BUILDING ENVELOPE IN AIRPORT REGIONS

AR3B025 Sustainable Design Graduation Studio: 'Make some noise Schiphol'

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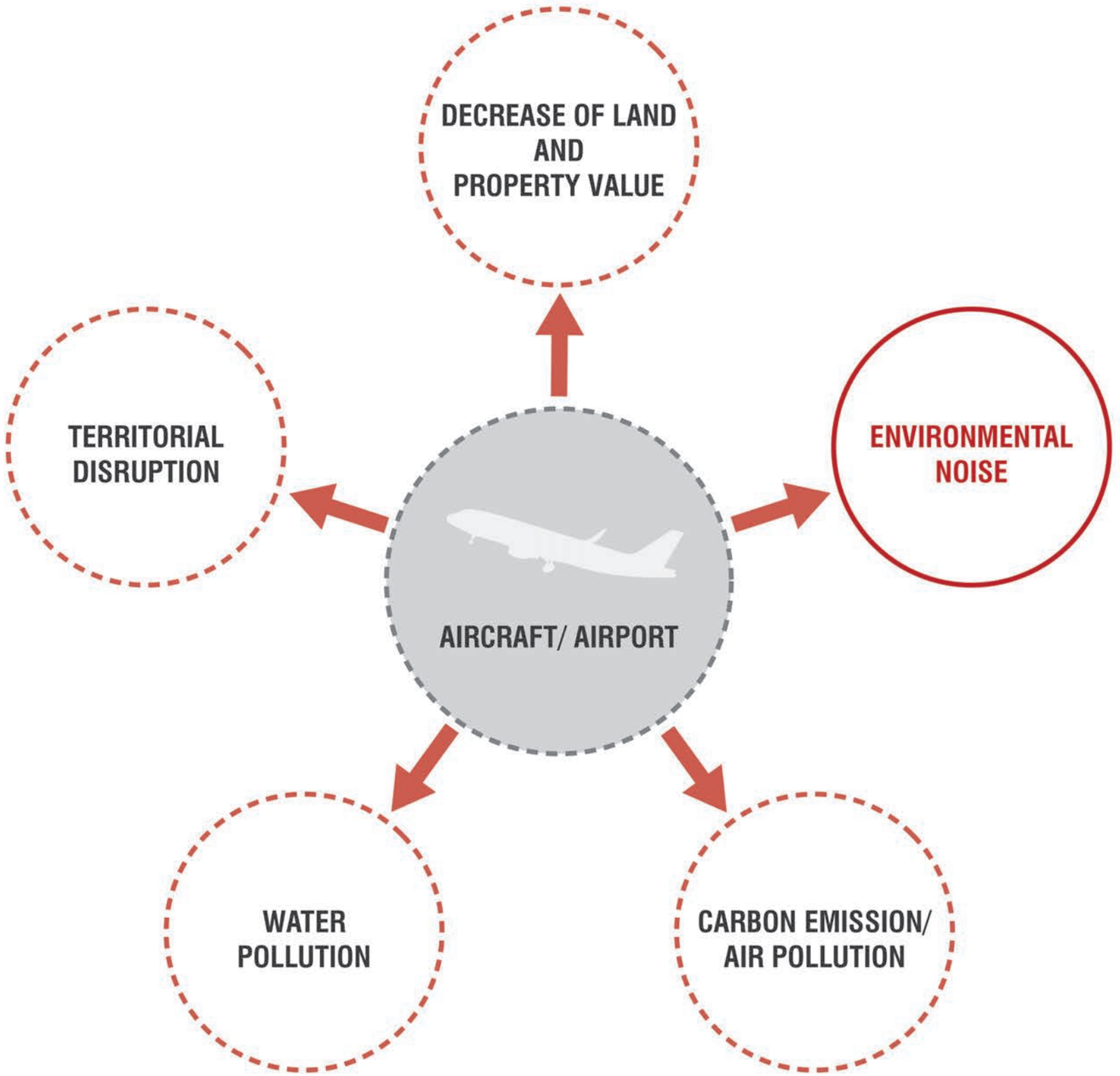
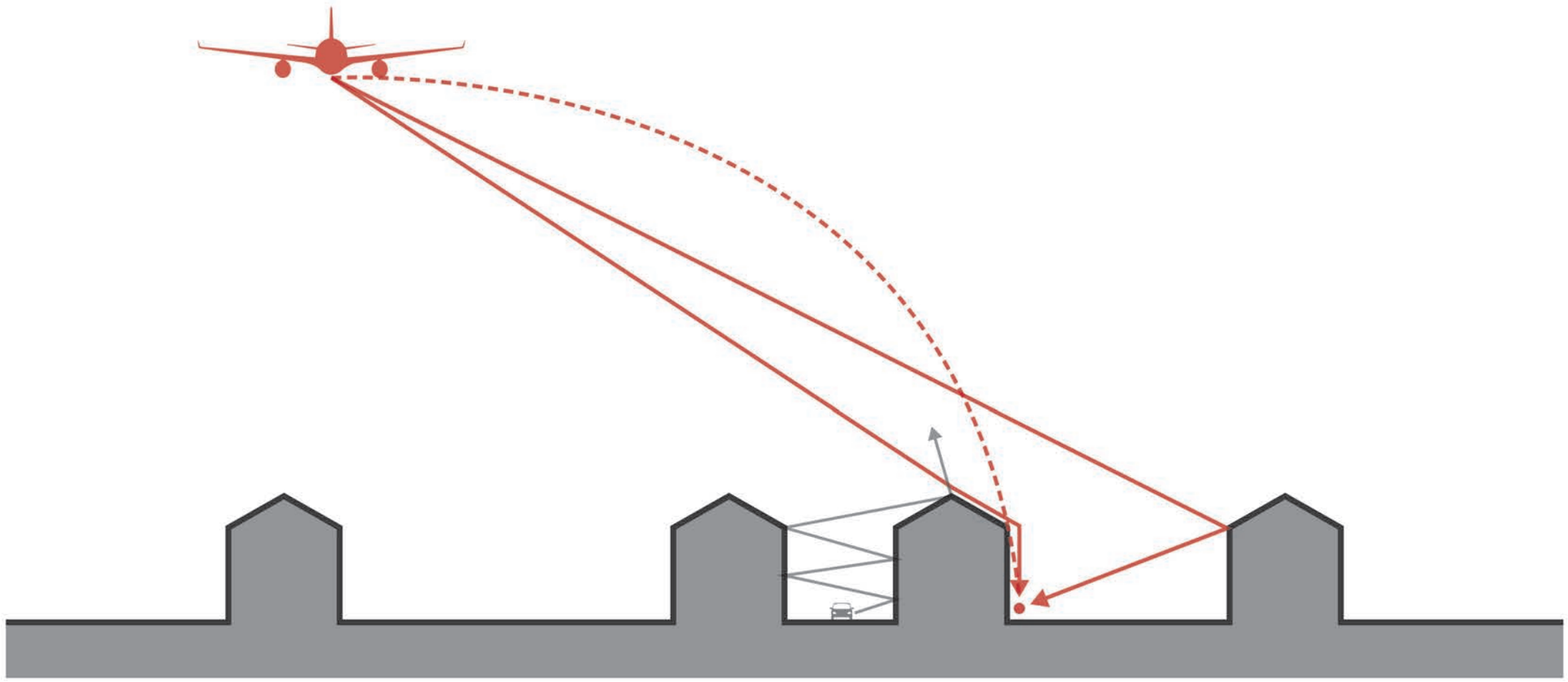
30th June, 2020



