

CLIMATE CUSTOMIZED FAÇADE

A prefabricated façade system customized for Ecuadorian climate regions

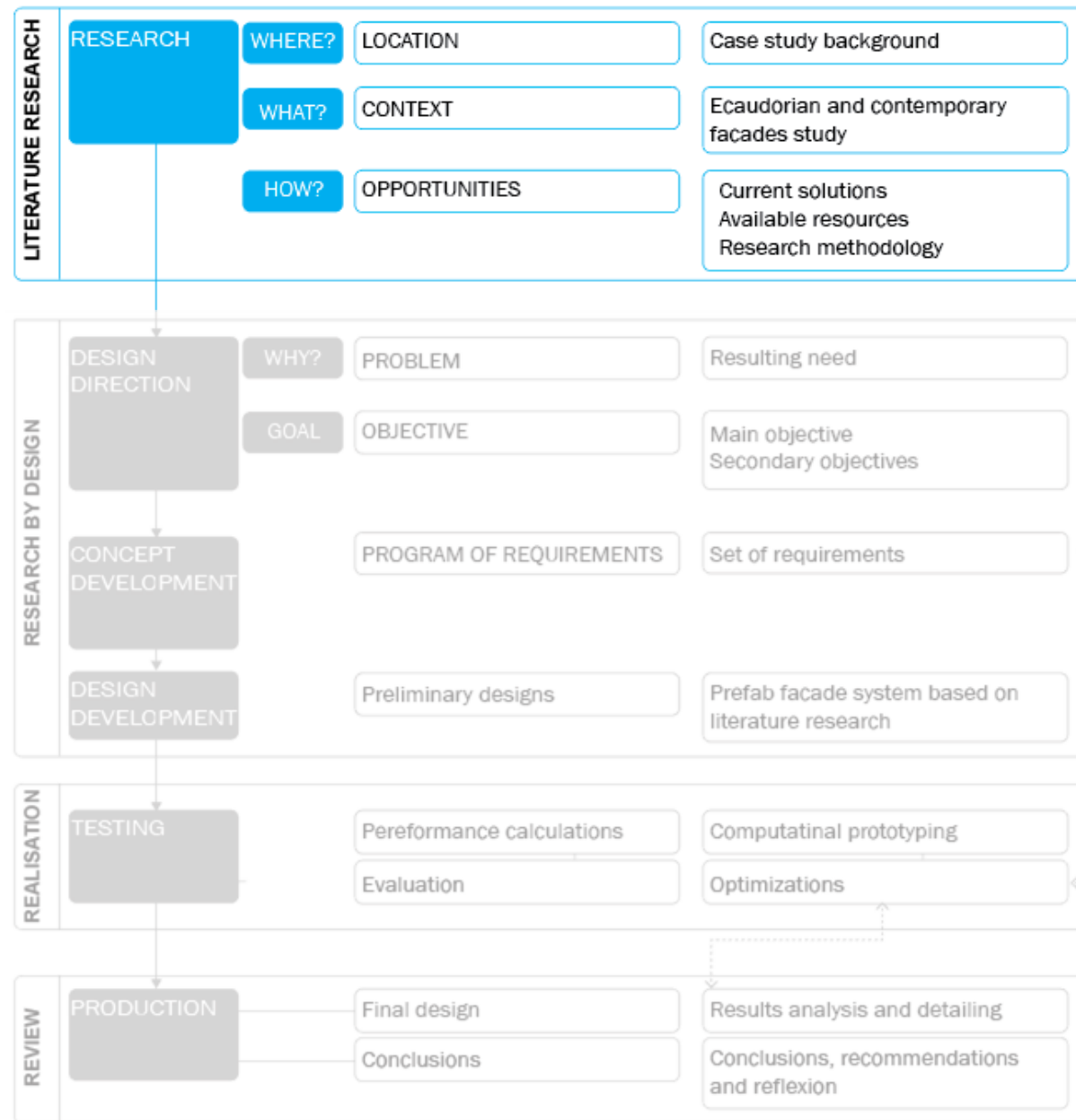
Amelia Tapia
4939123

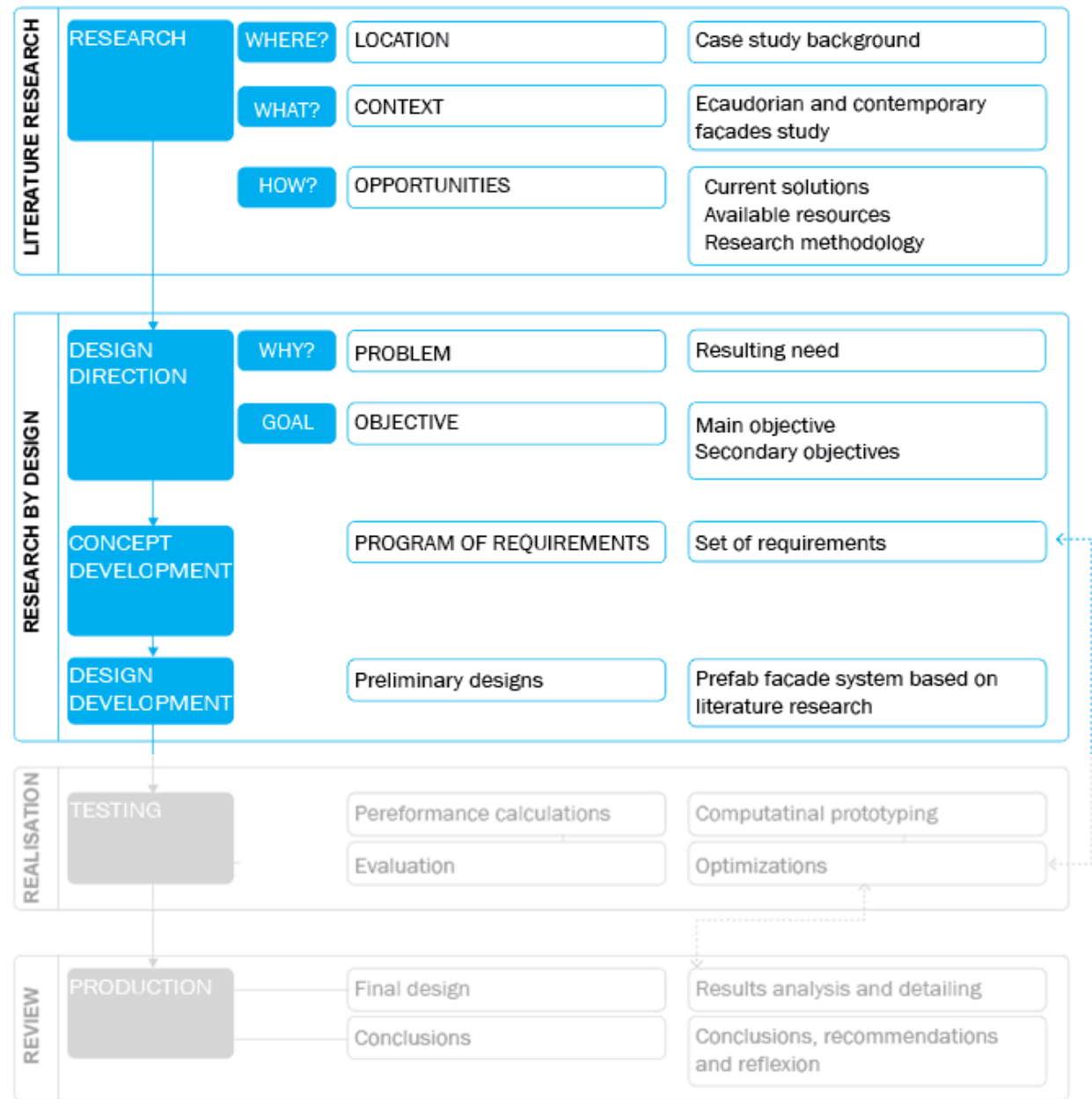
Graduation project
August 2020

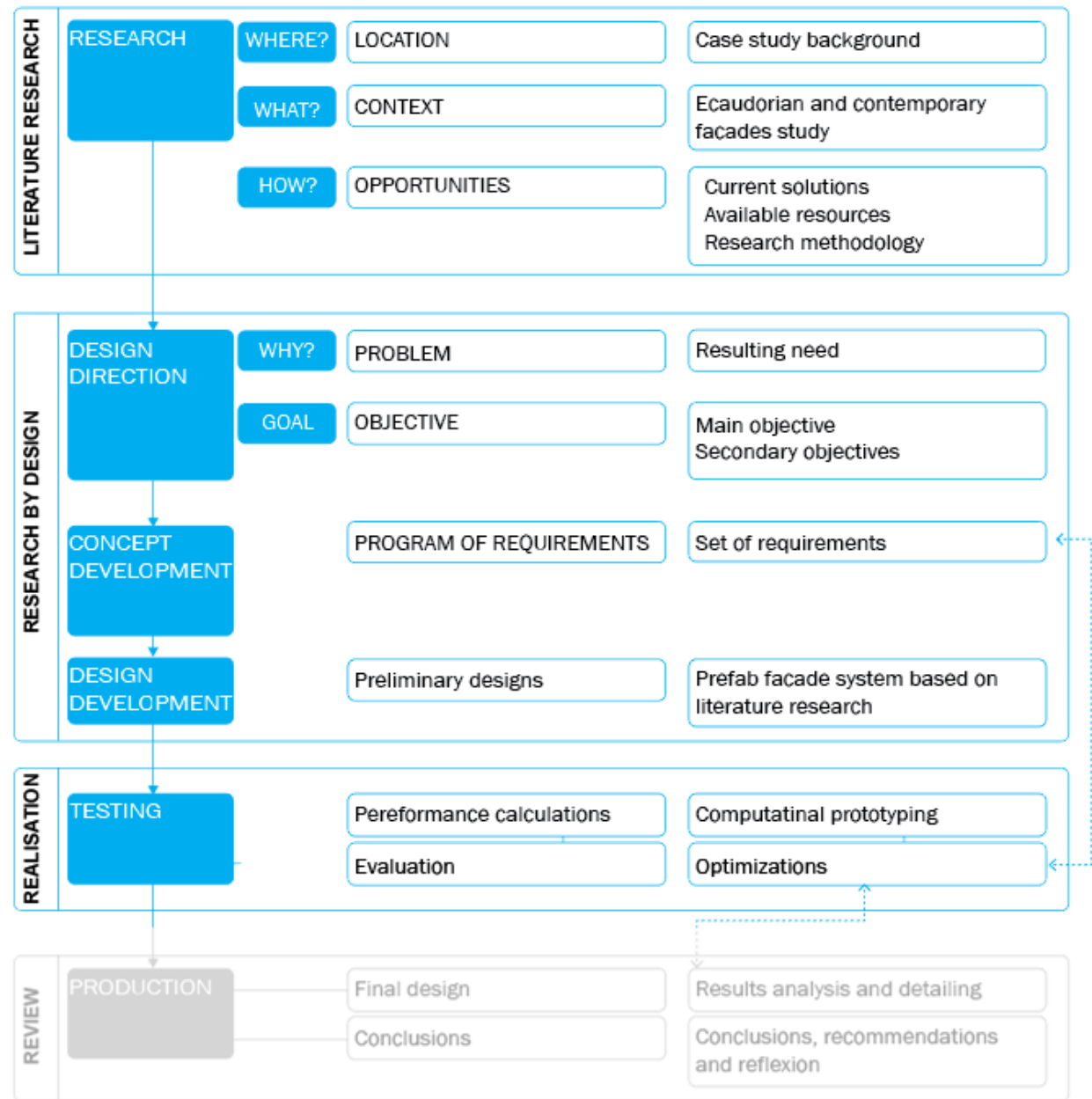
Main mentor
Ir. Pieter Stoutjesdijk
Façade design

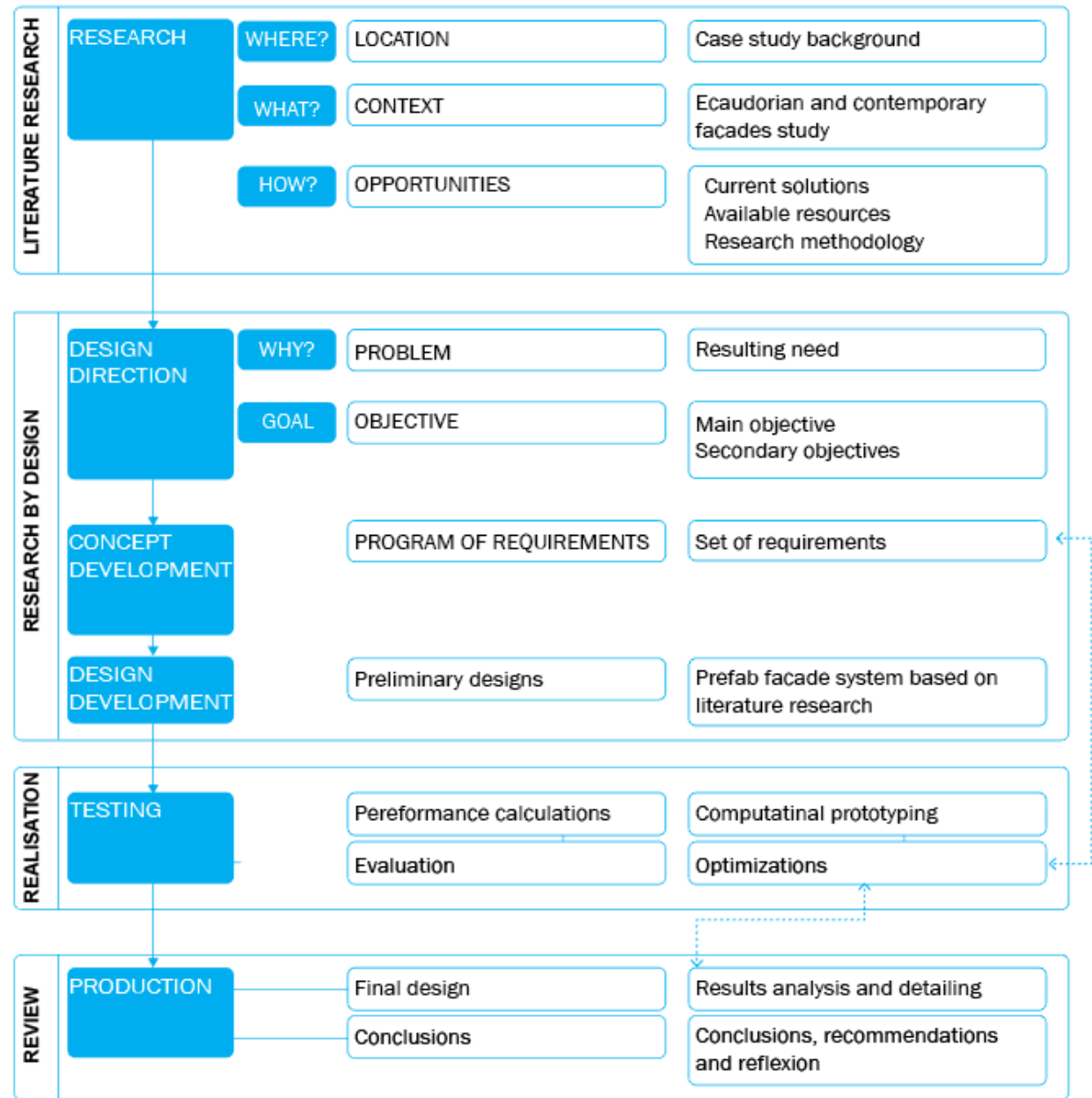
Second mentor
Ir. Christien Janssen
Climate design











LOCATION

WEATHER

4 MAIN REGIONS



WEATHER

2 TYPES OF CLIMATE

TEMPERATE CLIMATE

1800 - 6310 M.A.S.L.

0°C - 30°C

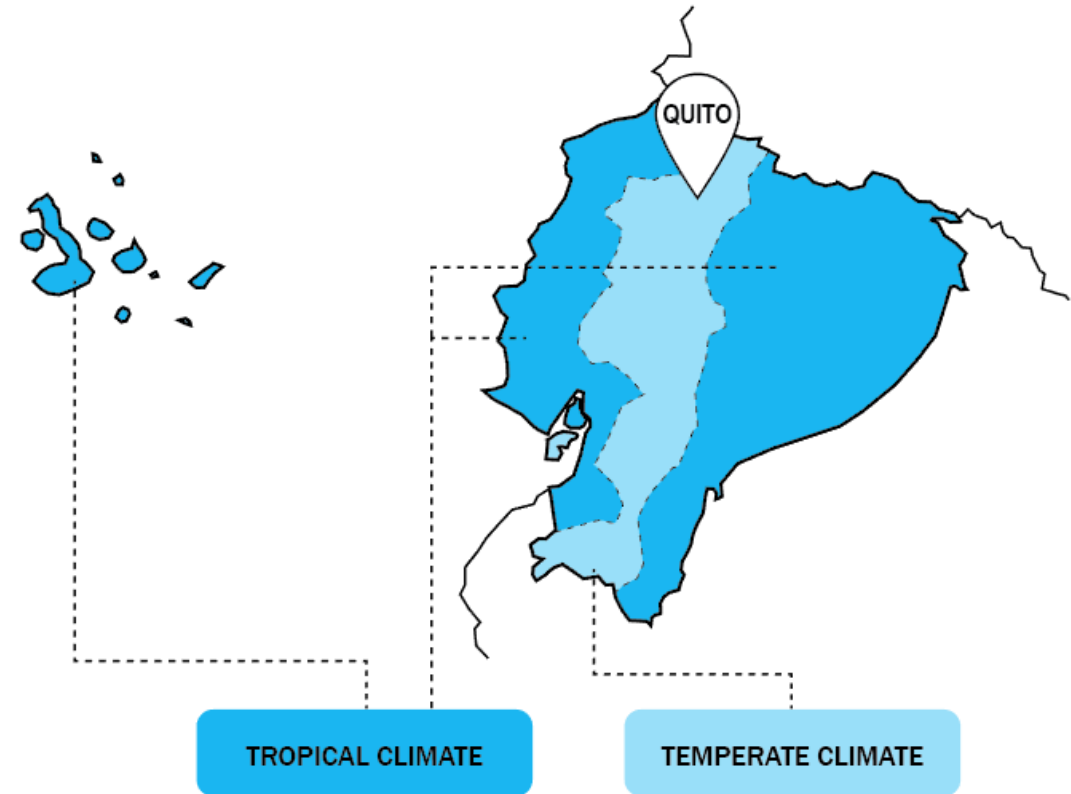
HIGHLANDS

TROPICAL CLIMATE

0 - 1700 M.A.S.L.

