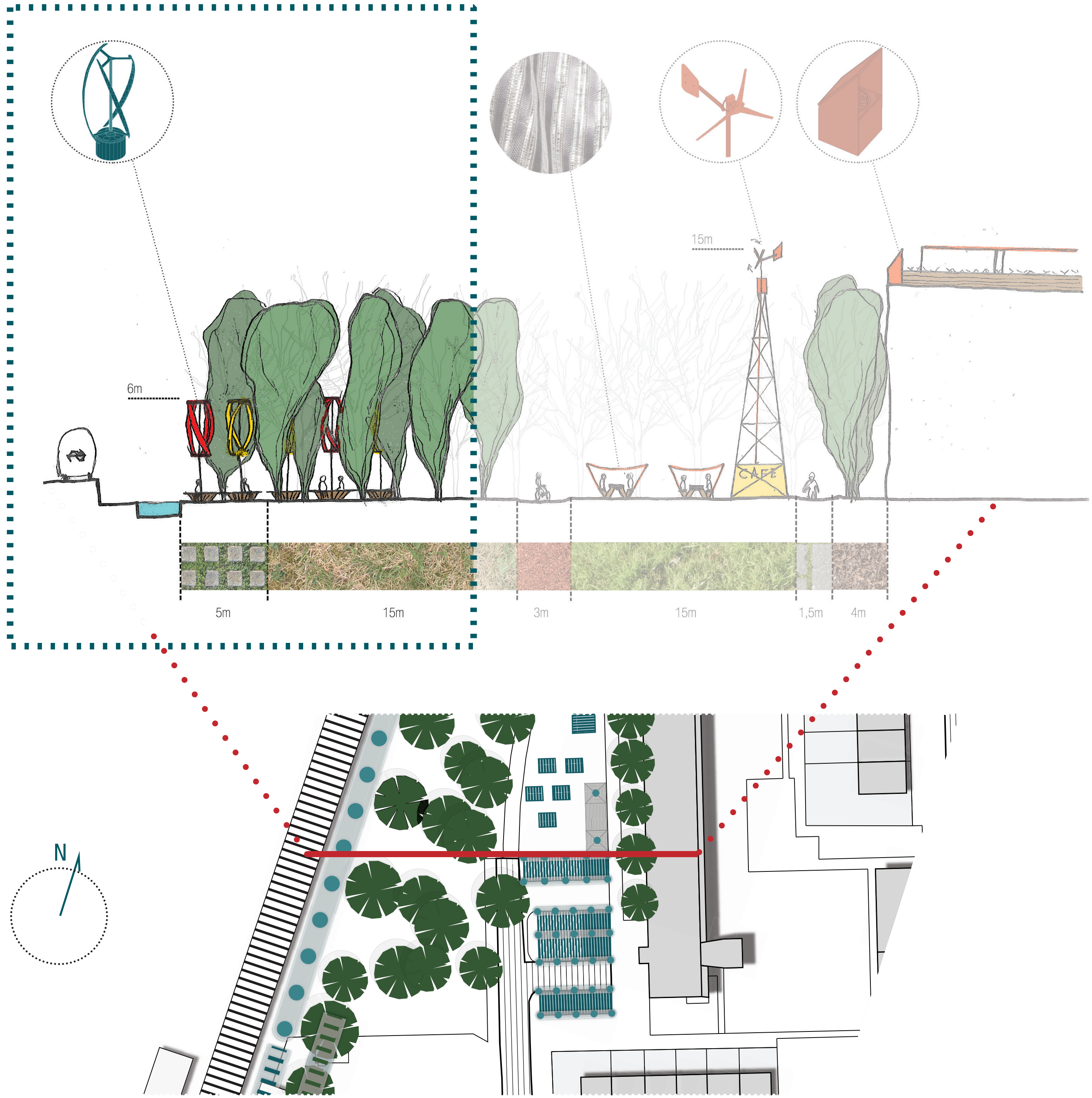


wind path

INSIGHT TO THE DESIGN METHOD

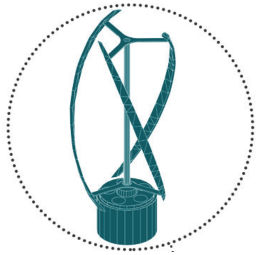
EXAMPLE

NEIGHBOURHOOD DESIGN



INSIGHT TO THE DESIGN METHOD

EXAMPLE



P6_VAWT

1 day=8,640 s

$E = P\,dt$

$P = \frac{1}{2}\,C_p\,\rho\,A\,v^3$ → *P= 681.7* → *E≈ 5.9 MJ/day* → $\boxed{E \approx 2{,}150\ \text{MJ/year}}$

P is power
Cp is the power coefficient,
ρ is air density,
A is the swept area of the turbine,
v is the wind speed