ENVIRONMENTAL IMPACTS CAUSED BY AVIATION ACTIVITIES

Aviation activites have several environmental impacts. Noise is by far the most problematic issues, due to ...



1. DIFFICULT TO AVOID DUE TO THEIR UNIQUE POSITION AND DIRECTIVITY

Aircraft noise are more difficult of avoid when compared to other noise sources, such as traffic and railway.

- Propagation path of ground source
- Propagation path of overhead source
- Propagation path due to refraction
- Receiver position

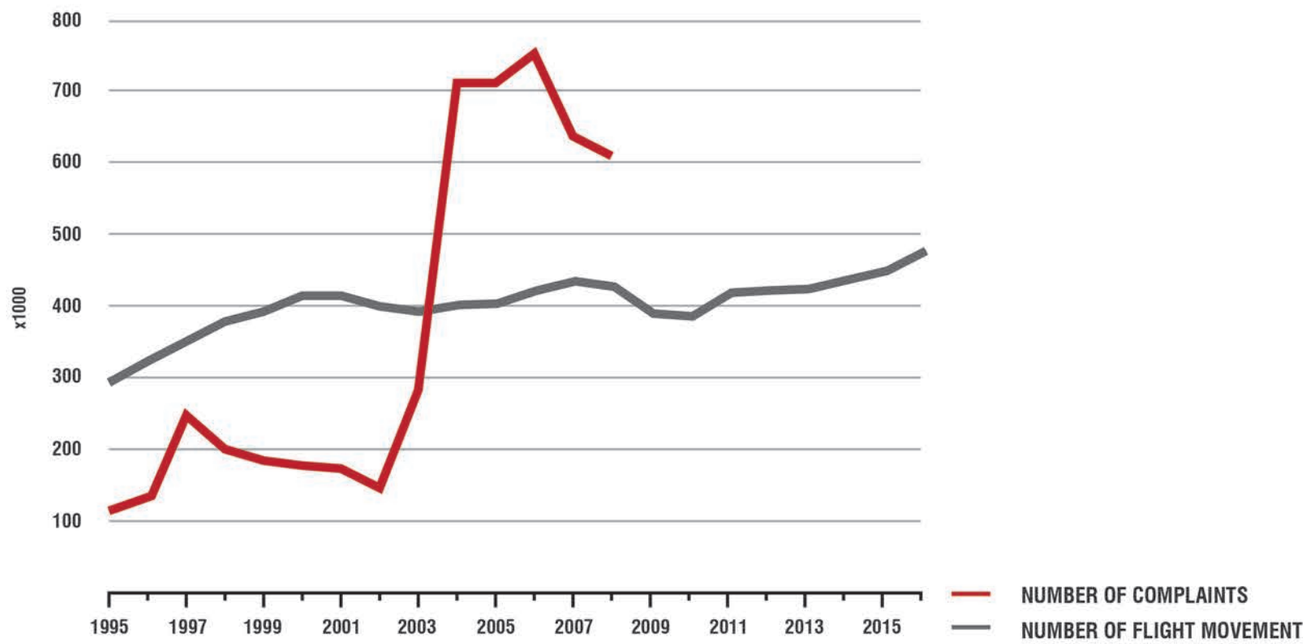
2. IT IS AN GROWING ISSUE

While the aircraft noise emission has decrase significantly due to aircraft advancement, it was out weighted by the frequency of activity due to growing demands.

TRANSFORMATION OF NOISE ZONE DUE TO ADVANCEMENT OF AIRCRAFT

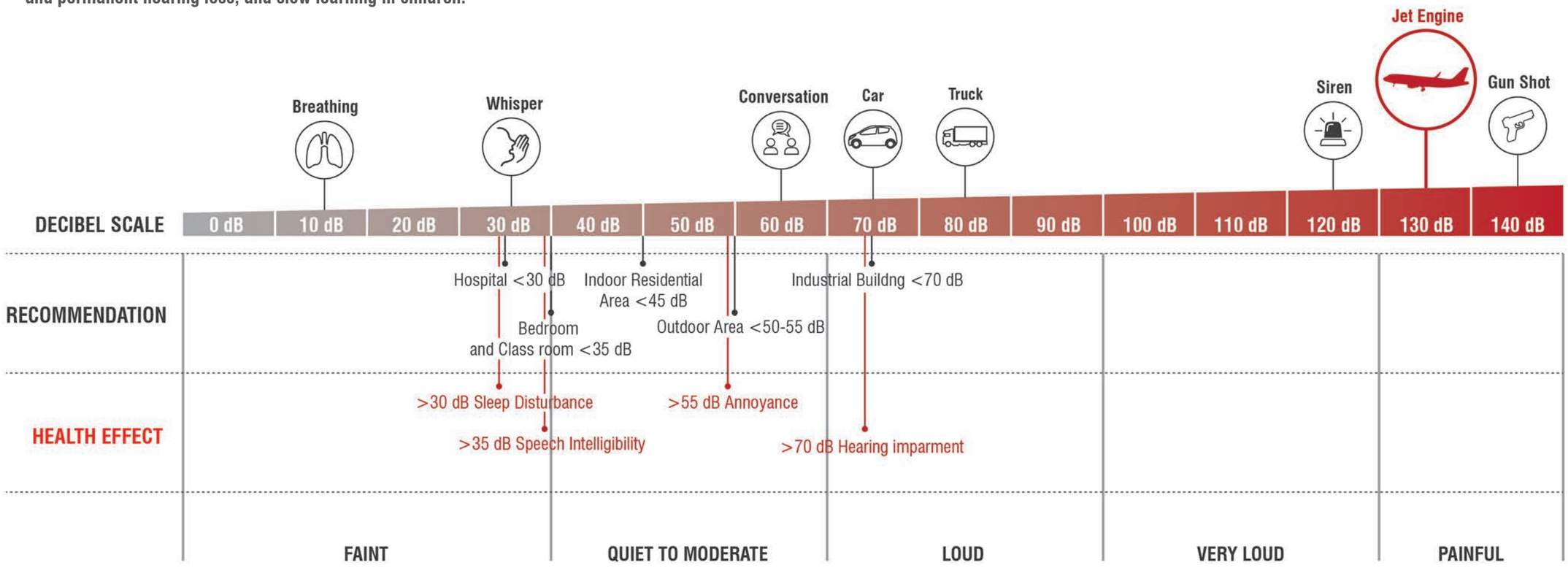
1990 2002 2017

NUMBER OF COMPLAINTS vs **FLIGHT MOVEMENT**



3. POSE NEGATIVE IMPACT ON HEALTH

Long exposure to loud noise may cause several health problem, this include heart disease, temporary and permanent hearing loss, and slow learning in children.