16°C - 34°C

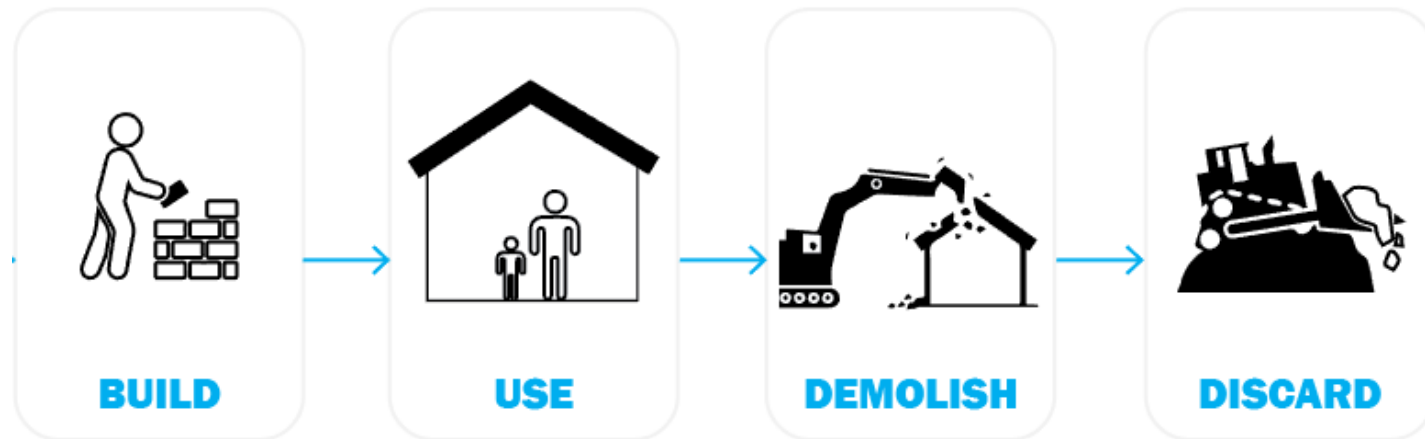
ISLANDS + COAST + RAINFOREST



PROBLEM

LOCAL CONSTRUCTION STOCK

LINEAR WORKFLOW



EXISTING CONSTRUCTION NORMATIVE
LACKS THERMAL COMFORT STANDARDS



EXISTING FACADE TYPOLOGIES

POOR INDOOR COMFORT

FLAT TYPOLOGY



**TERRACED
TYPOLOGY**



**BALCONY
TYPOLOGY**



**BOXES
TYPOLOGY**

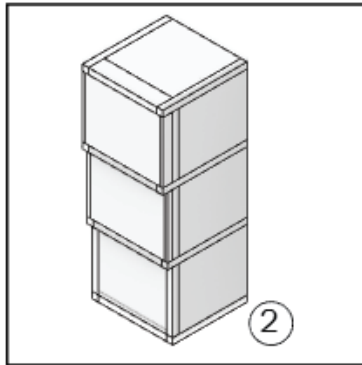
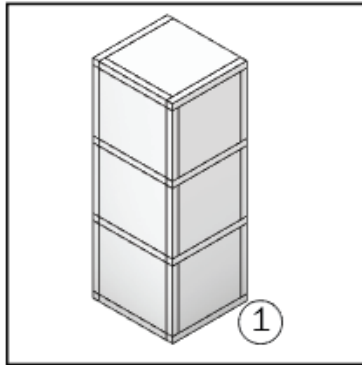


Most of existing façade typologies do not respond to local climate conditions

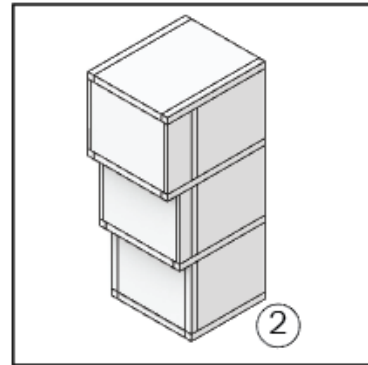
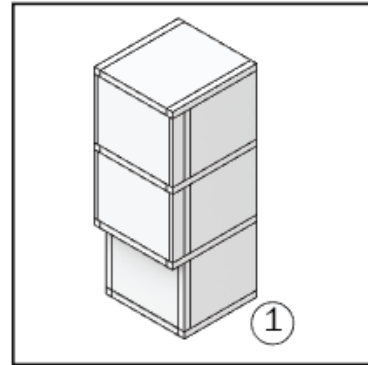
EXISTING FACADE TYPOLOGIES

POOR INDOOR COMFORT

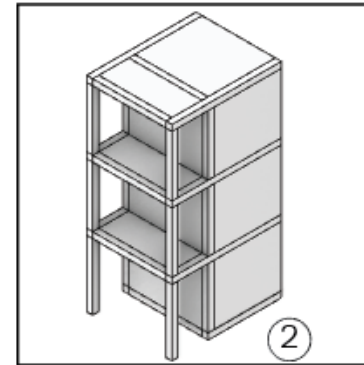
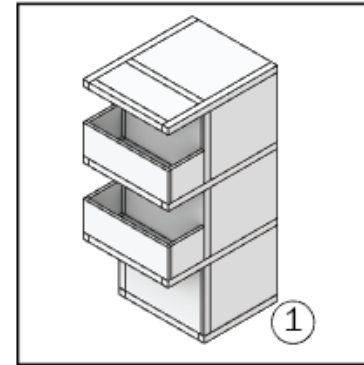
FLAT TYPOLOGY



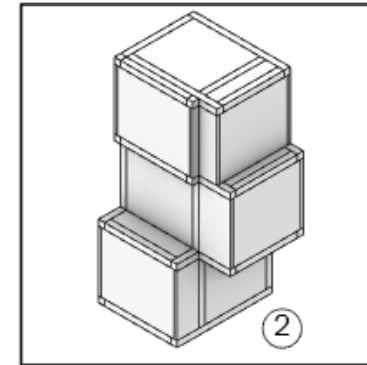
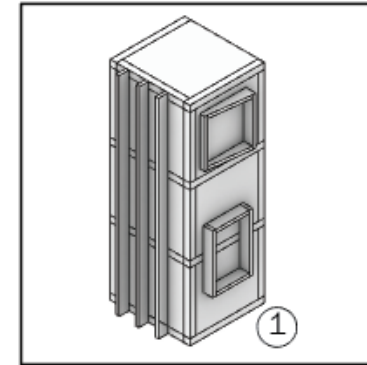
**TERRACED
TYPOLOGY**



**BALCONY
TYPOLOGY**



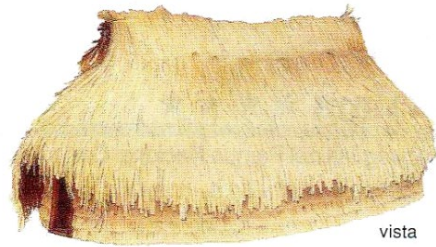
**BOXES
TYPOLOGY**



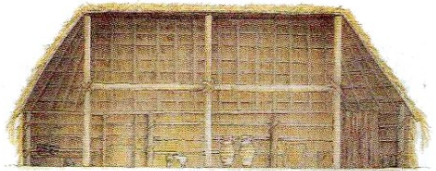
Most of existing façade typologies do not respond to local climate conditions

VERNACULAR ARCHITECTURE

TEMPERATE CLIMATE



vista



corte



planta



Enclosed architecture to gain and store heat

TROPICAL CLIMATE

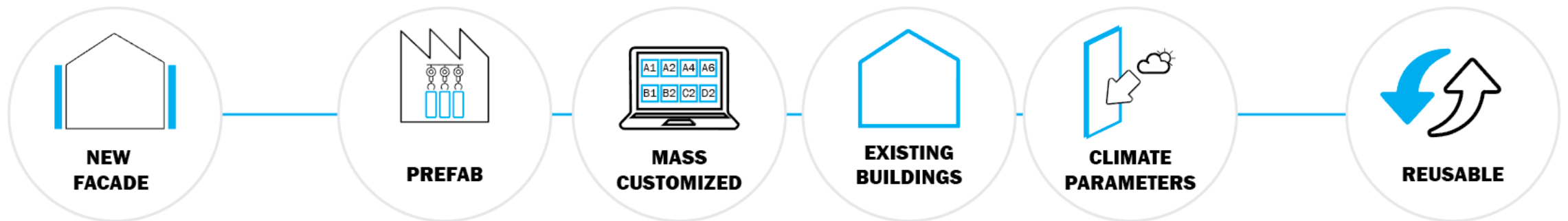


Permeable and shaded architecture

Use these concepts with Ecuadorian state-of-the-art technologies

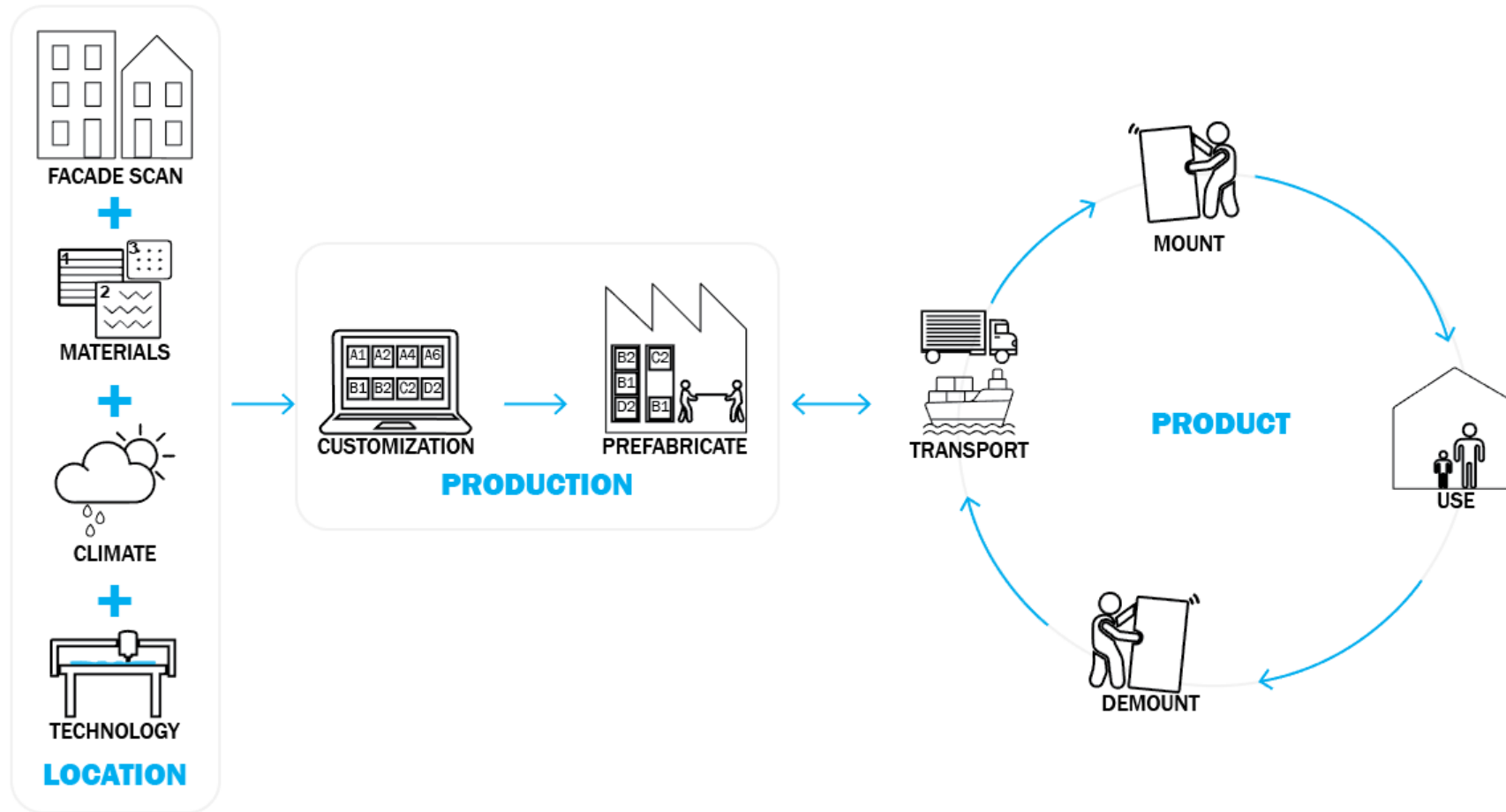
RESEARCH QUESTION

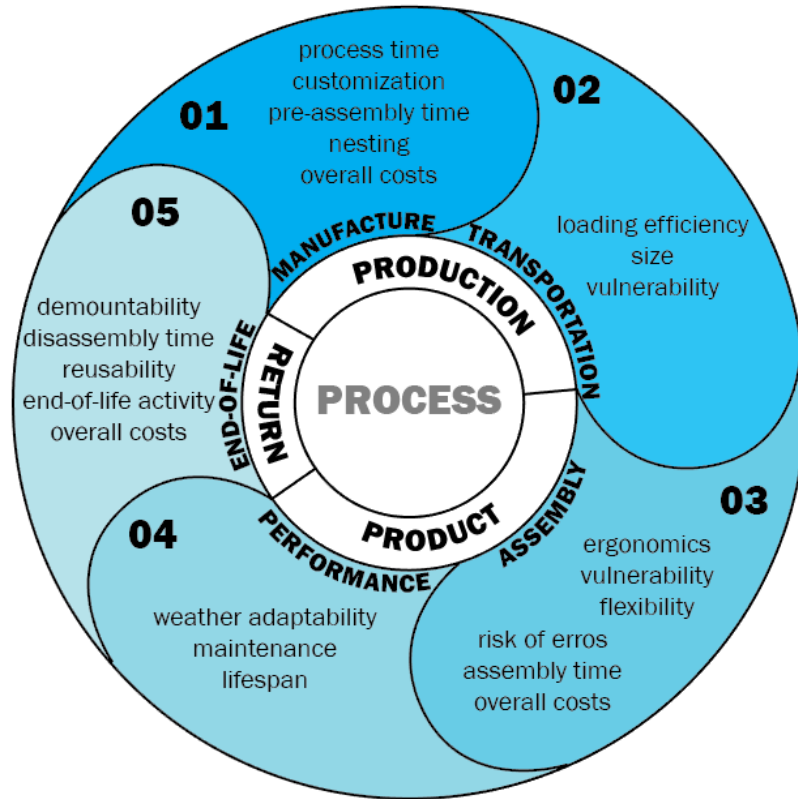
How can a prefabricated façade system be mass customized, for Ecuadorian climate regions and its existing building stock, to upgrade the indoor comfort, while providing a circular workflow based on local production, the use of local resources and the reusability of the system?



REQUIREMENTS

CIRCULAR WORKFLOW

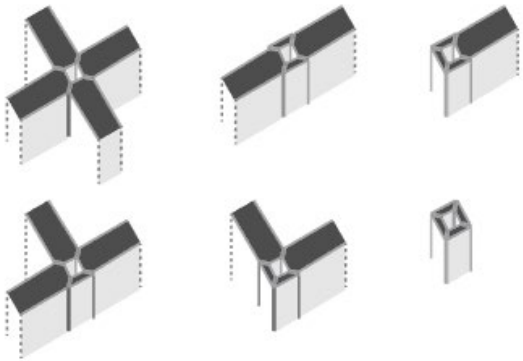




- ● ● MASS CUSTOMIZATION
- ● ● WEATHER ADAPTABILITY
- ● ● ASSEMBLY ADAPTABILITY
- ● ● DISASSEMBLY ERGONOMICS
- ● ● ASSEMBLE ERGONOMICS
- ● ● REUSABILITY
- ● EASY TRANSPORTATION
- ● VULNERABILITY
- ● LOW MAINTENANCE
- ● PRE-ASSEMBLY DIFFICULTY

REFERENCES ANALYSIS

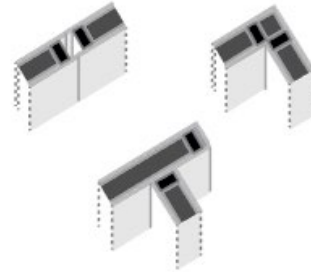
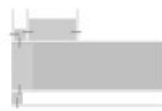
1. THE GENERAL PANEL WACHSMANN & GROPIUS