FOR THE WHOLE POST-WAR NEIGBOURHOOD OF SCHIEBROEK ZUID

4 wind corridors
total length: 2.2 km
VAWTS: 275

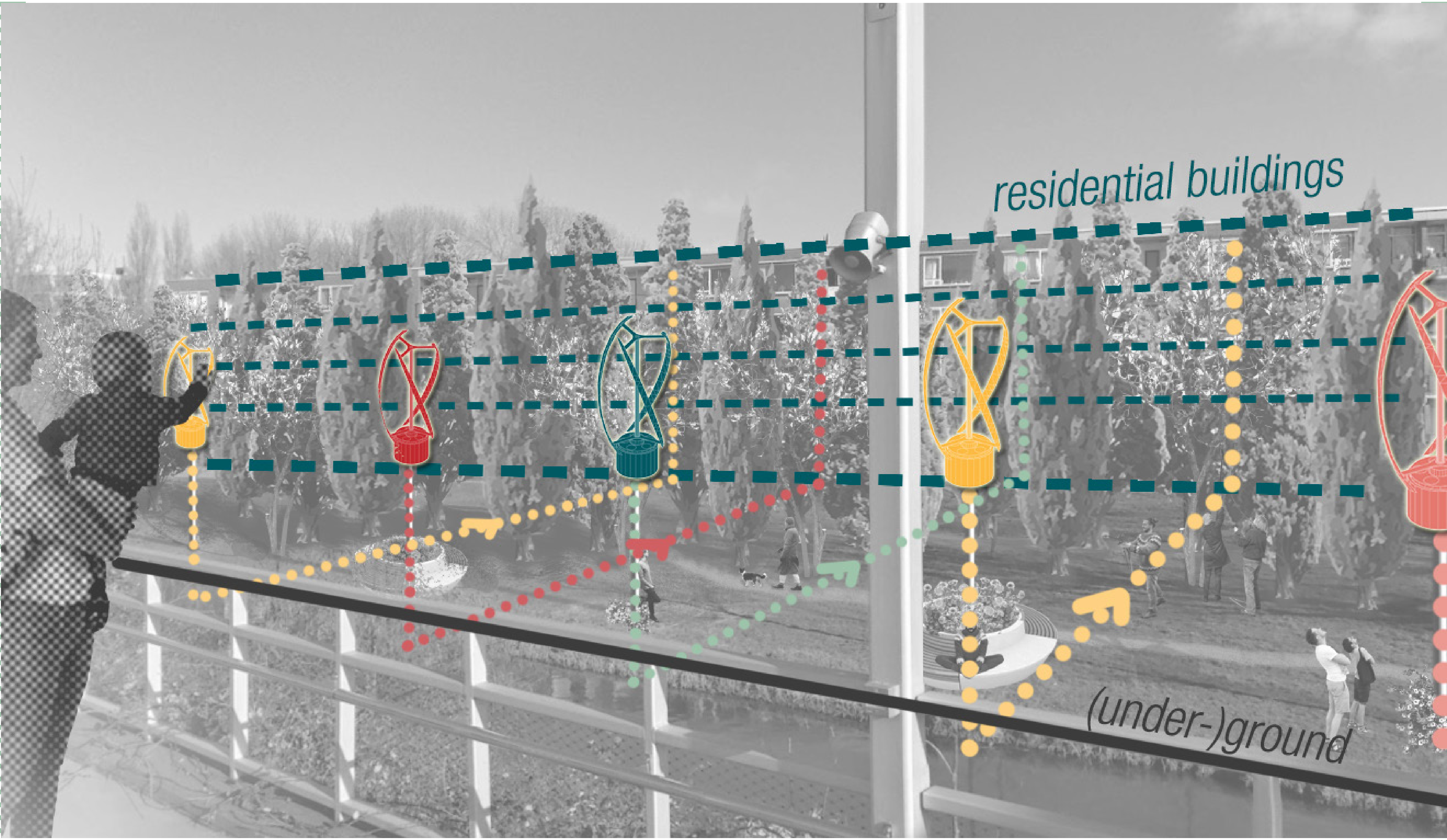
x 275 ⟹ *x 49*

490 mid-terraced dwellings within the studied part of Schiebroek Zuid

x 490

energy for space heating for the 10% of the mid-terraced housing stock

10%

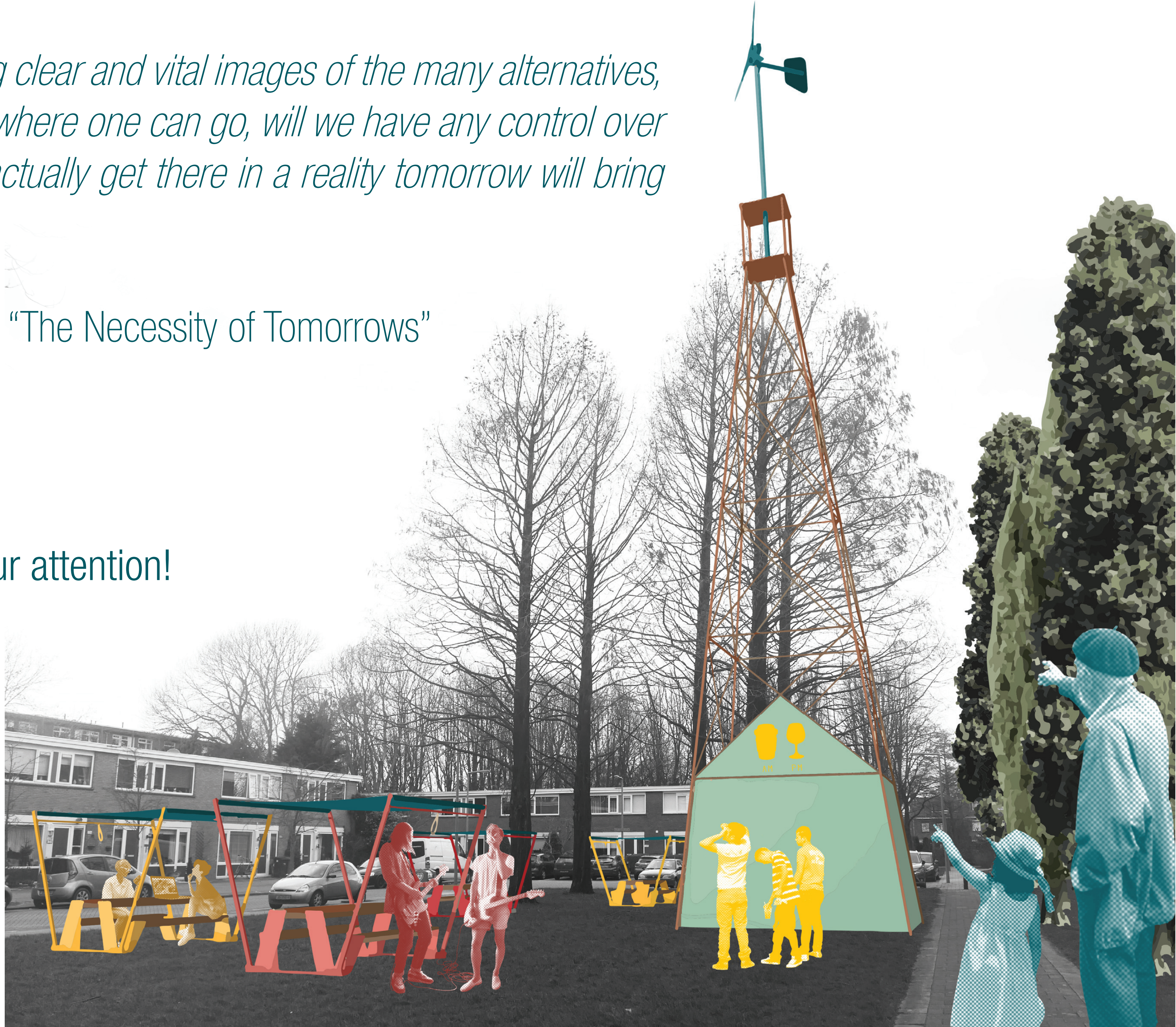

residential buildings
(under-)ground

CASE STUDY – STRUCTURE PLAN

"(..) Only by having clear and vital images of the many alternatives, good and bad, of where one can go, will we have any control over the way we may actually get there in a reality tomorrow will bring all too quickly."

Samuel R. Delany, "The Necessity of Tomorrows"

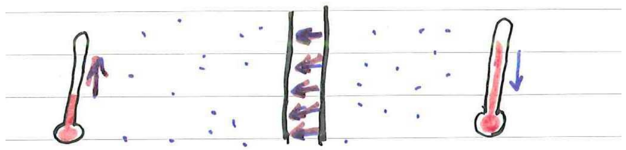
Thank you for your attention!