4. OBSTRUCT THE GROWTH OF URBAN FABRIC

In order to prevent the more citizen from being exposed to aircraft noise, the governement establishs a law to restrict several activities with in the noise zone.

NOISE CONTOR: BUILDINGS AND ACTIVITIES RESTRICTION

TYPE OF CONSTUCTION		COMPATABILITY			
		Zone 1	Zone 2	Zone 3	Zone 4
Residential	Single housing	○	○	×	×
	Dorms/Apartment	○	○	×	×
Institutional	Churches	○	○	×	×
	Schools	○	○	×	×
	Hospital	○	○	×	×
	Nursing home	○	○	×	×
	Libraries	○	○	×	×
Recreational	Sports/Play	○	○	○	○
	Arts/Instructional	○	○	×	×
	Camping	○	○	○	○
Commercial	-	○	○	○	○
Industrial	-	○	○	○	○
Agricultural	-	○	○	○	○

Landuse noise sensitive matric by FAA (The Federal Aviation Administration, 1998)

TYPE OF CONSTUCTION	COMPATABILITY			
	Zone 1	Zone 2	Zone 3	Zone 4
New housing	×	×	×	×
New office	×	×	×	○
Housing / office before 2005	○	○	○	○

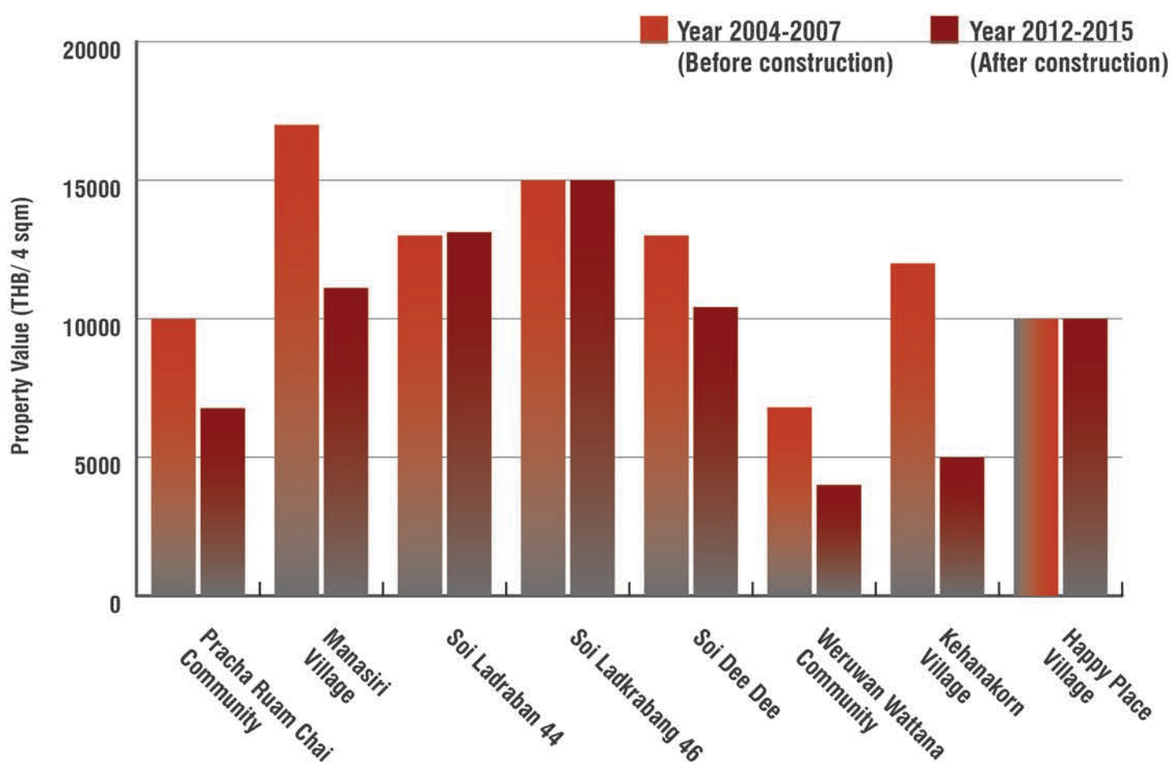
Landuse/buidling restriction (Luchthavenindelingsbesluit, or Airport allocation law (LIB), 2003)