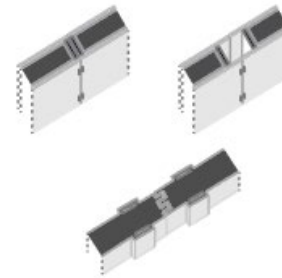
2. SIP SYSTEM USA



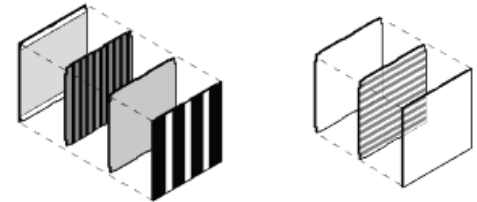
3. CHARRED TIMBER SYSTEM ERDC, ECUADOR

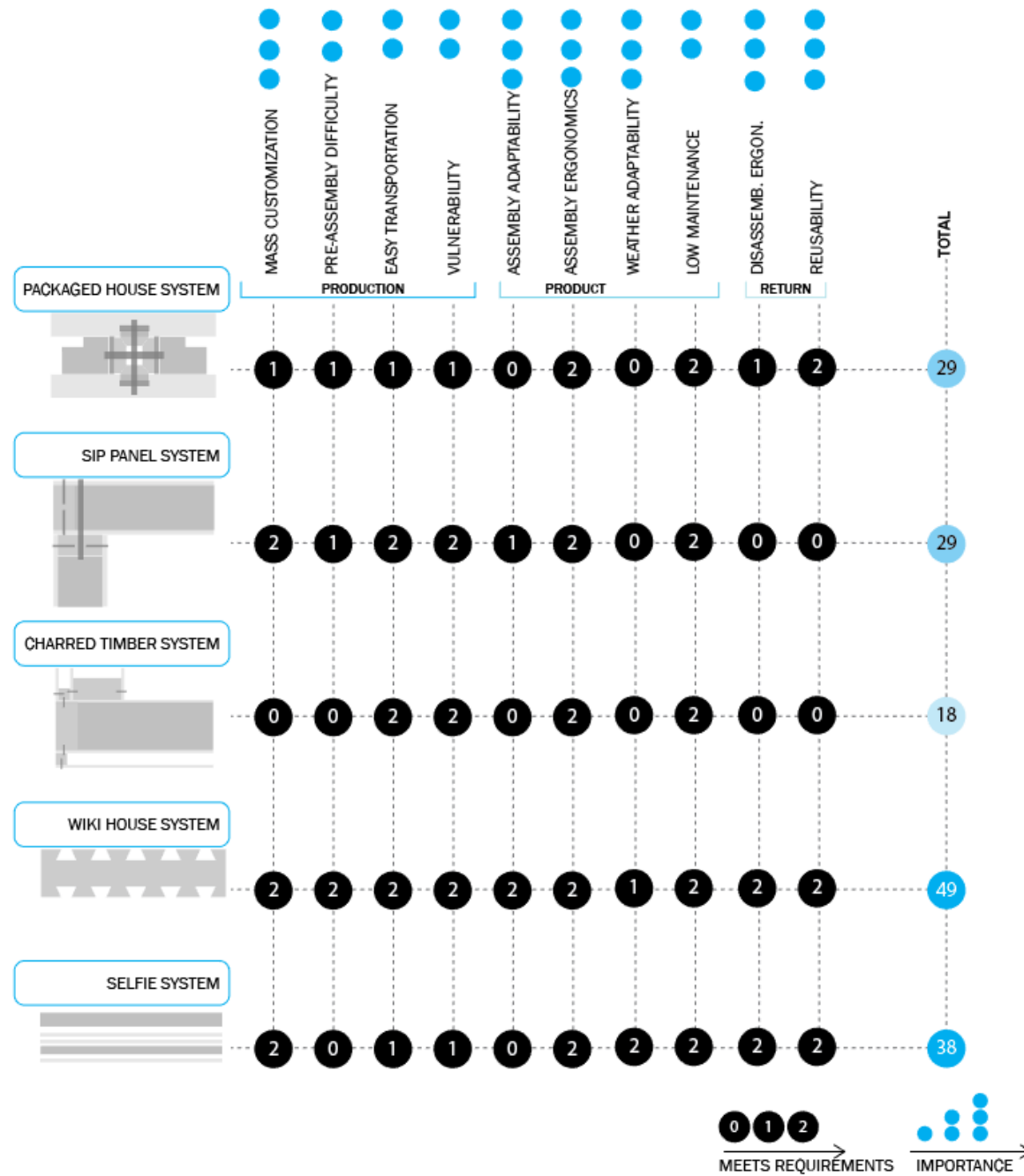


4. WIKI HOUSE SYSTEM CNC TECHNOLOGY

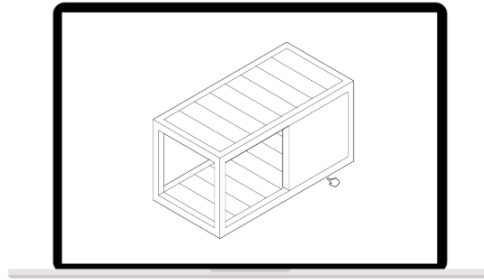


5. SELFIE MULTI-LAYERS

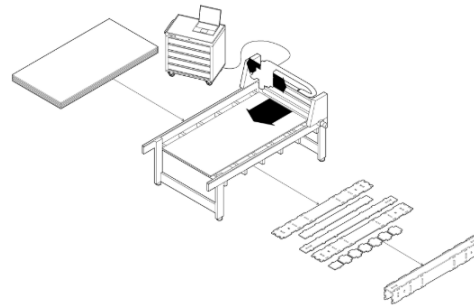




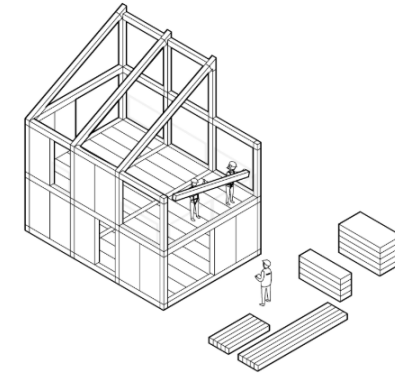
WikiHouse SYSTEM



MASS CUSTOMIZATION



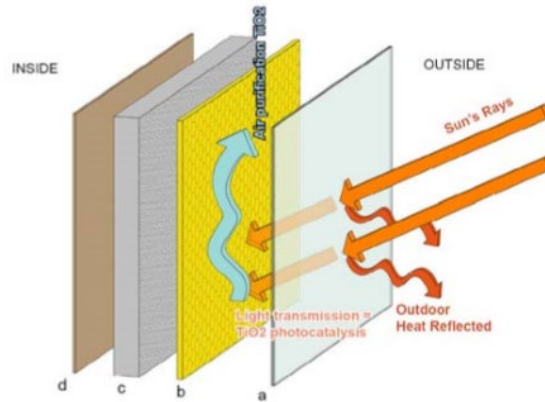
CNC PREFABRICATION



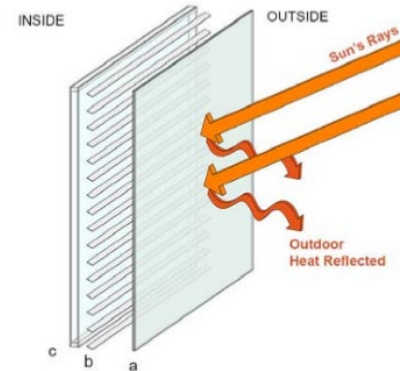
EASY ASSEMBLY-DISASSEMBLY

+

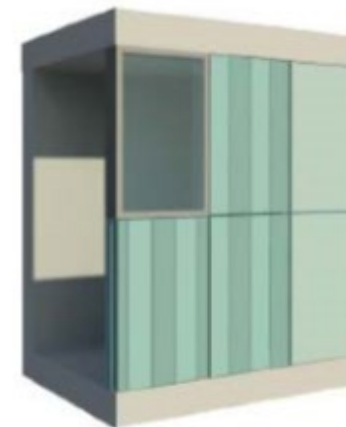
SELFIE SYSTEM



MULTILAYERED

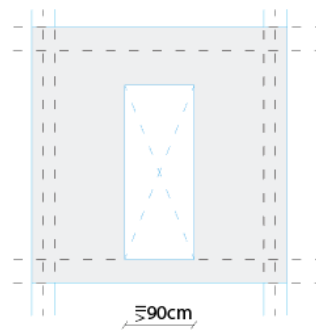


CLIMATE CUSTOMIZED

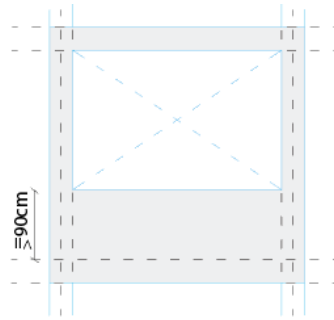


MODULAR

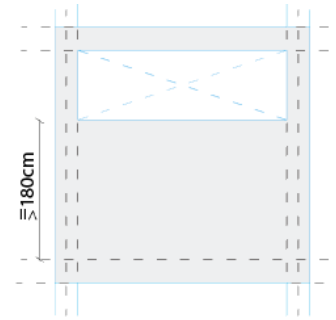
BUILDING SYSTEM



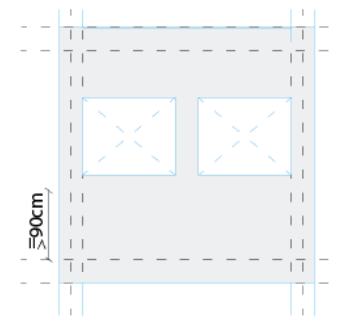
Most common door width



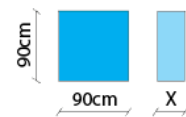
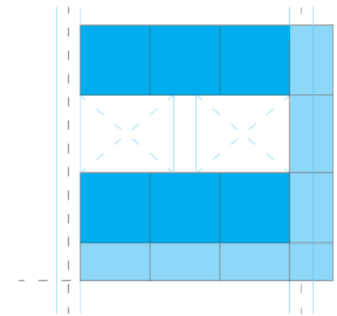
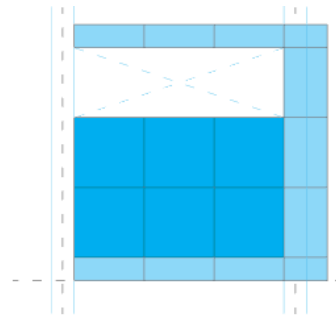
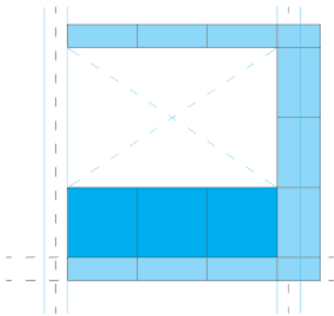
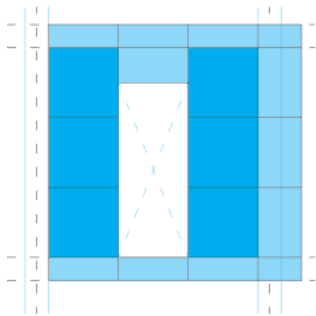
Most common window height



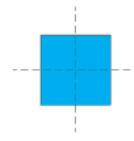
Most common window height



Most common window height



ADAPTABLE



SYMMETRIC

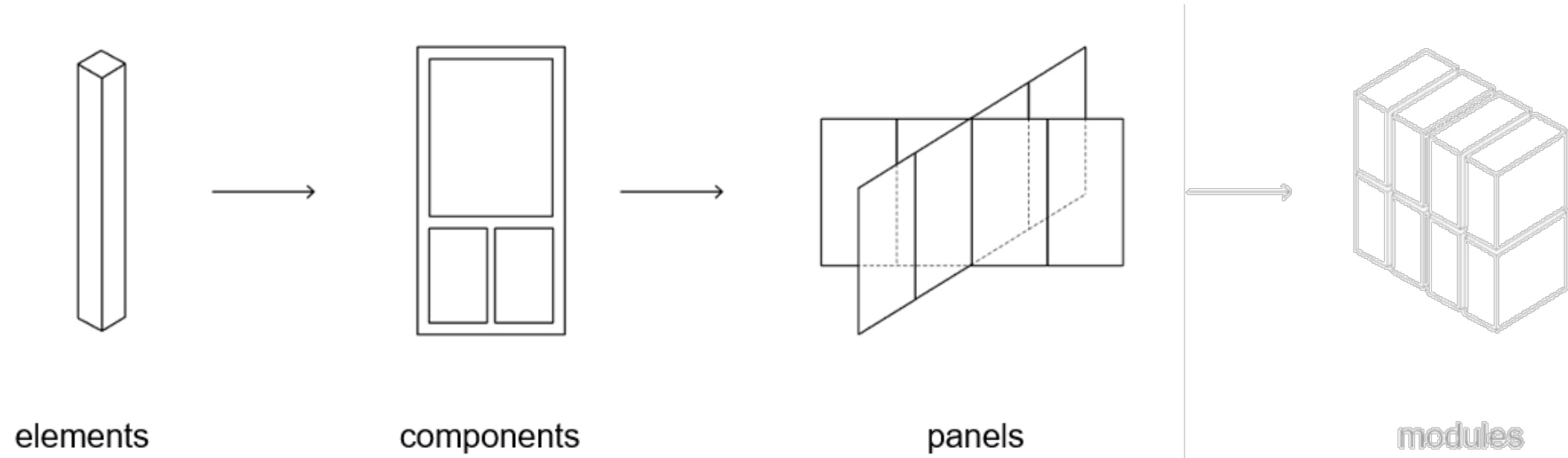


EASY ASSEMBLY

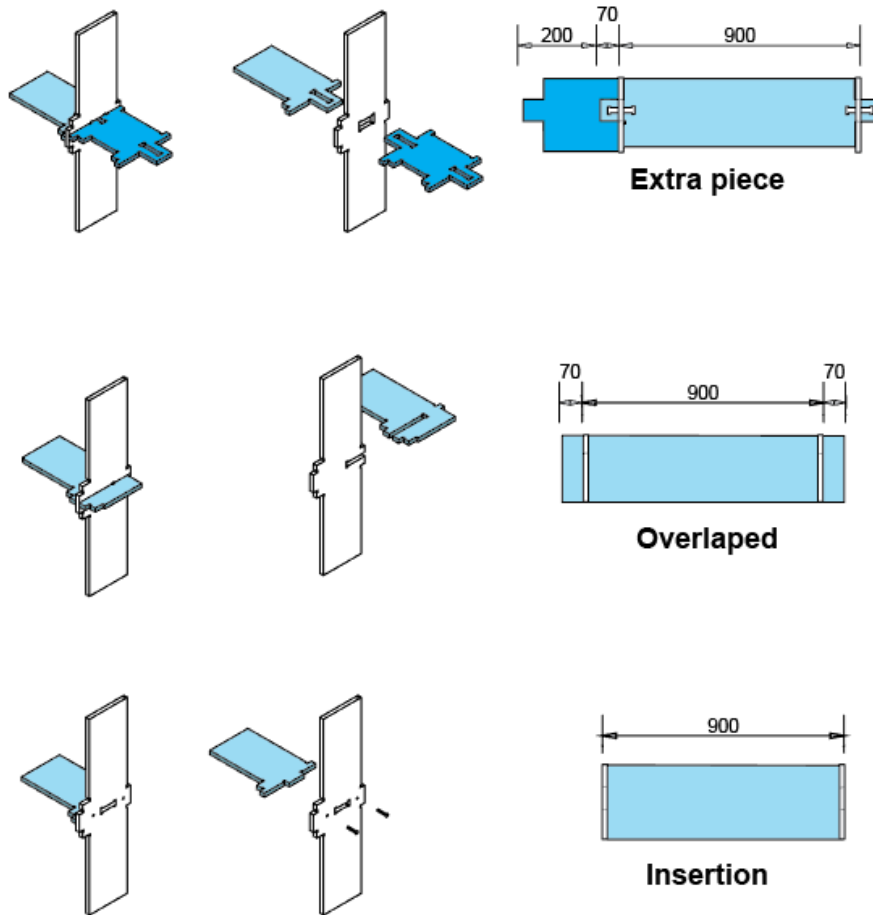


MODULAR
REPLICATION

PREFABRICATION SCALES



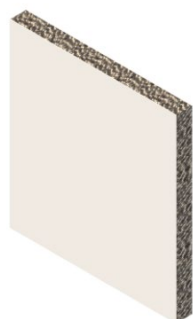
WIKI HOUSE ASSEMBLY PROCESS



ASSEMBLY TIME	ASSEMBLY ERGONOMICS	AMOUNT OF ELEMENTS	VULNERABILITY	DISASSEMBLY	PANELS CONTINUITY	TOTAL
0	1	0	0	2	0	3
2	2	2	2	1	0	7
2	1	1	2	2	2	10

LAYERS

INSULATION



CODE	U VALUE
1.1	0.22 W/m2K



CODE	U VALUE
1.2	0.18 W/m2K



CODE	U VALUE
1.3	0.18 W/m2K

WATER PROTECTION



CODE	U VALUE
3.1	5 W/m2K

COLLECTION



CODE	U VALUE
2.1	1.00 W/m2K



CODE	U VALUE
2.2	1.00 W/m2K

SUN PROTECTION



CODE	U VALUE
4.1	(closed) 5 W/m2K



CODE	U VALUE
4.2	-



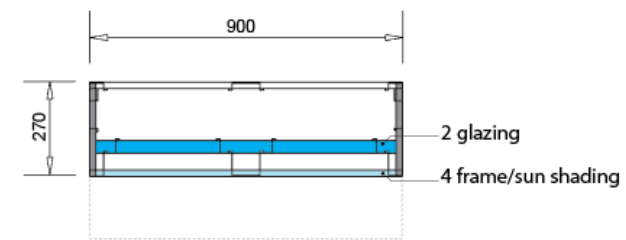
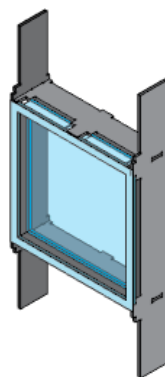
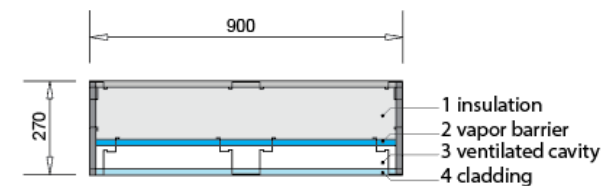
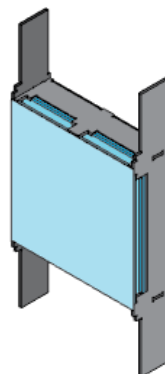
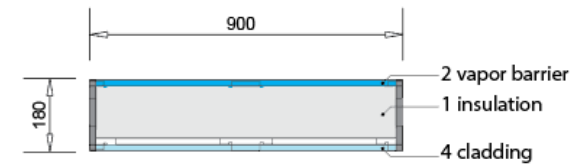
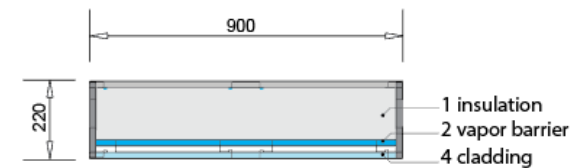
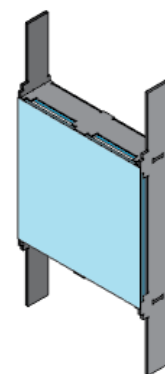
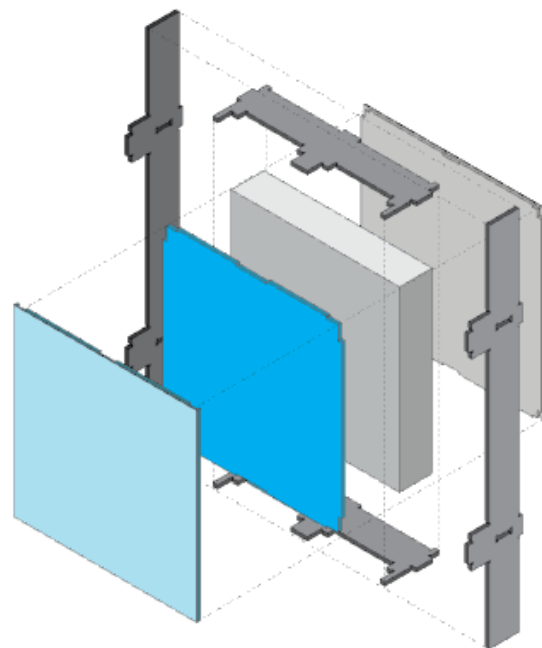
CODE	U VALUE
4.3	-