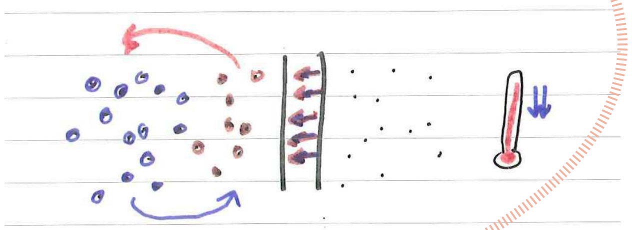
¬ CLIMATIC CONDITIONS: WIND AND SOLAR

Heat transfer

a. Conduction

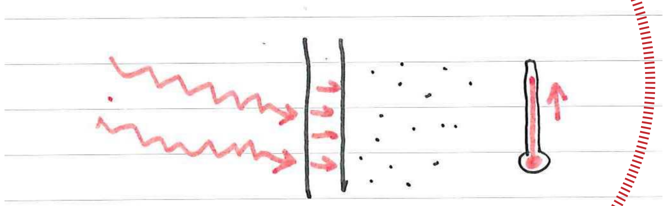


b. Convection



Heat loss

c. Radiation

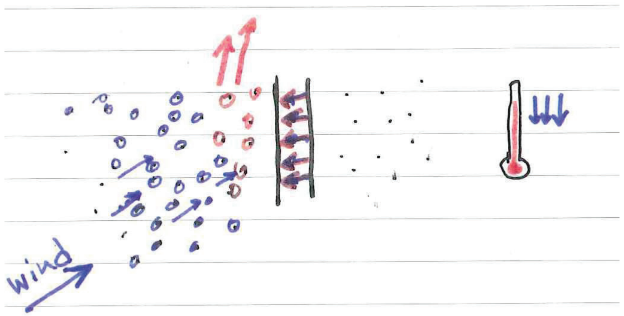


Heat gain

¬ CLIMATIC CONDITIONS: WIND AND SOLAR

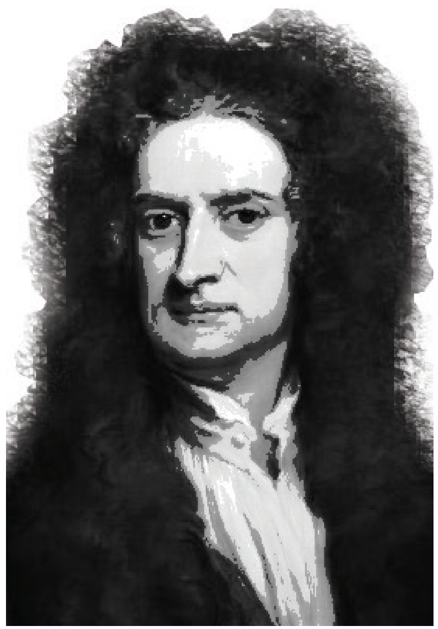
Heat losses from wind

Forced convection



"the rate of heat loss of a body is proportional to the difference in temperatures between the body and its surroundings while under the effects of a breeze"

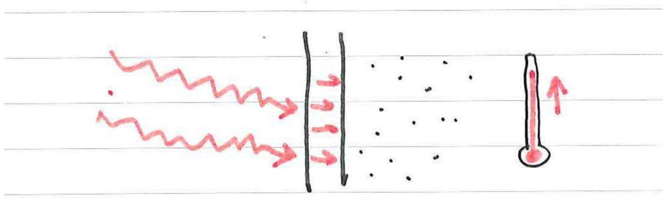
Newton's Law of Cooling



¬ CLIMATIC CONDITIONS: WIND AND SOLAR

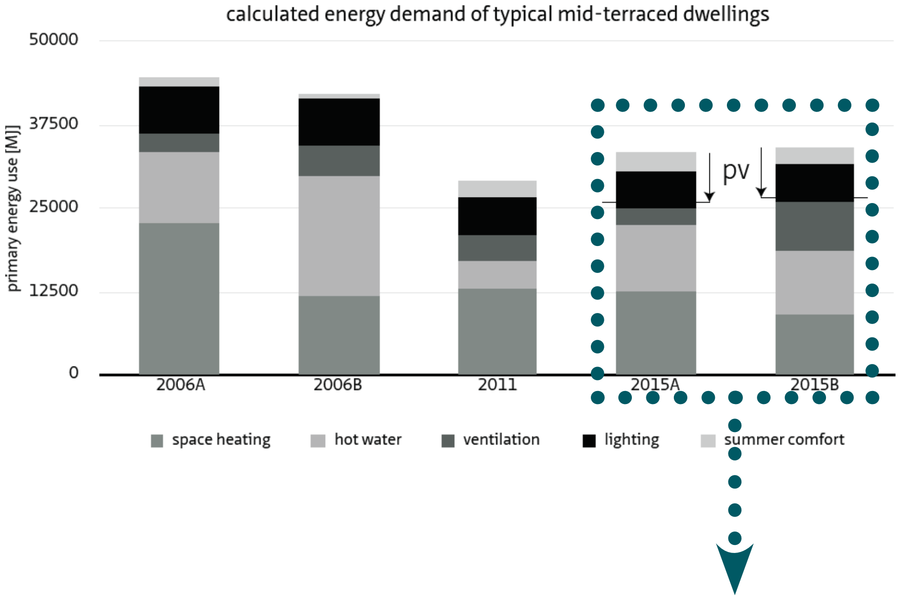
Heat gains from solar

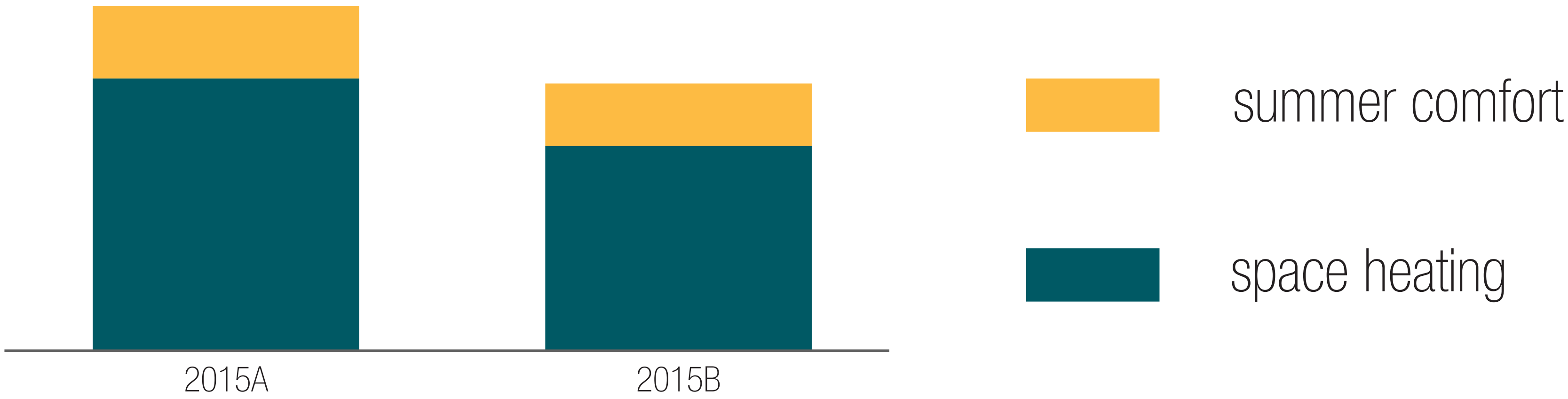
Radiation



¬ WINTER SEASON

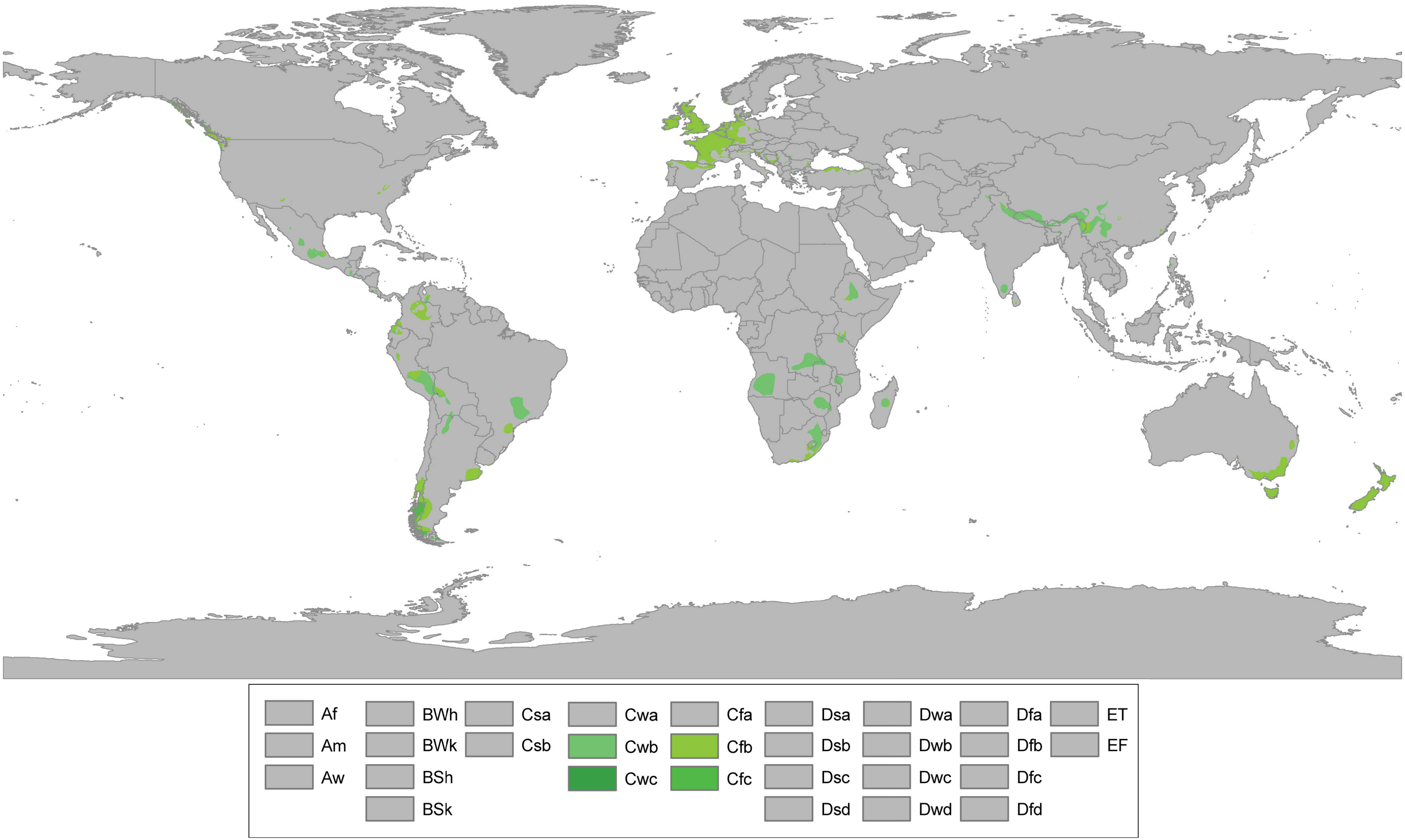
Calculated energy demand of typical dutch mid-terraced dwelling





¬ CLIMATE

Cfb – Oceanic or temperate maritime climate influenced by the North Sea



CASE STUDY – **SUB-PATTERN IMPLEMENTATION**

	BASIC ELEMENTS			EFFECT INFO		
	climatic condition	building size	morphology/ surface	density	effect on wind	restores H/W ratio
P1	wind	S & M		high		✓
P2	wind	S & M		low		✗
P3	wind	All		low		✗
P19	wind	L		high		✗
P20	wind	S & M		high		✓
P21	wind	S & M		high		✓
P22	solar	S & M		high		✓
P24	solar	All		-		✓