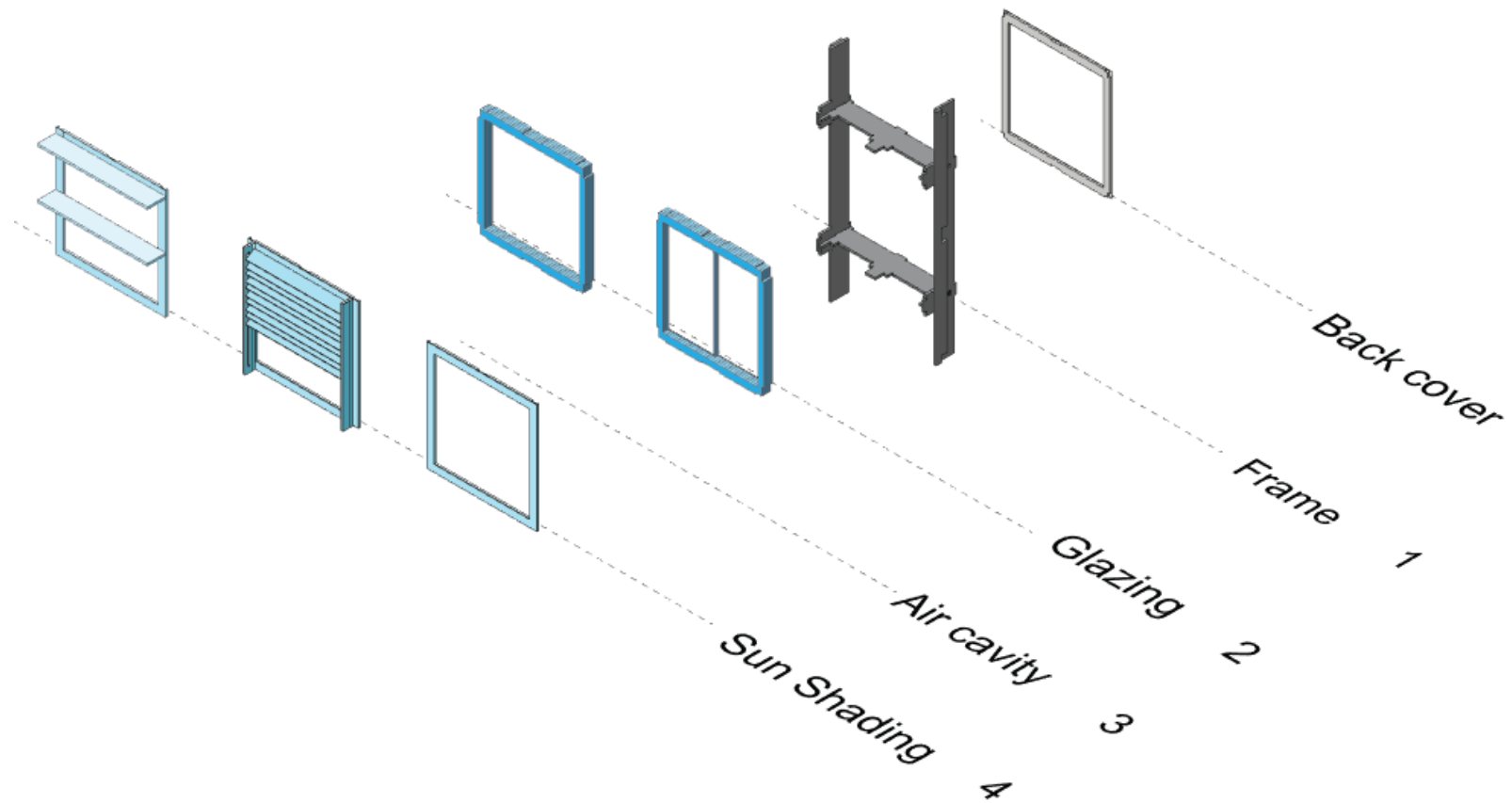


CODE	U VALUE
4.4	2.50 W/m2K

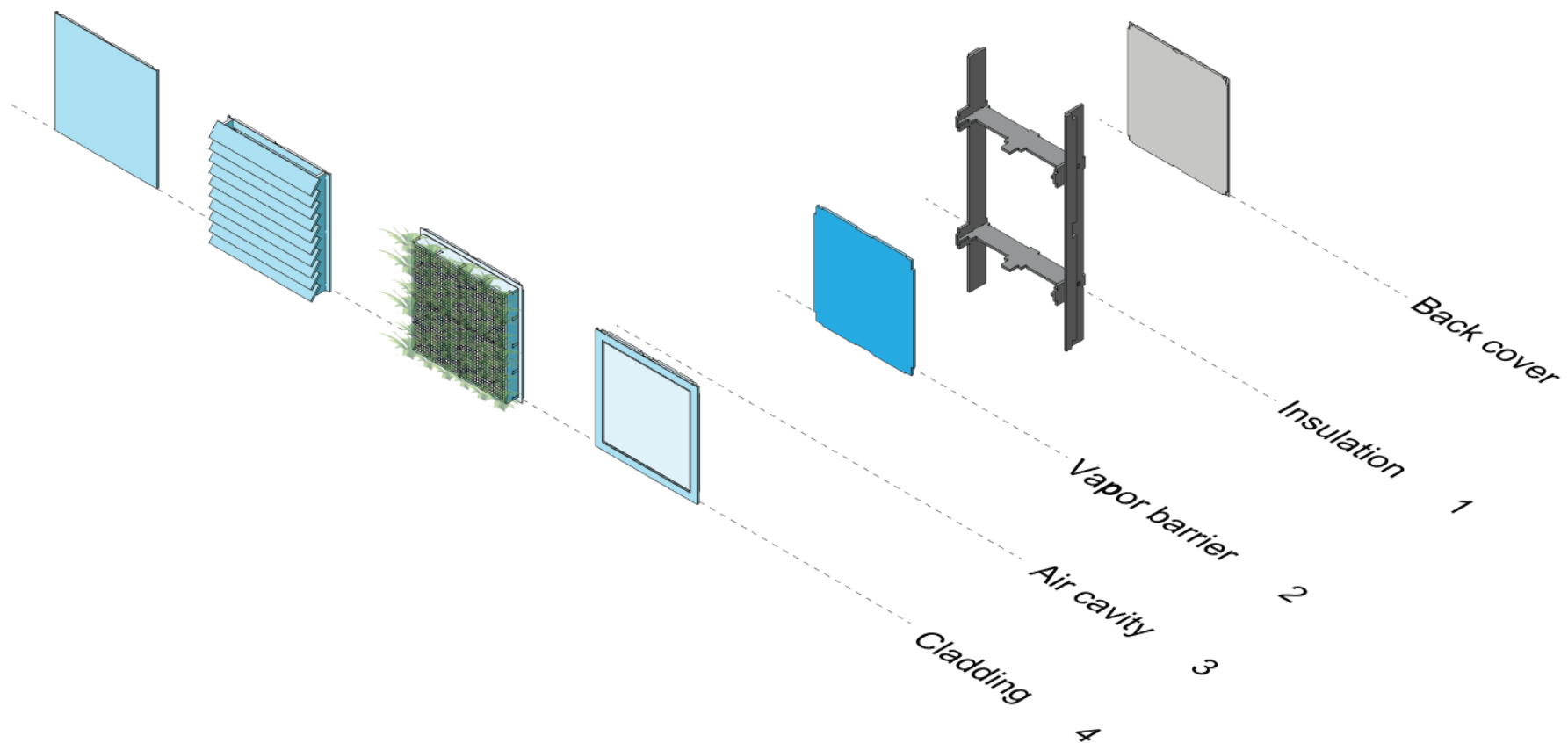


CODE	U VALUE
4.5	0.35 W/m2K





Openings

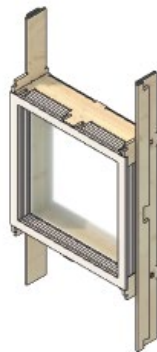


Enclosed facades

COMPONENTS

OPENINGS

FIXED WINDOW



CODE	FUNCTION	U-VALUE
A1	COLLECTION + VIEWS	1.00 W/m2K

OPERABLE WINDOW



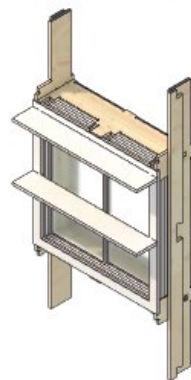
CODE	FUNCTION	U VALUE
A2	COLLECTION + VENTILATION	1.00 W/m2K

HEATING WINDOW



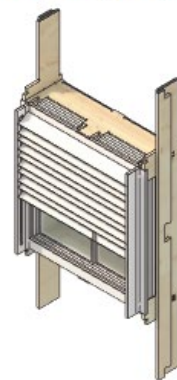
CODE	FUNCTION	U VALUE
A3	COLLECTION + HEATING	0.98 W/m2K

FIXED SHADING



CODE	FUNCTION	U VALUE
B1	COLLECTION	1.00 W/m2K

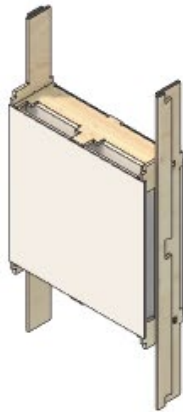
OPERABLE SHADING



CODE	FUNCTION	U VALUE
B2	SHADE + VIEWS	0.84 W/m2K

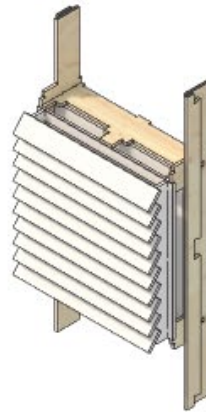
ENCLOSED

AIRTIGHT CLADDING



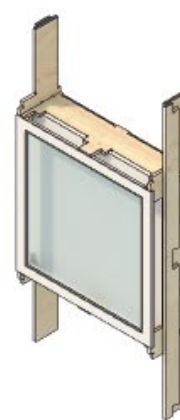
CODE	FUNCTION	U VALUE
C1	SHADE	0.22 W/m ² K

VENTILATED CLADDING



CODE	FUNCTION	U VALUE
C2	SHADE	0.18 W/m ² K

PASSIVE HEATING



CODE	FUNCTION	U-VALUE
C3	SHADE + HEATING	0.15 W/m ² K

GREEN

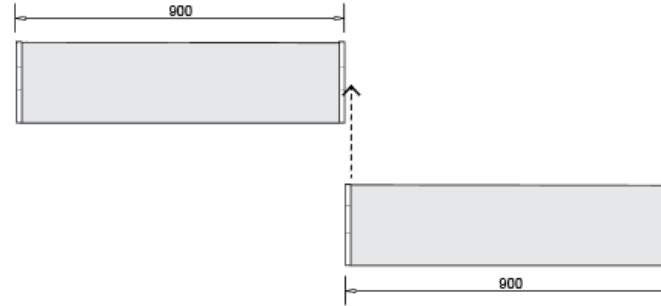
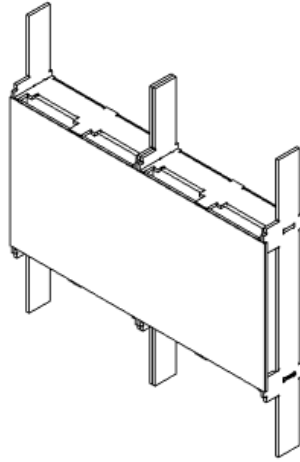


CODE	FUNCTION	U VALUE
C4	SHADE + AIR PURIFICATION	0.33 W/m ² K

PANELS

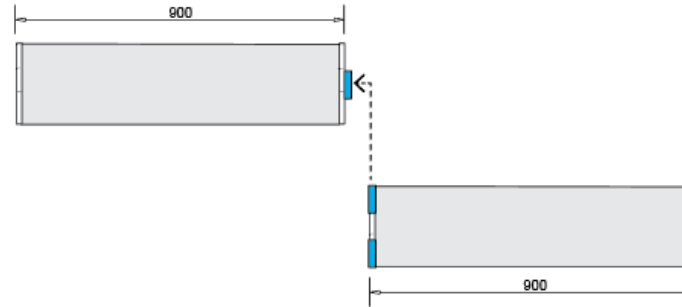
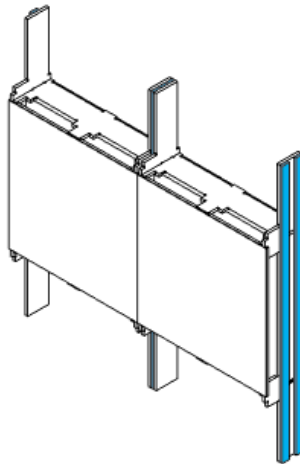
ASSEMBLY

sliding



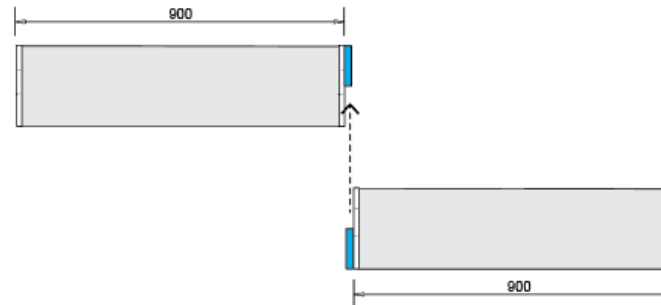
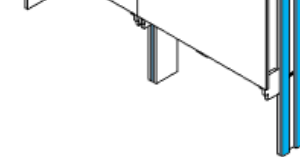
ASSEMBLY TIME	CONNECTION ERGONOMICS	AMOUNT OF ELEMENTS	VULNERABILITY	DISASSEMBLY	INTERCONNECTION	TOTAL
0	1	0	1	1	0	3

male - female



ASSEMBLY TIME	ASSEMBLY ERGONOMICS	AMOUNT OF ELEMENTS	VULNERABILITY	DISASSEMBLY	INTERCONNECTION	TOTAL
1	1	1	1	1	2	7

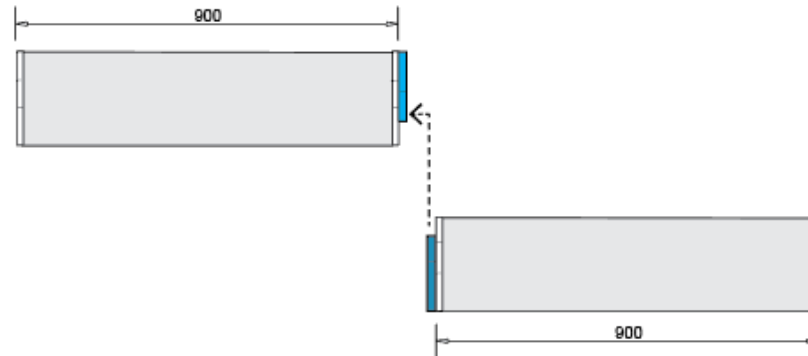
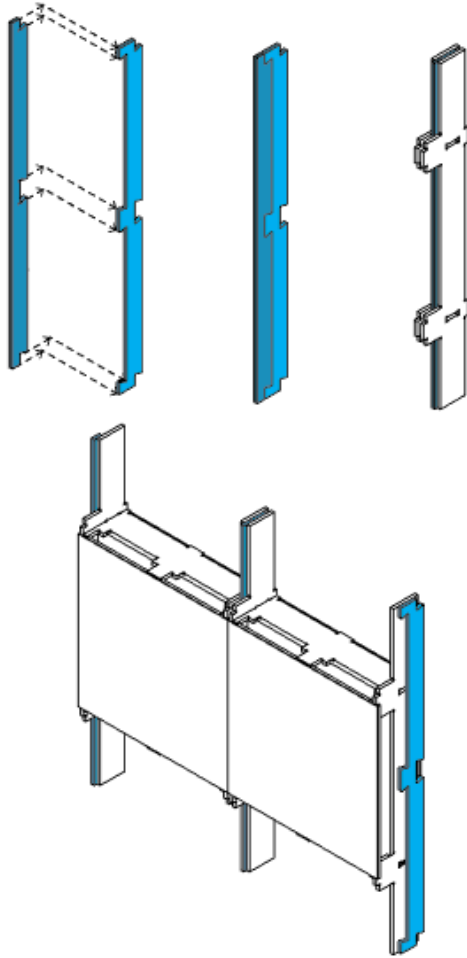
half lap



ASSEMBLY TIME	ASSEMBLY ERGONOMICS	AMOUNT OF ELEMENTS	VULNERABILITY	DISASSEMBLY	INTERCONNECTION	TOTAL
1	1	1	1	1	2	7

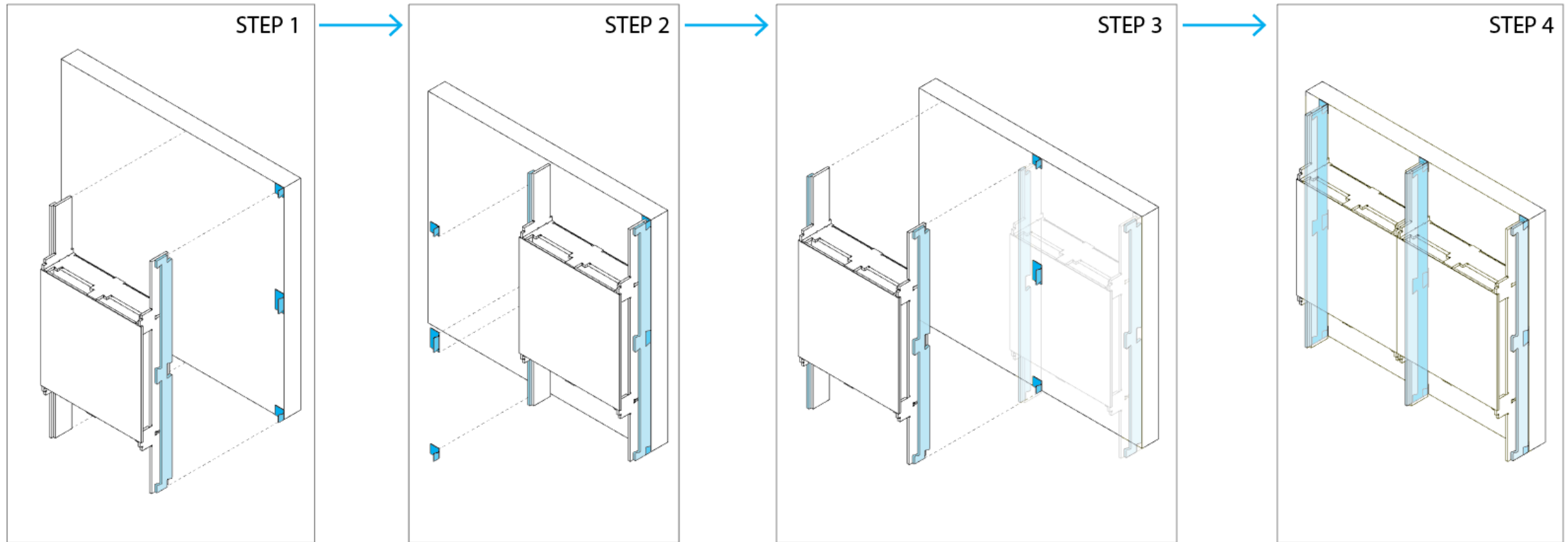
ASSEMBLY

dovetail

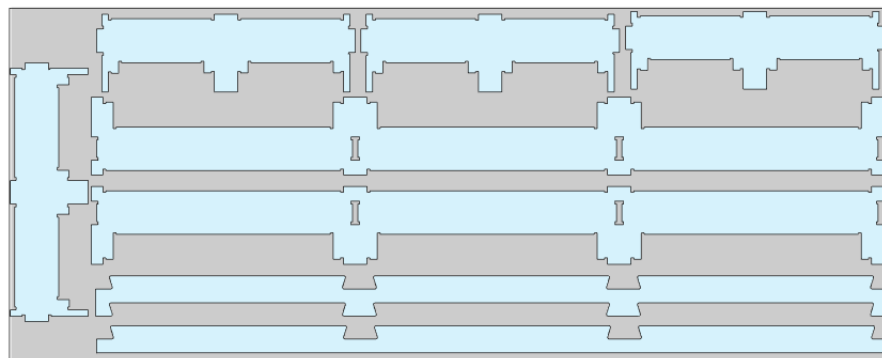
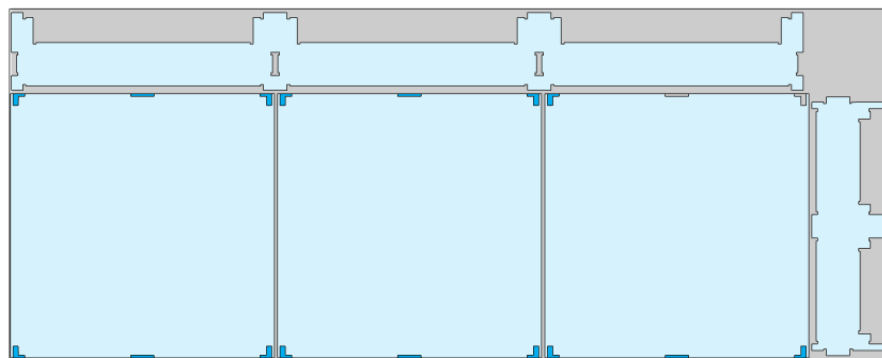
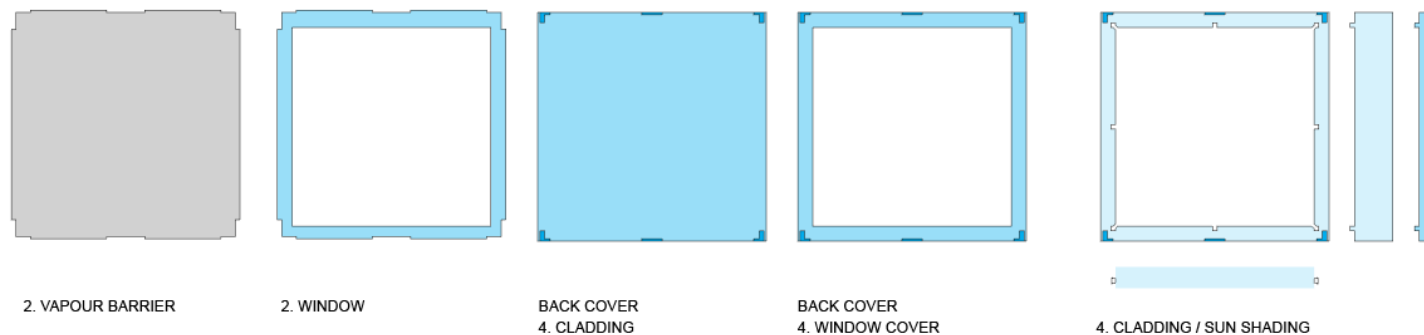