		P17_compact forms	P18_parallel linear blocks	P19_perimeter blocks	P22_T-shaped/cross forms
WINTER	wind protection	☺ ☺ ☺	☺ ☺	☺ ☺ ☺	☺
	solar gains	☺	☺ ☺	☹	☺
	heat preservation	☺ ☺ ☺	☺	☺ ☺ ☺	☺ ☺
SUMMER	all of the above into consideration	☺ ☺	☺	☹ ☹	irrelevant/unknown
adaptation [to dutch post-war neighbourhoods]					

☺ works

☹ does not work

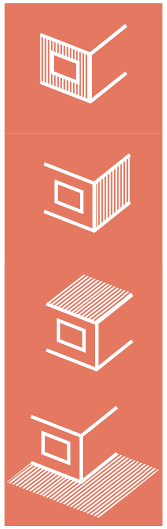
irrelevant/unknown

ENERGY PRODUCTION	1	technology	HAWT (Horizontal Axis Wind Turbines)	[5]Wang et al., 2017; [6]Bell et al.,n.d.; [7]Guzzetta et al., 2007; [8]Smith et al., 2012; [9]Micallef et al., 2016 [10]Park et al., 2015 [11]Ledo et al., 2011; [12]Korprasertsak & Leephakpreeda, 2015; [13]Dekker, 2012	PV panels & parabolic collectors	parabolic rooftop collectors	[17]Mostafavi et al., 2010; [16]Scott, Ben-Joseph, 2012
		orientation	windward (WT adjustable)		South to East	South to West	
		location	mid- & high-rise build., towers open sp.		mid- & high-rise build.	mid- & high-rise build.	
		morphology	roof (optimum type: curved)		unshaded and spacious rooftops (prefer. on non-residential build.)	shaded roofgarden/patio	
	2	technology	VAWT or micro-wind turbines or IRWES[13]		solar roads & paths		
		orientation	windward (only for micro-wind)		---		
		location	high- & mid-rise build. (possible for low)		infrastructure & public space		
		morphology	flat roof, corners & facades		away from buildings (low dens. vegetation)		
	3	technology	ducted wind turbines		thin-film solar (textile)	thin-film solar (textile)	
		orientation	windward (fixed position)		South to East (120-degree range)	South to West	
		location	high-rise build.		mid- & high-rise build.	build. & open spaces	
		morphology	flat roof		large vertical blind facades	rooftops (summer terraces)	
	4	technology	savonius VAWT or Binopterus VAWT		see-through transparent solar panels		
		orientation	independent of orientation		South to East		
		location	bus stops, shelters, roof patios - open sp.		buildings		
		morphology	VAWT with wind booster system (vanes) are appropriate for low winds[12]		balconies and windows		
	5	technology	Kite power systems				
		orientation	independent of orientation				
		location	mid- & high-rise build.				
		morphology	independent				

DESIGN PATTERNS: LOCATION

- M — Mid-rise buildings (4-10 floors)
- L — High-rise buildings (≥10 floors)
- NR — Non-Residential buildings
- PS — Public spaces