ASSEMBLY TIME	ASSEMBLY ERGONOMICS	AMOUNT OF ELEMENTS	VULNERABILITY	DISASSEMBLY	INTERCONNECTION	TOTAL
2	2	2	2	2	2	12

ASSEMBLY

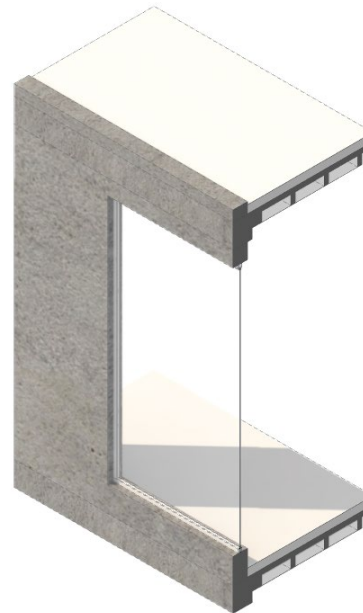


SHEET MATERIALS + CNC TECHNOLOGY



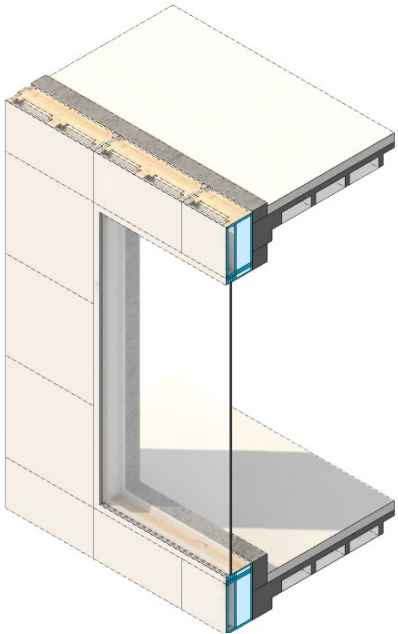
Digital design
Local production
Local and natural sheet materials
Lego assembly
Material efficiency
Easy transport
High precision
Demountable
Reusable

COMBINATIONS

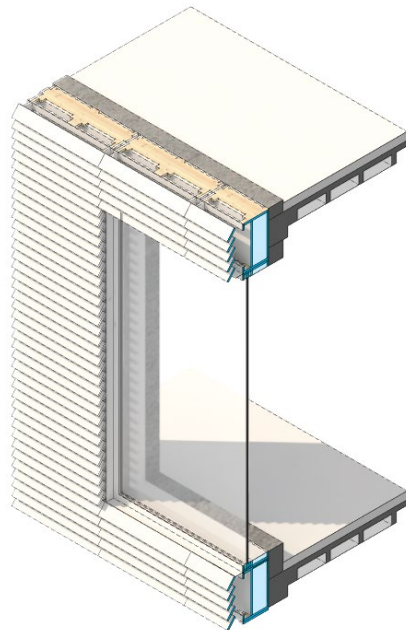


Existing building

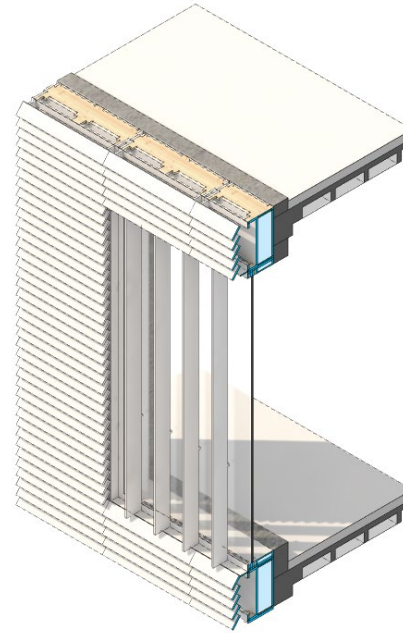
COMBINATIONS



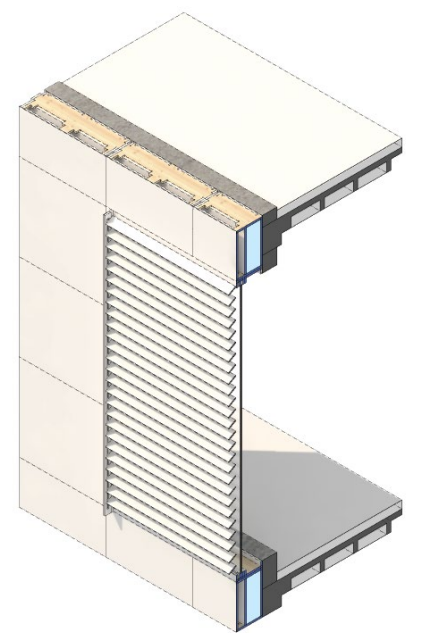
Stationary air cavity cladding
+ improved glazing



Ventilated cavity cladding
+ improved glazing



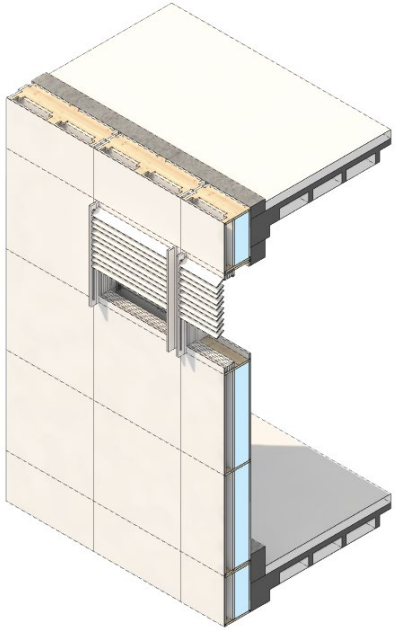
Ventilated air cavity cladding
+ vertical louvers



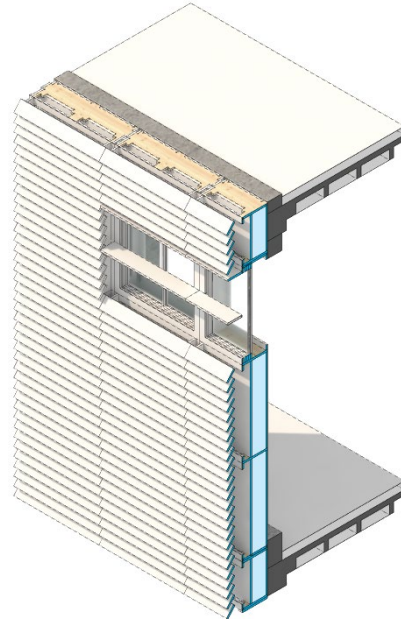
Stationary cavity cladding
+ blinds

Responding to climate

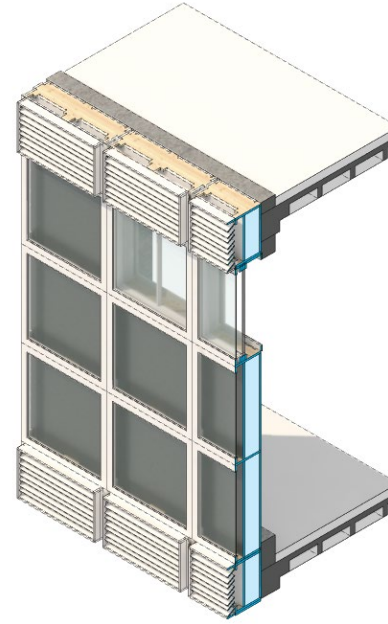
COMBINATIONS



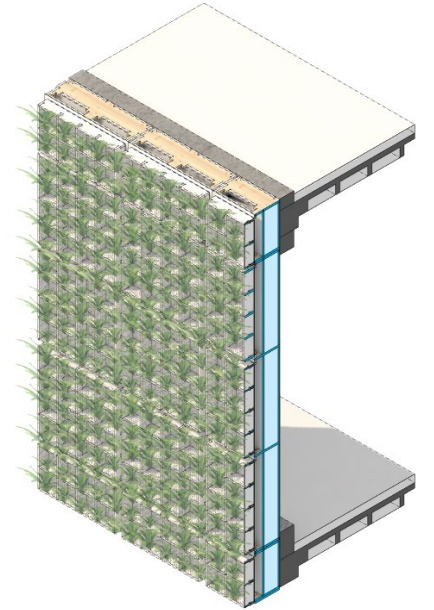
Stationary air cavity cladding
+ reduced shaded glazing



Stationary air cavity cladding
+ reduced shaded glazing



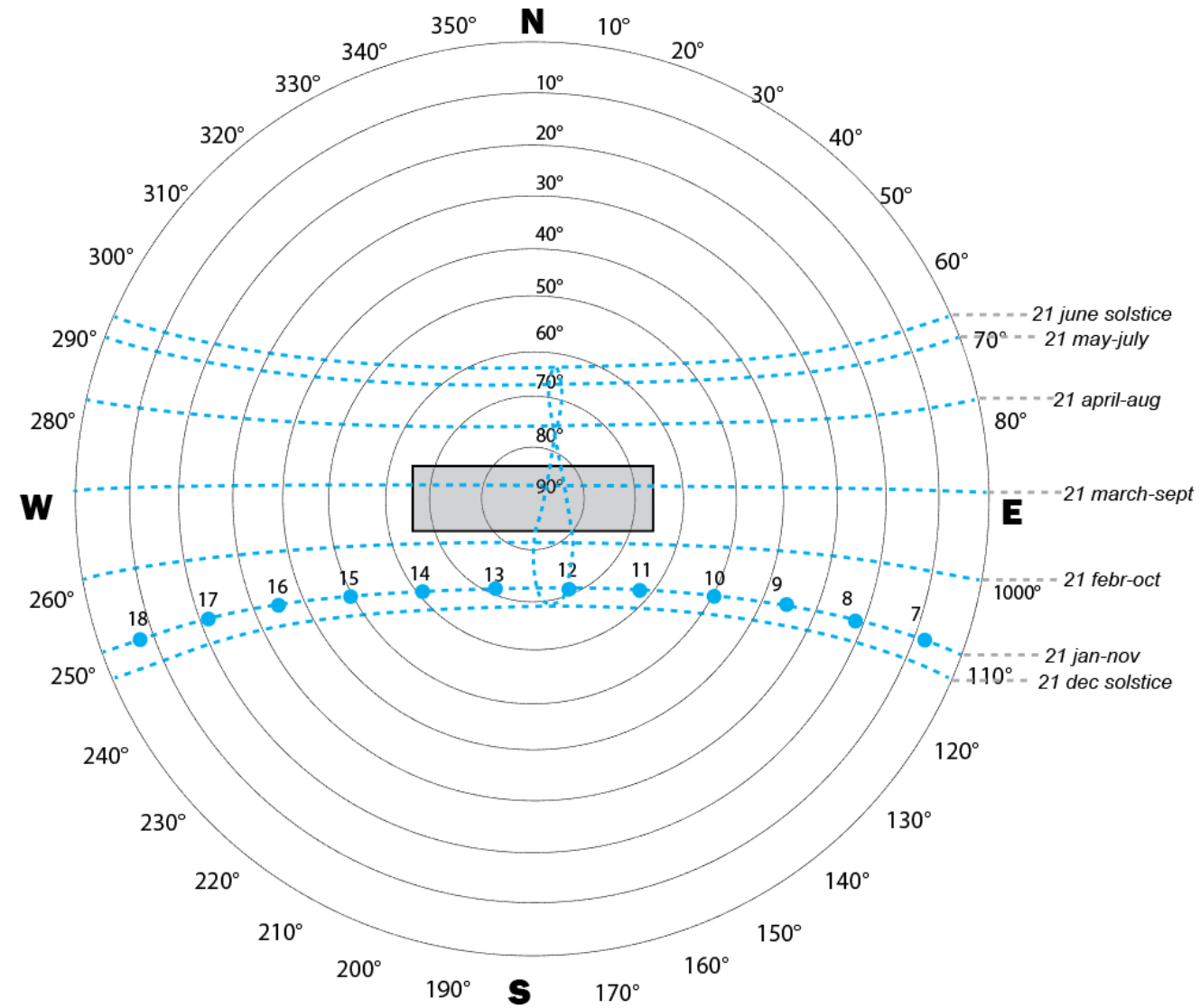
Passive heating cladding
+ reduced glazing



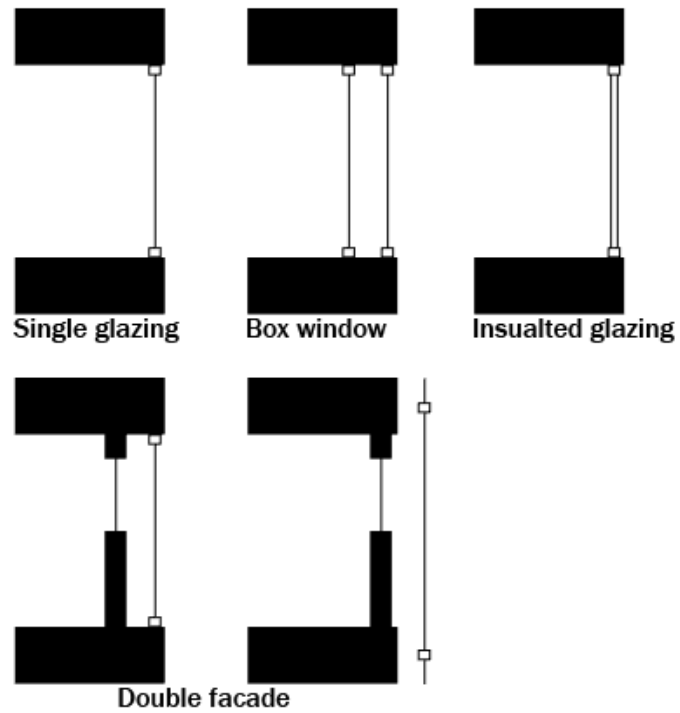
Green cladding
+ no glazing

CLIMATE DESIGN

SUN PATH



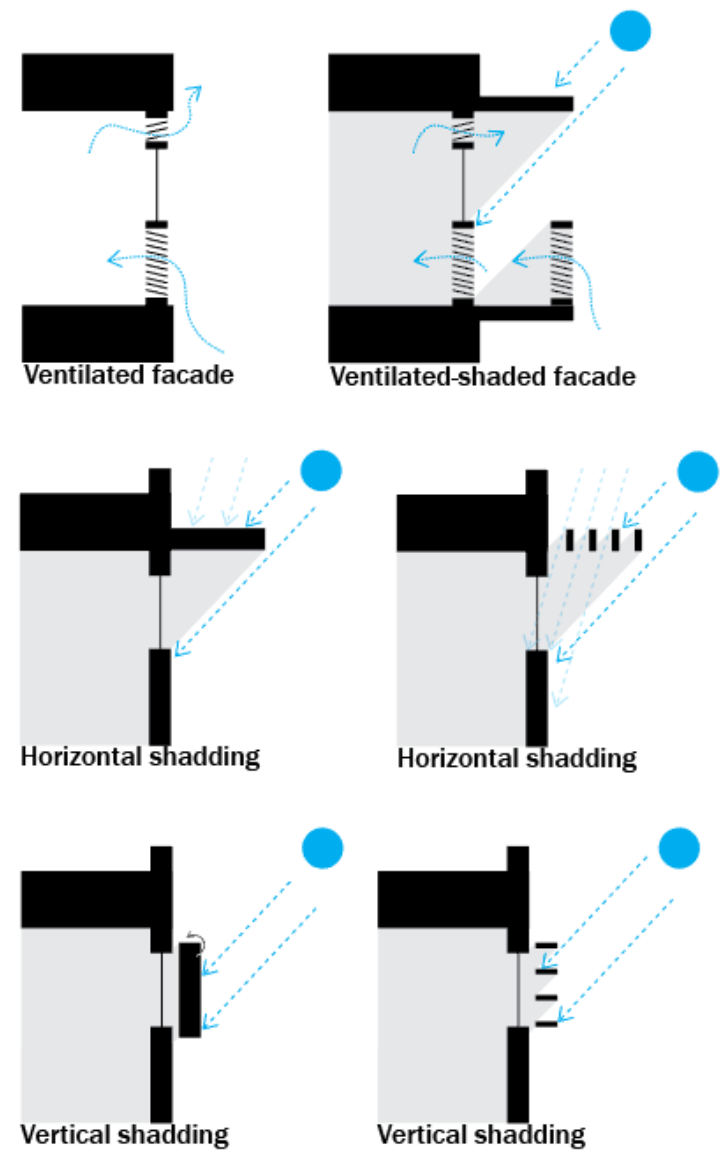
Temperature fluctuations between day and night