DESIGN PATTERNS: MORPHOLOGY/SURFACES OF SENSITIVITY OR POTENTIAL



facades

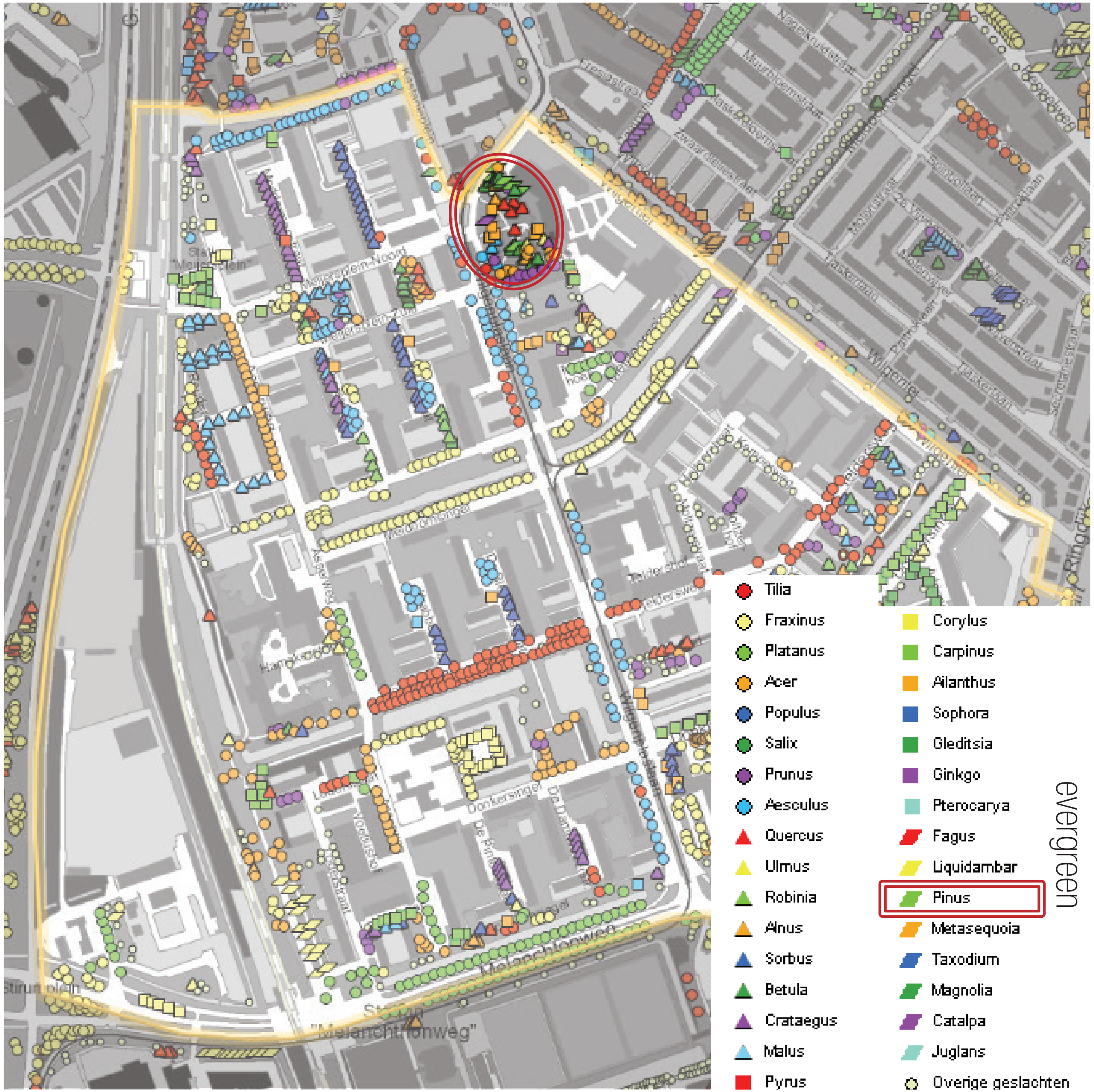
blind walls

rooftops

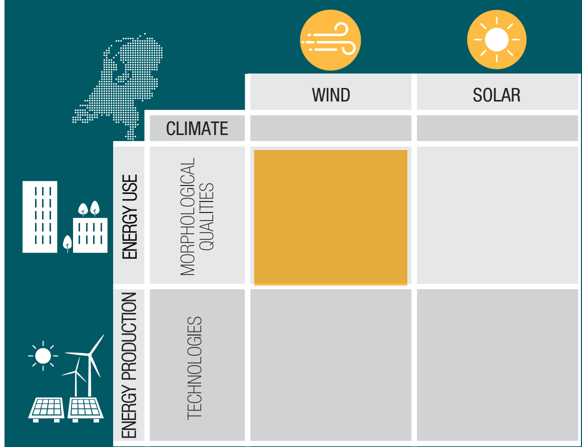
'open' space

DESIGN PATTERNS

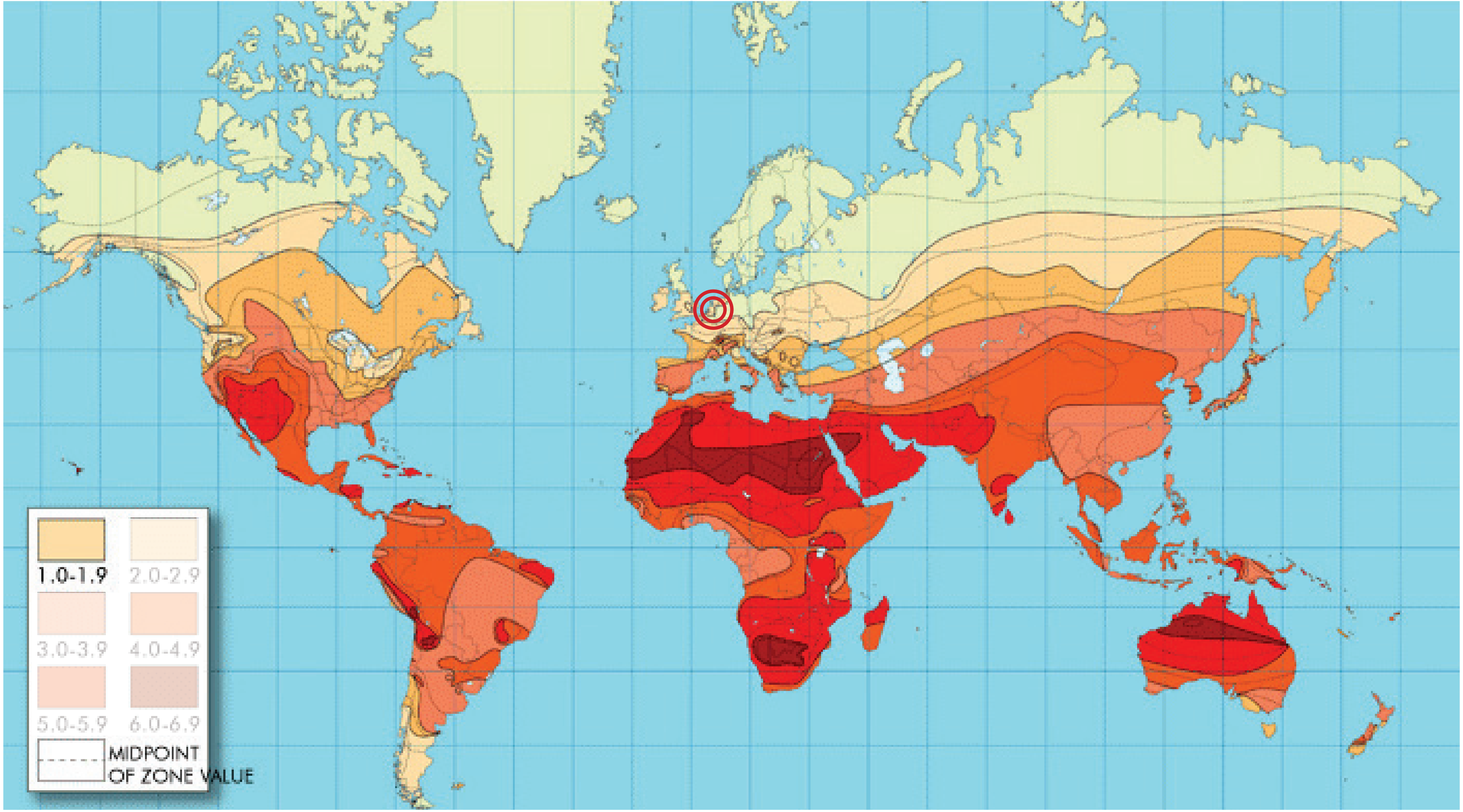
TYPES OF VEGETATION

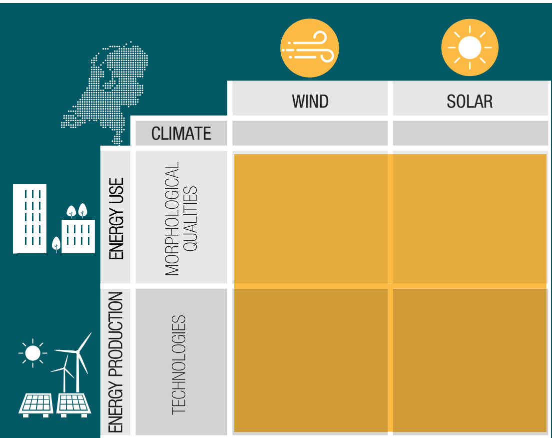


source: http://www.gis.rotterdam.nl



CASE STUDY - LOCAL CONDITIONS





BOEKEL ECODORP, NETHERLANDS

"Now we are close to realizing our dreams. We learned a lot in the last 5 years. We are going to grow our food with Permaculture, heat our homes with Rocket Mass Heaters. We are going to build our houses with wood, straw bales and hemp.
We are going to build a polydome as an example for sustainable food production
We are going to build the nicest tree huts for ecotourists.
And we will be a center of sustainable companies that create win-win situations for each other and the partners we work with
So that can happen when you go with the flow. You have no idea where you are going, and not how long it takes. So be sure to make the trip worthwhile . Then it does not matter where you end up or how long it takes. It only means that you can realize your dream and make your part of the world a bit better..

	SIZE	CURRENT STAGE	POSITION RELATED TO URBAN CENTRE	ENERGY					FOOD	WATER	WASTE	MATERIALS	NATURAL ASSETS	STRUCTURE/FORM		BASIC PLANNING CONCEPTS	PHASING	ORGANIZATION & PROFIT