Heat gain + storage

TEMPERATE CLIMATE

Bioclimatic passive strategies

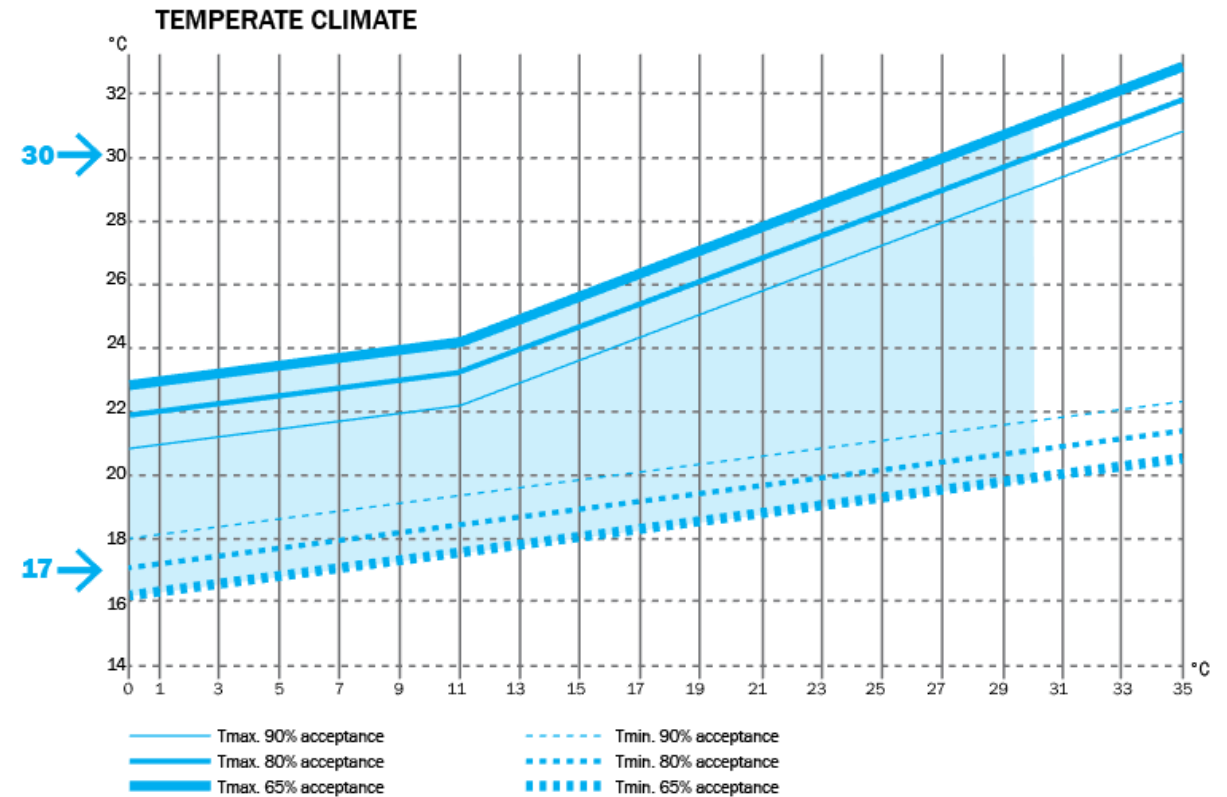
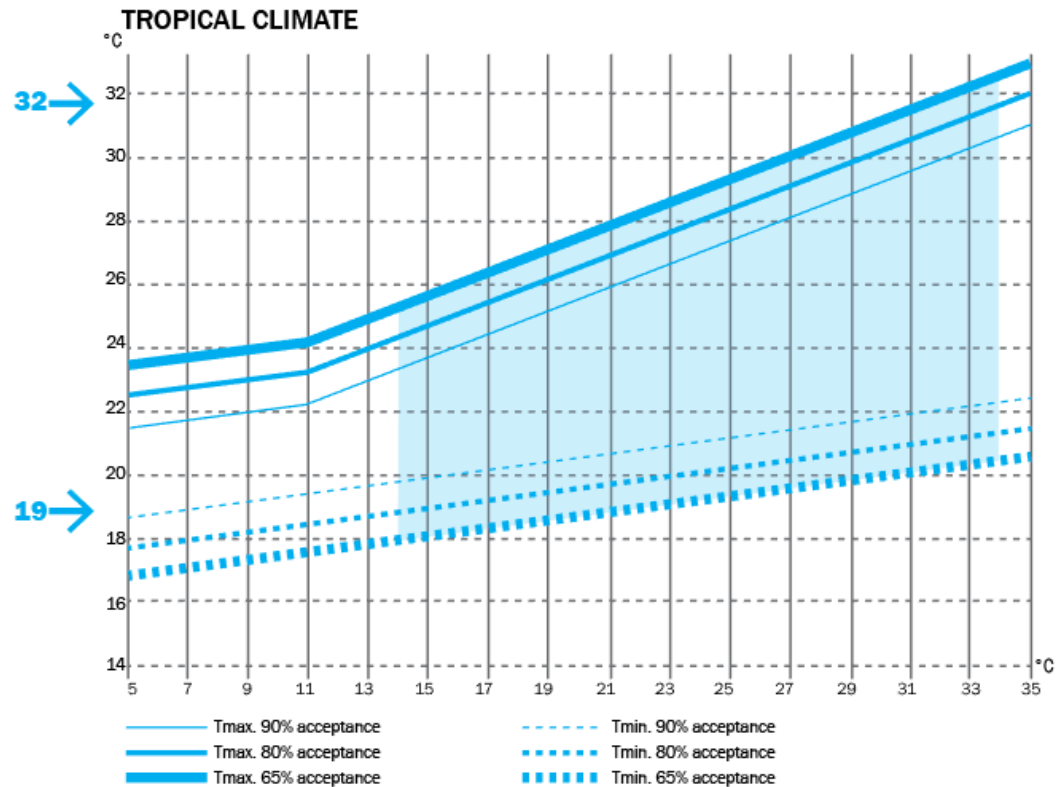


Shading + ventilation


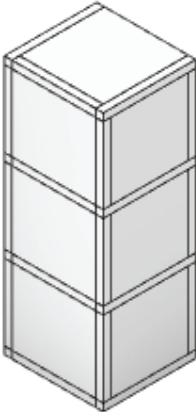


TROPICAL CLIMATE

SIMULATIONS

ADAPTIVE COMFORT MODEL



If a change occurs that produces discomfort, people react in ways which tend to restore their comfort.

TROPICAL CLIMATE	TEMPERATE CLIMATE
 	 

TROPICAL CLIMATE

0 - 1700 M.A.S.L.

16°C - 34°C

ISLANDS + COAST + RAINFOREST

TEMPERATE CLIMATE

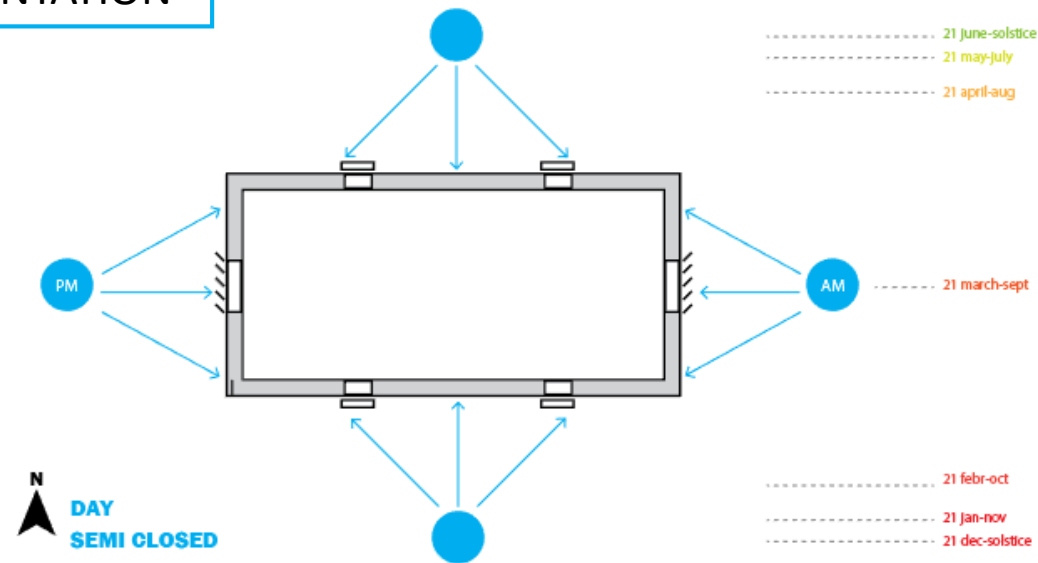
1800 - 6310 M.A.S.L.

0°C - 30°C

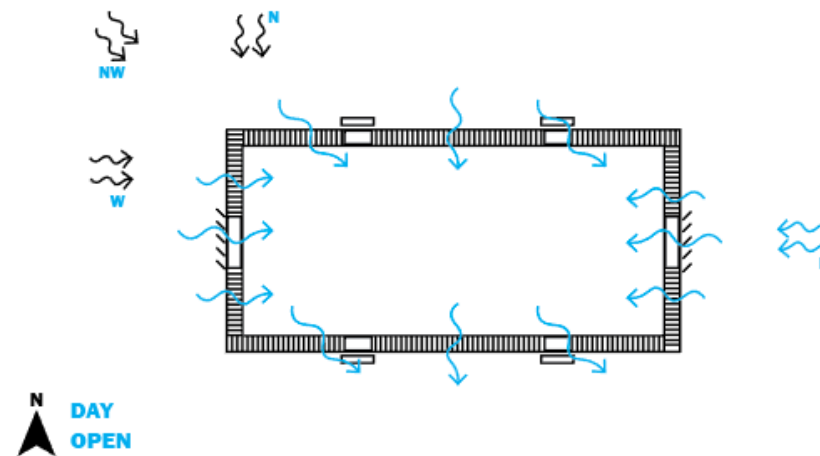
HIGHLANDS

TROPICAL CLIMATE

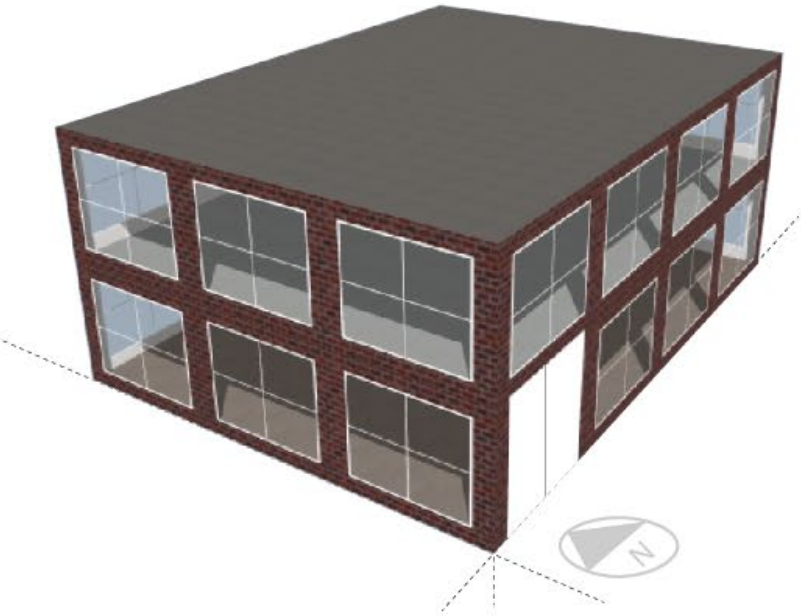
SUN ORIENTATION



WIND ORIENTATION

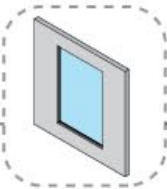


EXISTING BUILDING

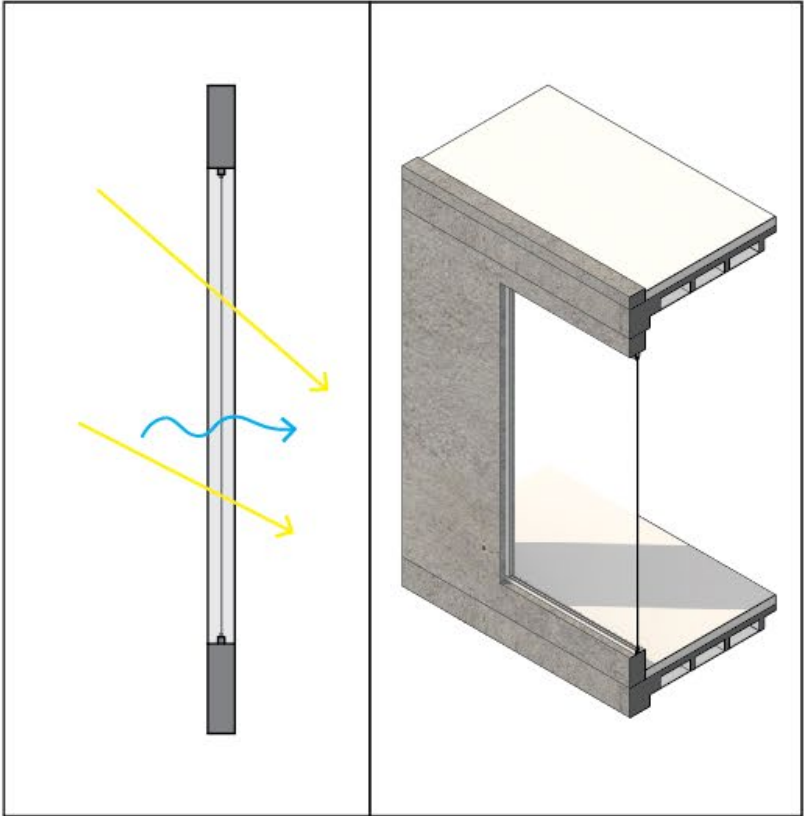


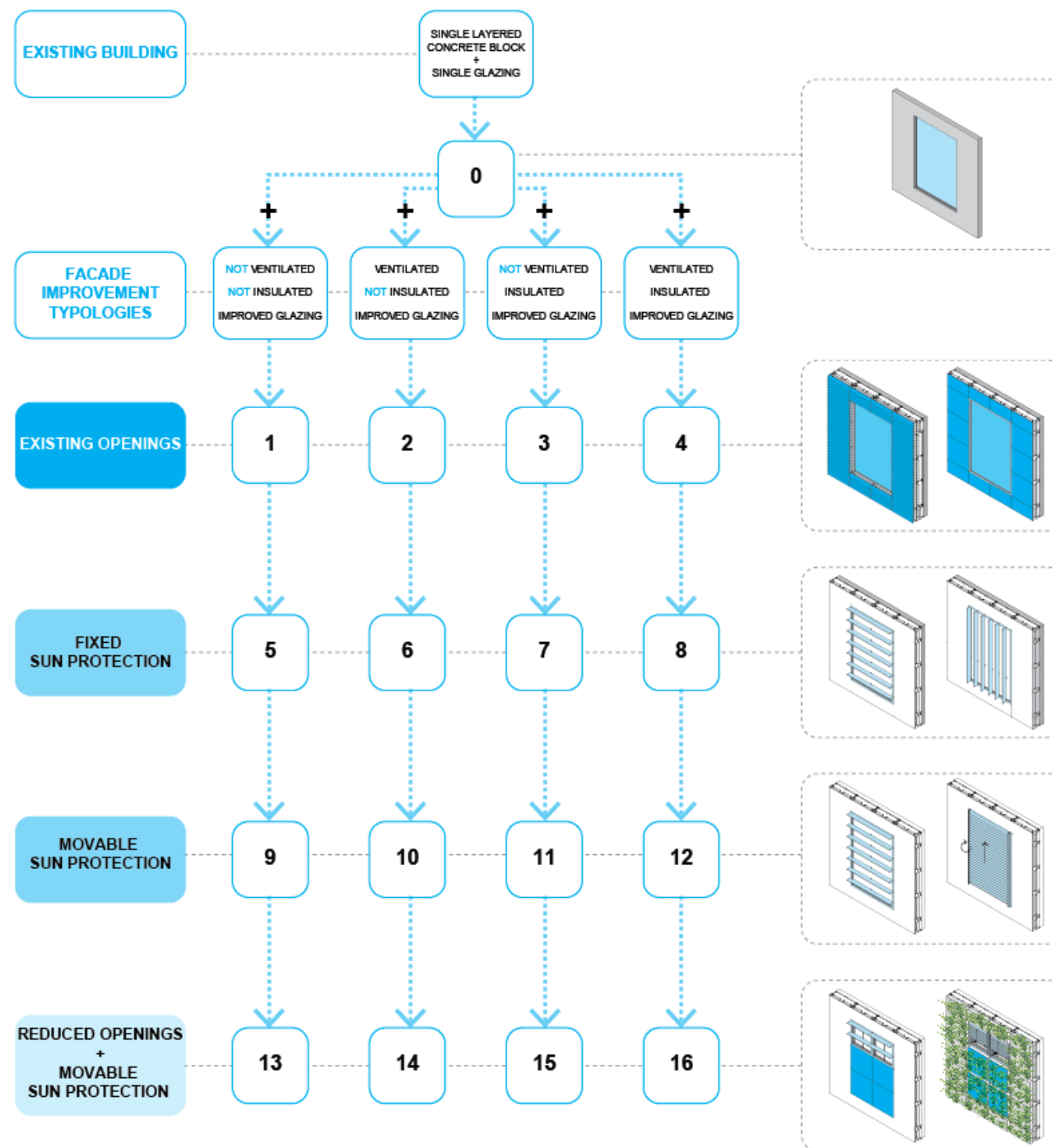
CLIMATE DATA	PARAMETERS	UNITS	CASE
			0
Tout.min. 16°C 6-July 3:00AM	T _{OPERATIVE}	°C	28.68
	T _{RADIANT}	°C	28.94
	GAINS _{WINDOW}	kW	0
	LIGHTING	kW	0
Tout.max. 34°C 23-July 3:00PM	T _{OPERATIVE}	°C	42.47
	T _{RADIANT}	°C	42.36
	GAINS _{WINDOW}	kW	19.48
	LIGHTING	kW	3.35

0



SINGLE GLAZED
SINGLE LAYER OF
CONCRETE BLOCK





RESULTS

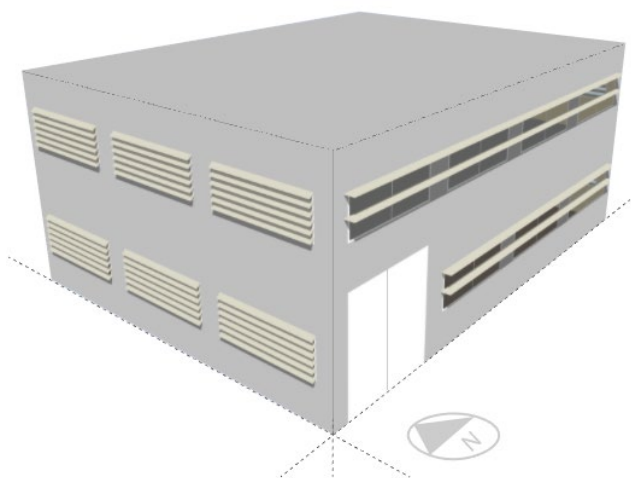
CLIMATE DATA	PARAMETERS	UNITS	SIMULATED CASE STUDIES																
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Tout.min. 16°C 6-July 3:00AM	T _{OPERATIVE}	°C	28.68	24.19	24.36	24.24	25.48	23.51	23.65	23.49	23.6	23.06	23.18	22.91	23.02	25.35	23.42	22.8	22.91
	T _{RADIANT}	°C	28.94	26.94	27.17	27.02	27.8	26.08	26.27	26.06	26.21	25.5	25.66	25.31	25.45	25.85	25.94	25.13	25.28
	GAINS _{WINDOW}	kW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LIGHTING	kW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tout.max. 34°C 23-July 3:00PM	T _{OPERATIVE}	°C	42.47	36.64	36.47	36.85	36.76	35.72	35.57	35.83	36.76	34.48	34.33	34.49	34.44	32.5	32.39	32.25	32.22
	T _{RADIANT}	°C	42.36	37.27	37.03	37.57	37.44	35.97	35.76	36.14	36.04	34.2	34	34.22	34.15	31.5	31.36	31.17	31.13
	GAINS _{WINDOW}	kW	19.48	11.64	11.64	11.64	11.64	10.77	10.77	10.77	10.77	6.78	6.78	6.78	6.78	3.1	3.1	3.1	3.1
	LIGHTING	kW	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
EXISTING	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING	VENTILATED, NOT INSULATED, IMPROVED GLAZING	NOT VENTILATED, INSULATED, IMPROVED GLAZING	VENTILATED, INSULATED, IMPROVED GLAZING	NO TVENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	NOT VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING HORIZ. LOUVERS + BLINDS	VENTILATED, NOT INSULATED, IMPROVED GLAZING HORIZ. LOUVERS + BLINDS	NOT VENTILATED, INSULATED, IMPROVED GLAZING HORIZ. LOUVERS + BLINDS	VENTILATED, NOT SULATED, IMPROVED GLAZING HORIZ. LOUVERS + BLINDS	NOT VENTILATED, NOT INSULATED, REDUCED GLAZING HORIZ. LOUVERS + BLINDS	VENTILATED, NOT INSULATED, REDUCED GLAZING HORIZ. LOUVERS + BLINDS	NOT VENTILATED, INSULATED, REDUCED GLAZING HORIZ. LOUVERS + BLINDS	VENTILATED, INSULATED, REDUCED GLAZING HORIZ. LOUVERS + BLINDS

CLIMATE DATA	PARAMETERS	UNITS	SIMULATED CASE STUDIES																
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Tout.min. 16°C 6-July 3:00AM	T _{OPERATIVE}	°C	28.68	24.19	24.36	24.24	25.48	23.51	23.65	23.49	23.6	23.06	23.18	22.91	23.02	25.35	23.42	22.8	22.91
	T _{RADIANT}	°C	28.94	26.94	27.17	27.02	27.8	26.08	26.27	26.06	26.21	25.5	25.66	25.31	25.45	25.85	25.94	25.13	25.28
	GAINS _{WINDOW}	kW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LIGHTING	kW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tout.max. 34°C 23-July 3:00PM	T _{OPERATIVE}	°C	42.47	36.64	36.47	36.85	36.76	35.72	35.57	35.83	36.76	34.48	34.33	34.49	34.44	32.5	32.39	32.25	32.22
	T _{RADIANT}	°C	42.36	37.27	37.03	37.57	37.44	35.97	35.76	36.14	36.04	34.2	34	34.22	34.15	31.5	31.36	31.17	31.13
	GAINS _{WINDOW}	kW	19.48	11.64	11.64	11.64	11.64	10.77	10.77	10.77	10.77	6.78	6.78	6.78	6.78	3.1	3.1	3.1	3.1
	LIGHTING	kW	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35

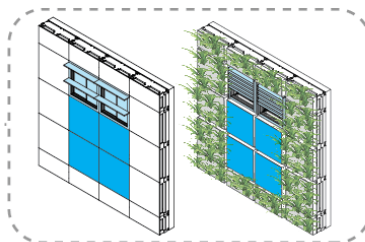
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
EXISTING	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING	VENTILATED, NOT INSULATED, IMPROVED GLAZING	NOT VENTILATED, INSULATED, IMPROVED GLAZING	VENTILATED, INSULATED, IMPROVED GLAZING	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	NOT VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	NOT VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	NOT VENTILATED, NOT INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS	VENTILATED, NOT INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS	NOT VENTILATED, INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS	VENTILATED, INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS

ADAPTIVE COMFORT:	16	
	18	
	20	
	22	
	24	
	26	
	28	
	30	
	32	
	34	
	36	
	38	
	40	
	42	

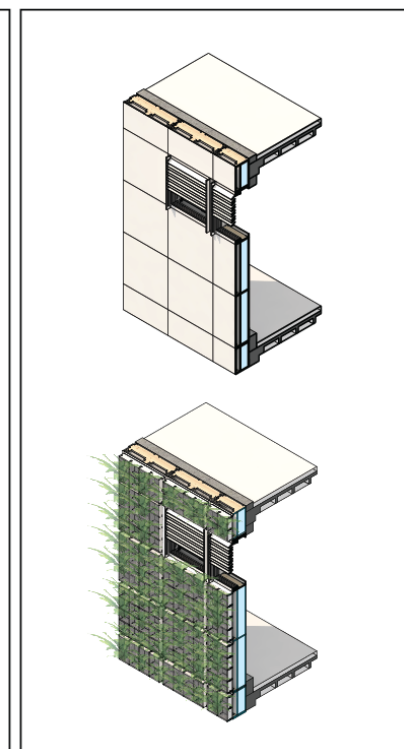
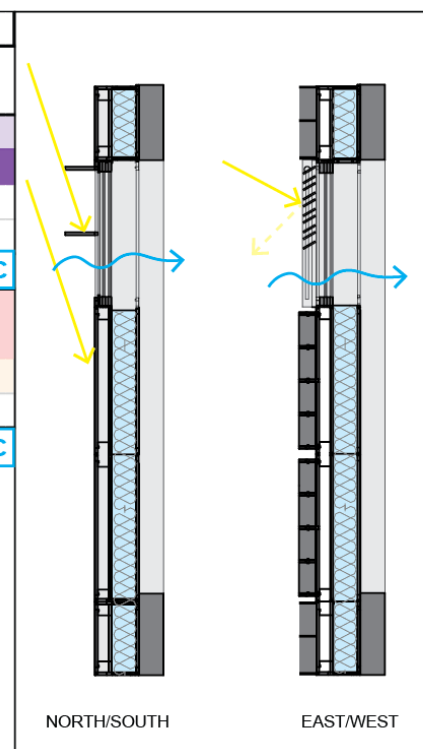


CLIMATE DATA	PARAMETERS	UNITS	CASE	CASE
			0	15
Tout.min. 16°C 6-July 3:00AM	T _{OPERATIVE}	°C	28.68	22.8
	T _{RADIANT}	°C	28.94	25.13
	GAINS _{WINDOW}	kW	0	0
	LIGHTING	kW	0	0
	T _{variation}	°C	-5.88°C	
Tout.max. 34°C 23-July 3:00PM	T _{OPERATIVE}	°C	42.47	32.25
	T _{RADIANT}	°C	42.36	31.17
	GAINS _{WINDOW}	kW	19.48	3.1
	LIGHTING	kW	3.35	3.35
	T _{variation}	°C	-10.22°C	

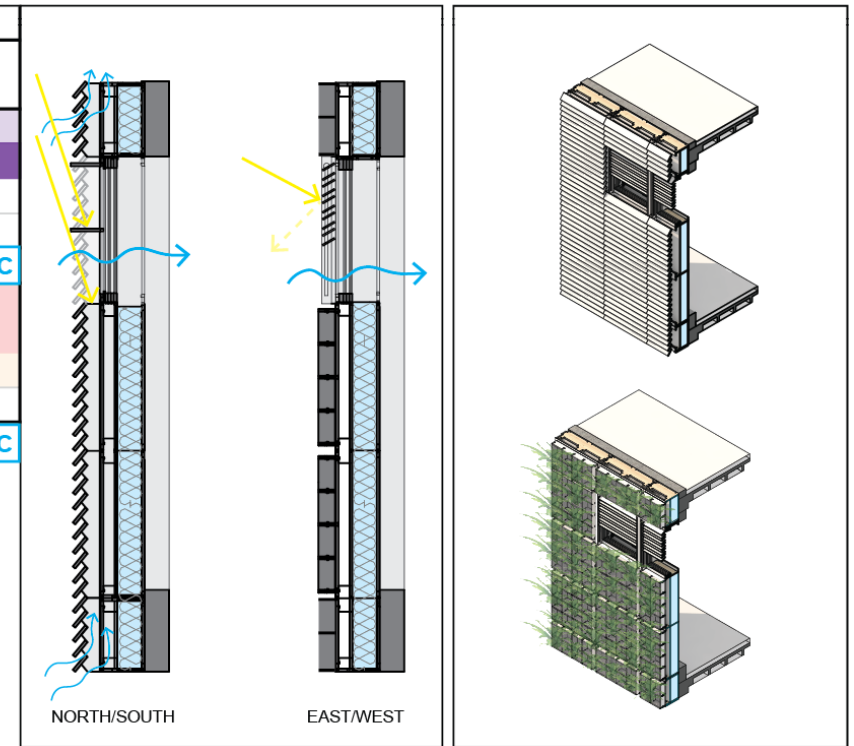
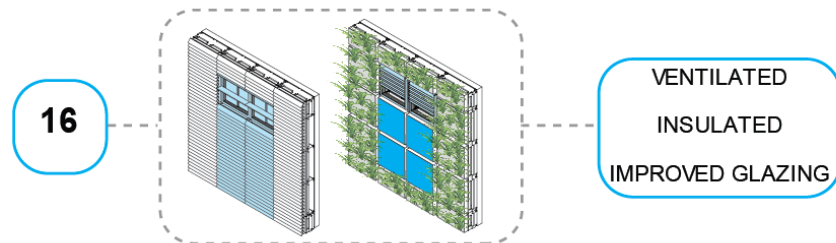
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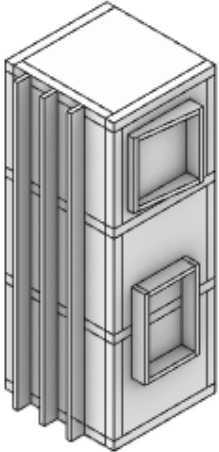
NOT VENTILATED
INSULATED
IMPROVED GLAZING



CLIMATE DATA	PARAMETERS	UNITS	CASE	CASE
			0	16
Tout.min. 16°C 6-July 3:00AM	T _{OPERATIVE}	°C	28.68	22.91
	T _{RADIANT}	°C	28.94	25.28
	GAINS _{WINDOW}	kW	0	0
	LIGHTING	kW	0	0
	T _{variation}	°C	-5.77°C	
Tout.max. 34°C 23-July 3:00PM	T _{OPERATIVE}	°C	42.47	32.22
	T _{RADIANT}	°C	42.36	31.13
	GAINS _{WINDOW}	kW	19.48	3.1
	LIGHTING	kW	3.35	3.35
	T _{variation}	°C	-10.25°C	



TEMPERATE CLIMATE

TROPICAL CLIMATE	TEMPERATE CLIMATE
 	 

TROPICAL CLIMATE

0 - 1700 M.A.S.L.

16°C - 34°C

ISLANDS + COAST + RAINFOREST

TEMPERATE CLIMATE

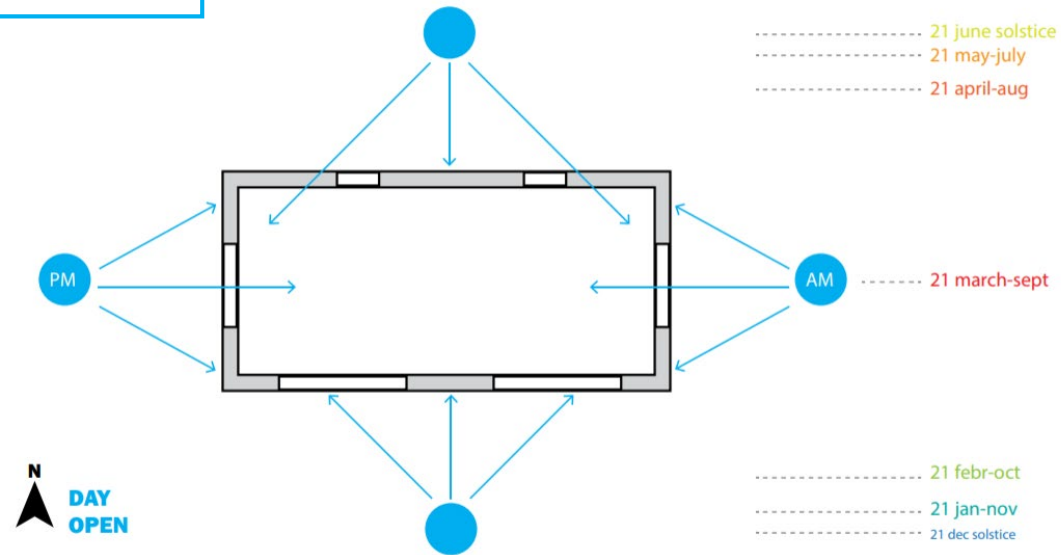
1800 - 6310 M.A.S.L.

0°C - 30°C

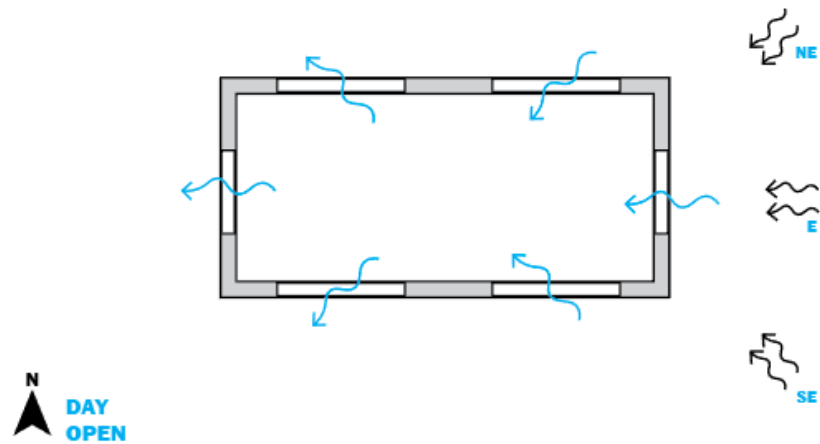
HIGHLANDS



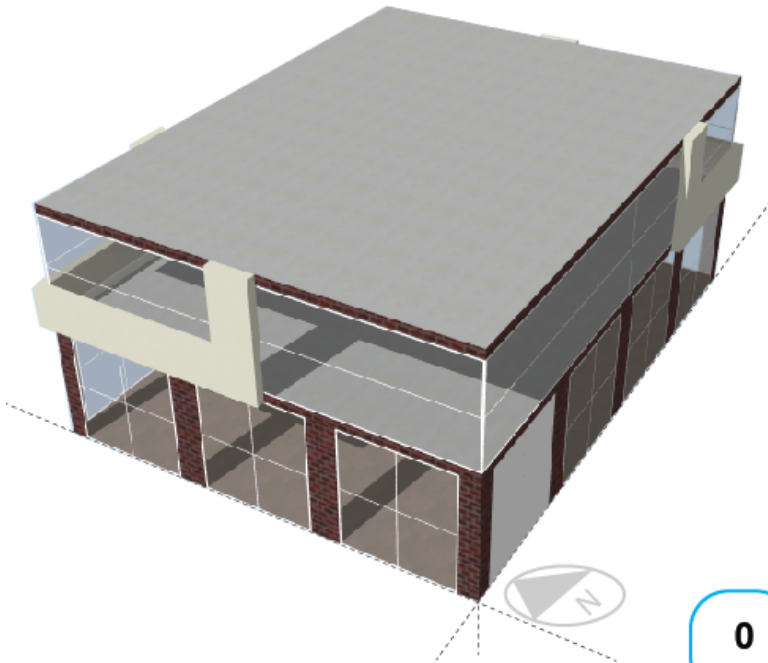
SUN ORIENTATION



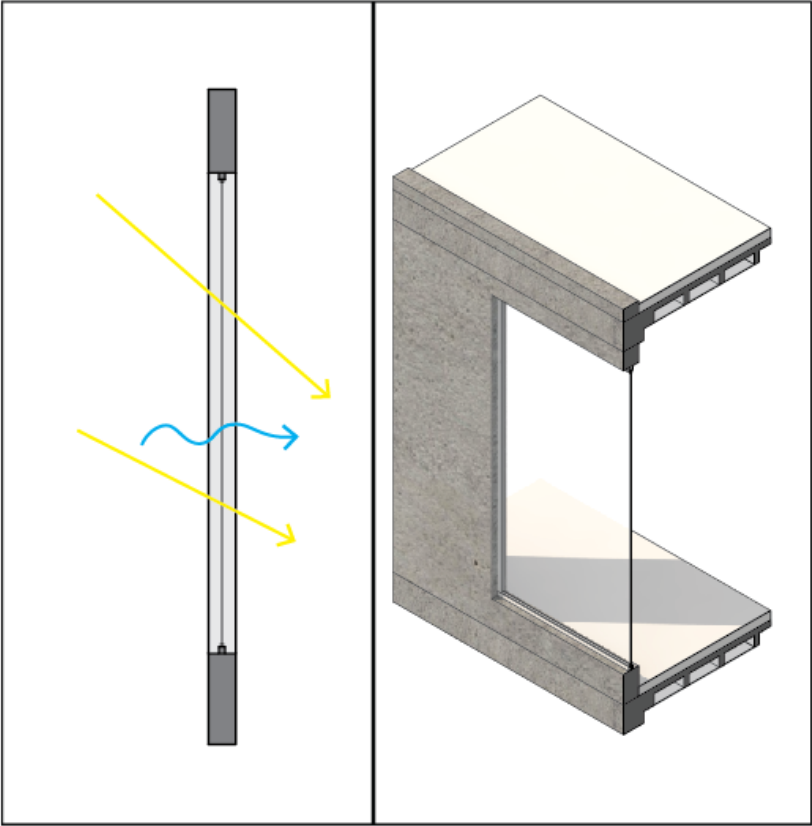
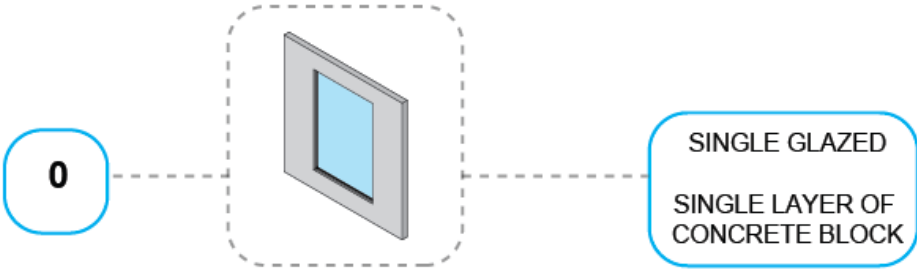
WIND ORIENTATION

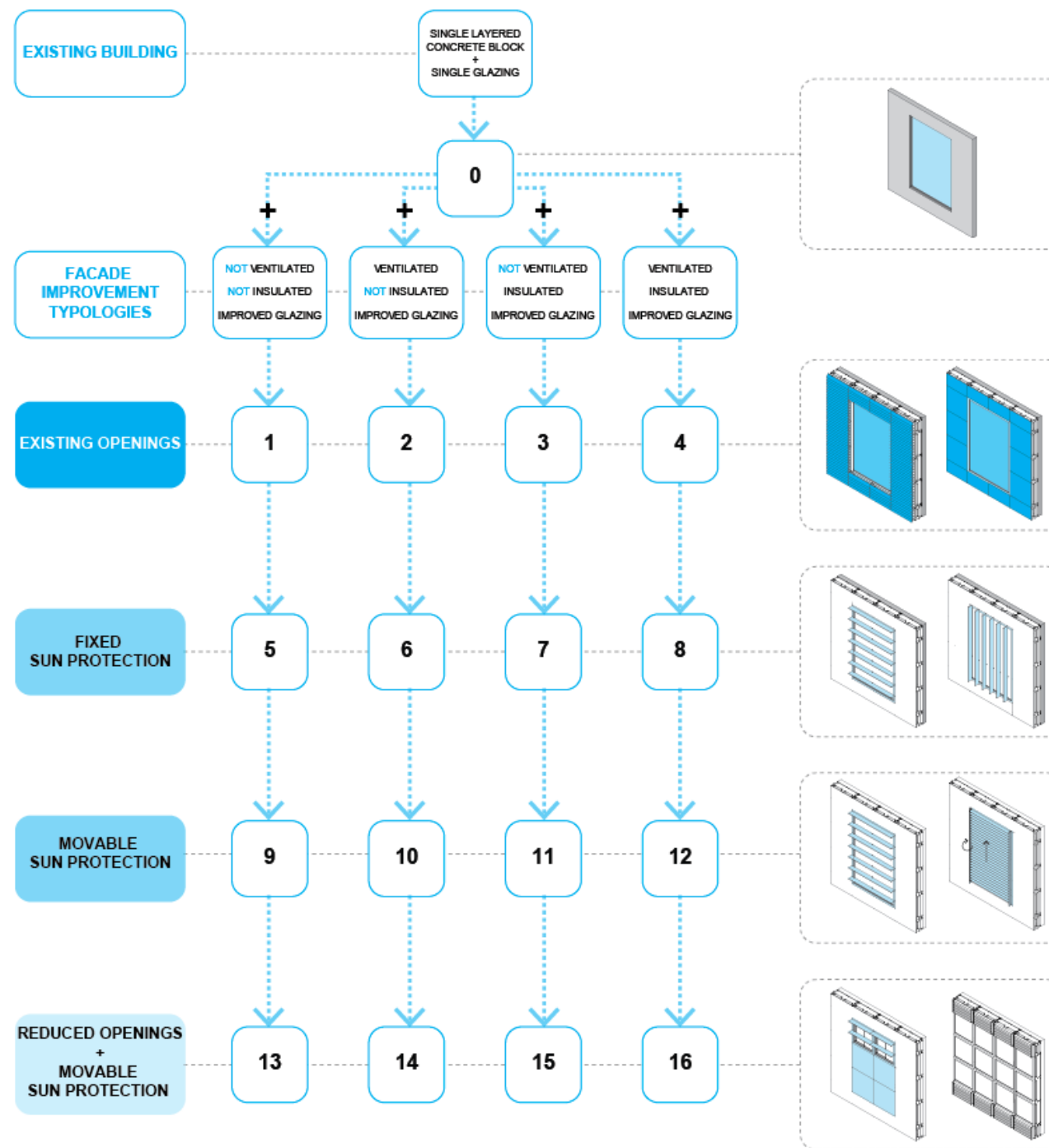


EXISTING BUILDING



CLIMATE DATA	PARAMETERS	UNITS	CASE
			0
T _{out} . 0-24°C 2-March 3:00AM	T _{OPERATIVE}	°C	11.03
	T _{RADIANT}	°C	12.98
	GAINS _{WINDOW}	kW	0
	LIGHTING	kW	0
T _{out} . 7-30°C 8-September 2:00PM	T _{OPERATIVE}	°C	34.83
	T _{RADIANT}	°C	35.63
	GAINS _{WINDOW}	kW	25.2
	LIGHTING	kW	3.35