				WIND	SOLAR	BIOMASS	GEOTHERMAL	SYSTEM & STORAGE						Architecture	Urban/village			
			Fringe of the small town of Boekel 1km away from its centre	Max 12m	Solar panels, solar collectors on the roofs	Wood, biogas from composting		Smart Grid – 1kWh battery storage per kWp to PV FUTURE: Hydrogen energy storage	Food forest Permaculture garden Fish farm	Helium filter: toilets Hemel (s) water: rain water infiltration micro-algae reactor: toilets and agriculture	Compost toilets Vegetable waste → chicken & fish deconstruction: 2nd hand materials	Organic & renewable Proximity of origin Slightly processed 2nd hand materials	D'n Eik forest	High insulation A lot of daylight Passive solar Solar tubes & LED lights	Small houses: less materials, less energy to build & to heat, cool, etc. Neighbourhood house	Permaculture Biomimicry Healing architecture Pattern language Polydome	P1 preparation exploring potentials, allocation of tasks P2 grouping Attract people (experts, volunteers, supporters) →action oriented organization P3 agreement with municipality • Temporary occupation • Boomhuttenhotel • Food forest	Cooperative Ecodorp Boekel (rental company): residents will be renting the houses Model: Holarchie Profit: Boomhuttenhotel "Dragon dreaming" Project management service (external)
synergies					●■	□			● ○	●	□	○	○	■				