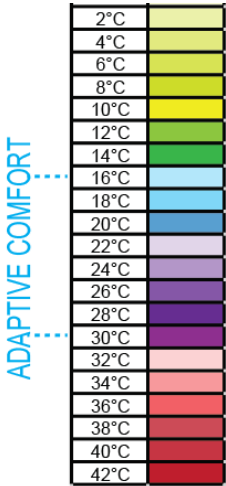
RESULTS

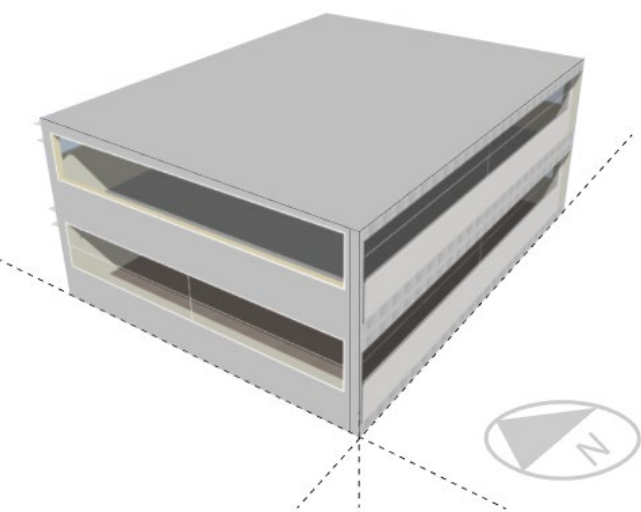
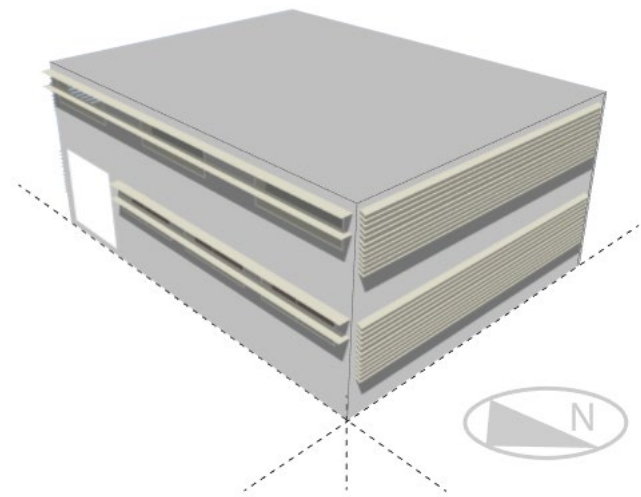
CLIMATE DATA	PARAMETERS	UNITS	CASE 0	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6	CASE 7	CASE 8	CASE 9	CASE 10	CASE 11	CASE 12	CASE 13	CASE 14	CASE 15	CASE 16
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T _{out} . 0-24°C 2-March 3:00AM	T _{OPERATIVE}	°C	11.03	18.5	17.6	19.8	20.02	16.26	16.8	18.59	18.76	16.75	17.39	19.4	19.6	19.33	20.08	23.16	23.23
	T _{RADIANT}	°C	12.98	18.69	18.4	20.73	20.95	16.96	17.57	19.48	19.67	17.47	18.15	20.34	20.55	20.2	21	24.25	24.31
	GAINS _{WINDOW}	kW	0	0	0	0	0	0	0	0	0	0	0	10.2 (MIDDAY)	0	0	0	0	
	LIGHTING	kW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T _{out} . 7-30°C 8-September 2:00PM	T _{OPERATIVE}	°C	34.83	34.13	34.27	35.06	34.98	33.42	33.34	34.04	33.98	31.38	31.24	31.6	31.56	29.8	29.61	29.92	29.81
	T _{RADIANT}	°C	35.63	34.85	34.89	35.92	35.81	33.78	33.67	34.6	34.52	31.07	30.9	31.35	31.3	29.09	28.87	29.25	29.13
	GAINS _{WINDOW}	kW	25.2	18.07	18.07	18.07	18.07	13.59	13.59	13.59	13.59	10.5	10.5	10.5	10.5	2.96	2.96	2.96	2.96
	LIGHTING	kW	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
EXISTING	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING	VENTILATED, NOT INSULATED, IMPROVED GLAZING	NOT VENTILATED, INSULATED, IMPROVED GLAZING	VENTILATED, INSULATED, IMPROVED GLAZING	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	NOT VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVE	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	NOT VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	VENTILATED, NOT SULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	NOT VENTILATED, NOT INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS PASSIVE HEATING	VENTILATED, NOT INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS PASSIVE HEATING	NOT VENTILATED, INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS PASSIVE HEATING	VENTILATED, INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS PASSIVE HEATING

CLIMATE DATA	PARAMETERS	UNITS	CASE 0	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6	CASE 7	CASE 8	CASE 9	CASE 10	CASE 11	CASE 12	CASE 13	CASE 14	CASE 15	CASE 16
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T _{out} . 0-24°C 2-March 3:00AM	T _{OPERATIVE}	°C	11.03	18.5	17.6	19.8	20.02	16.26	16.8	18.59	18.76	16.75	17.39	19.4	19.6	19.33	20.08	23.16	23.23
	T _{RADIANT}	°C	12.98	18.69	18.4	20.73	20.95	16.96	17.57	19.48	19.67	17.47	18.15	20.34	20.55	20.2	21	24.25	24.31
	GAINS WINDOW	kW	0	0	0	0	0	0	0	0	0	0	0	10.2 (MIDDAY)	0	0	0	0	
	LIGHTING	kW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T _{out} . 7-30°C 8-September 2:00PM	T _{OPERATIVE}	°C	34.83	34.13	34.27	35.06	34.98	33.42	33.34	34.04	33.98	31.38	31.24	31.6	31.56	29.8	29.61	29.92	29.81
	T _{RADIANT}	°C	35.63	34.85	34.89	35.92	35.81	33.78	33.67	34.6	34.52	31.07	30.9	31.35	31.3	29.09	28.87	29.25	29.13
	GAINS WINDOW	kW	25.2	18.07	18.07	18.07	18.07	13.59	13.59	13.59	13.59	10.5	10.5	10.5	10.5	2.96	2.96	2.96	2.96
	LIGHTING	kW	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35

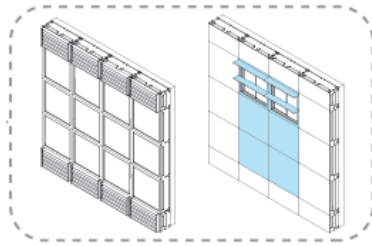
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
EXISTING	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING	VENTILATED, NOT INSULATED, IMPROVED GLAZING	NOT VENTILATED, INSULATED, IMPROVED GLAZING	VENTILATED, INSULATED, IMPROVED GLAZING	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVER	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVER	NOT VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVER	VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ.+VERT. LOUVER	NOT VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	NOT VENTILATED, INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	VENTILATED, NOT INSULATED, IMPROVED GLAZING, HORIZ. LOUVERS + BLINDS	NOT VENTILATED, NOT INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS, PASSIVE HEATING	VENTILATED, NOT INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS, PASSIVE HEATING	NOT VENTILATED, INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS, PASSIVE HEATING	VENTILATED, INSULATED, REDUCED GLAZING, HORIZ. LOUVERS + BLINDS, PASSIVE HEATING



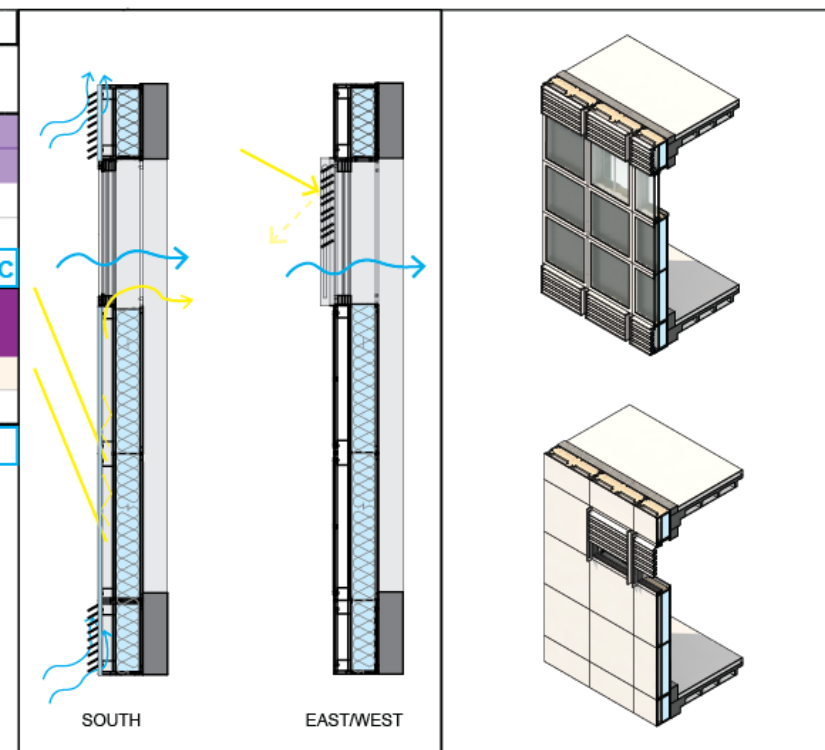


CLIMATE DATA	PARAMETERS	UNITS	CASE	CASE
			0	15
T _{out} . 0-24°C 2-March 3:00AM	T _{OPERATIVE}	°C	11.03	23.16
	T _{RADIANT}	°C	12.98	24.25
	GAINS _{WINDOW}	kW	0	0
	LIGHTING	kW	0	0
	T _{variation}	°C	+12.13°C	
T _{out} . 7-30°C 8-September 2:00PM	T _{OPERATIVE}	°C	34.83	29.92
	T _{RADIANT}	°C	35.63	29.25
	GAINS _{WINDOW}	kW	25.2	2.96
	LIGHTING	kW	3.35	3.35
	T _{variation}	°C	-4.91°C	

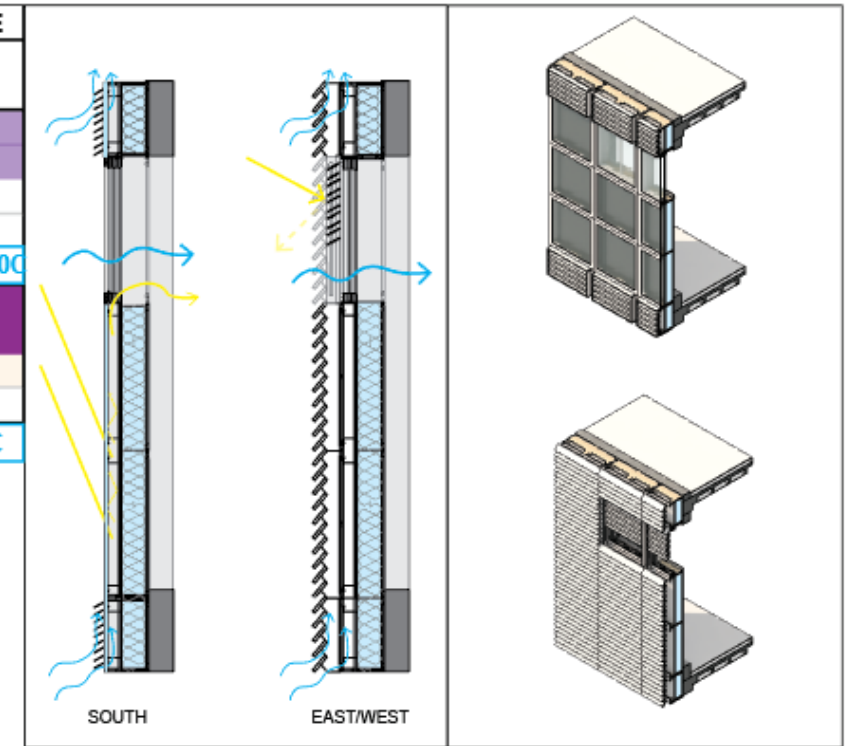
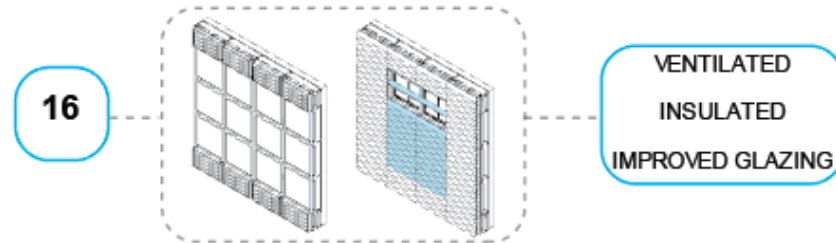
15



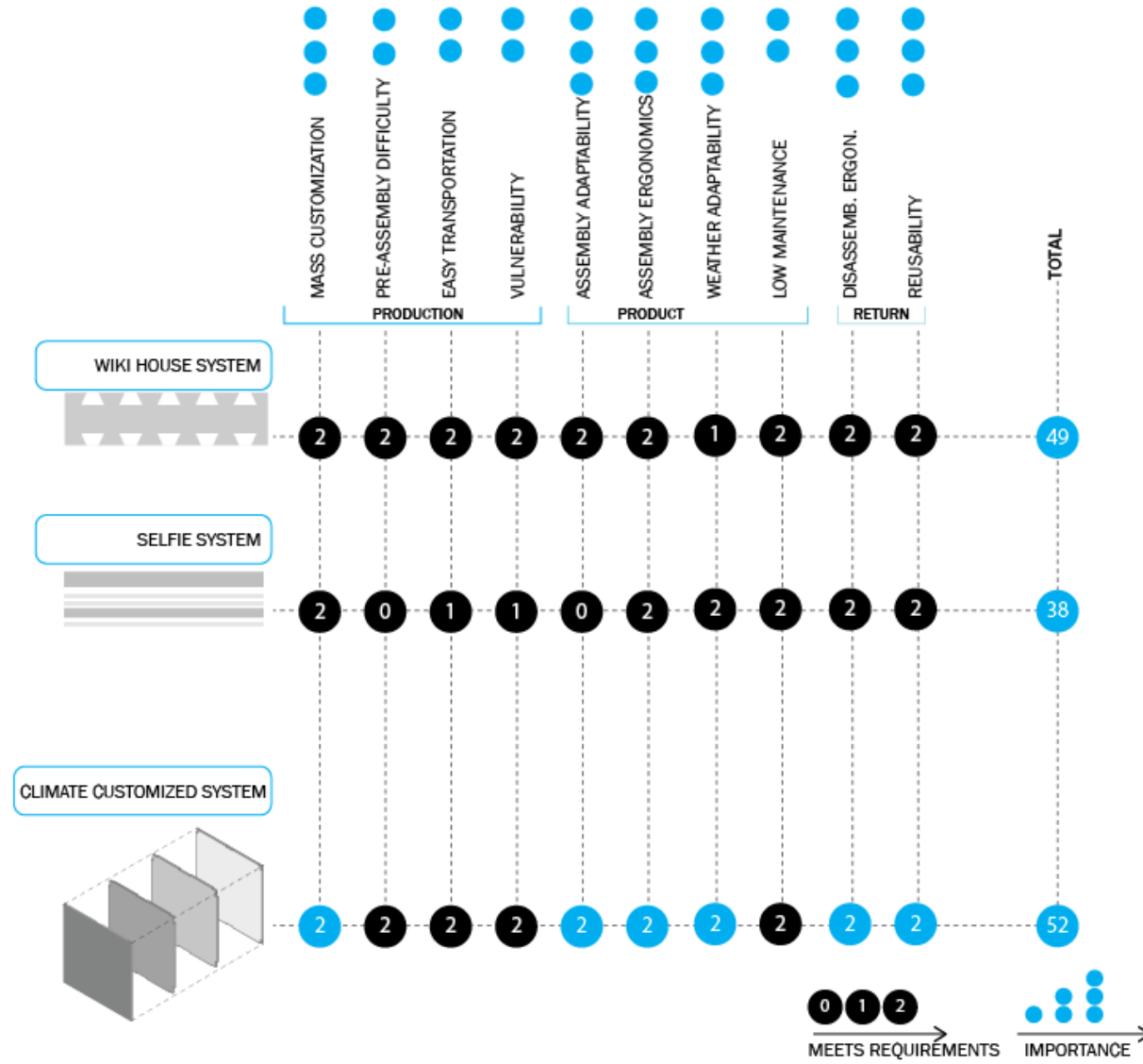
NOT VENTILATED
INSULATED
IMPROVED GLAZING



CLIMATE DATA	PARAMETERS	UNITS	CASE	CASE
			0	16
T _{out} . 0-24°C 2-March 3:00AM	T _{OPERATIVE}	°C	11.03	23.23
	T _{RADIANT}	°C	12.98	24.31
	GAINS _{WINDOW}	kW	0	
	LIGHTING	kW	0	0
	T _{variation}	°C	+12.20°C	
T _{out} . 7-30°C 8-September 2:00PM	T _{OPERATIVE}	°C	34.83	29.81
	T _{RADIANT}	°C	35.63	29.13
	GAINS _{WINDOW}	kW	25.2	2.96
	LIGHTING	kW	3.35	3.35
	T _{variation}	°C	-5.02°C	



CONCLUSIONS



RESEARCH QUESTION

How can a prefabricated façade system be mass customized, for Ecuadorian climate regions and its existing building stock, to upgrade the indoor comfort, while providing a circular workflow based on local production, the use of local resources and the reusability of the system?

- Facade development must be based on static and dynamic parameters. The sun orientation, and wind prevailing direction, are the main dynamic parameter to be taken for this façade system development.
- The study of new technologies that can be used for indoor comfort improvement of existing buildings is one of the most important steps within this research.
- The final design was developed by adding the advantages of climate mass customization of the SELFIE façade and the assembly mass customization of the WikiHouse.
- By combining multiple layers with different properties, components with different functions can be created. By combining these different components, an existing façade can be upgraded, to improve the indoor comfort of the building's stock in Ecuador.
- The design of the façade system was tested multiple times with Design Builder software. There was a constant loop between designing and testing, until the final results were reached, where the indoor comfort temperature of the two tested climates stayed inside the adaptive comfort parameters.



THANK YOU

Amelia Tapia
August 2020