Zone 4 (55 - 60 dB) Zone 3 (60 - 65 dB) Zone 2 (65 - 70 dB) Zone 1 (70+ dB)

5. REDUCE LAND AND PROPERTY VALUES

The annoyance caused by the aircraft reduce the value of properties near the airport and cause various propblem for many real estate.

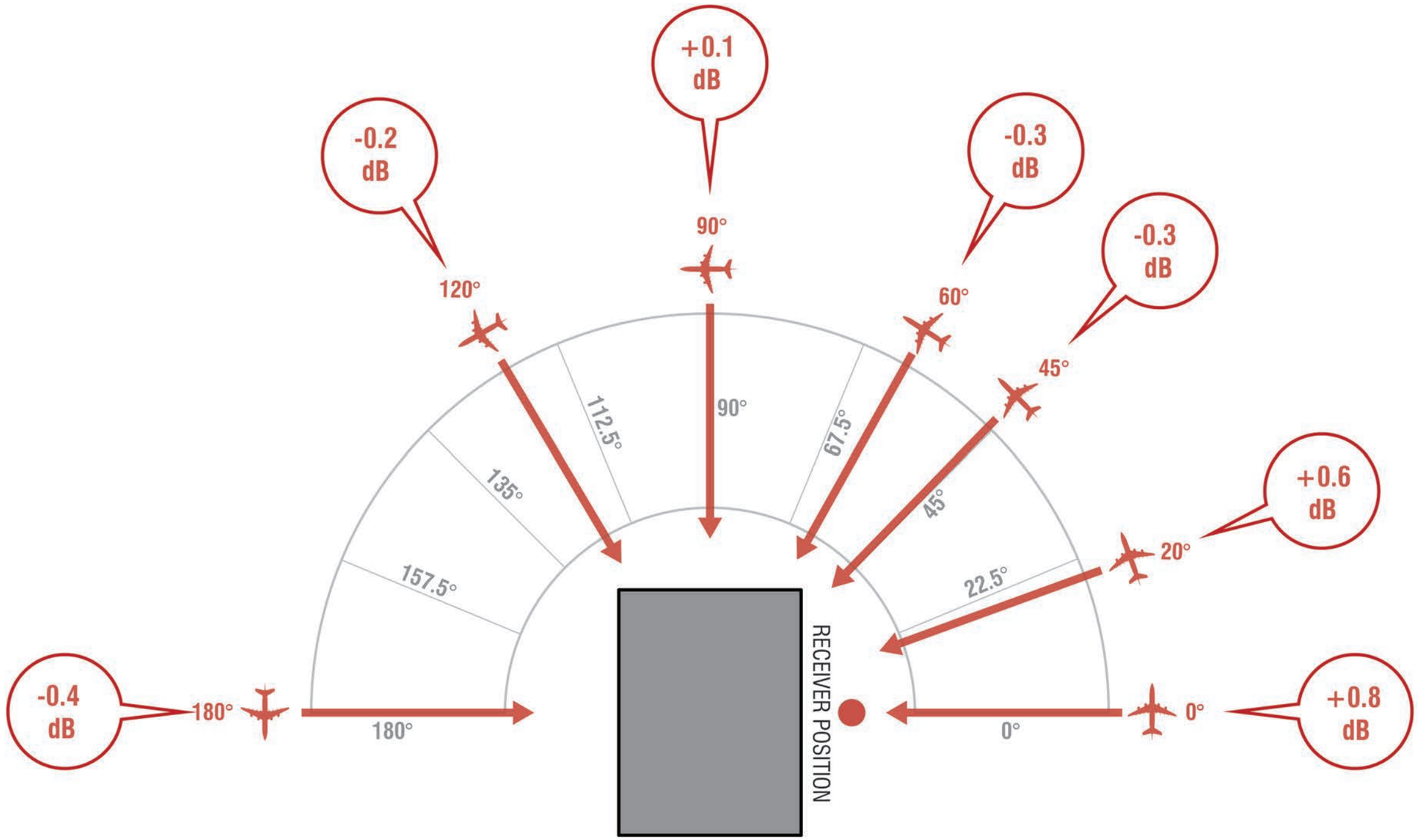
1997 2007 2020



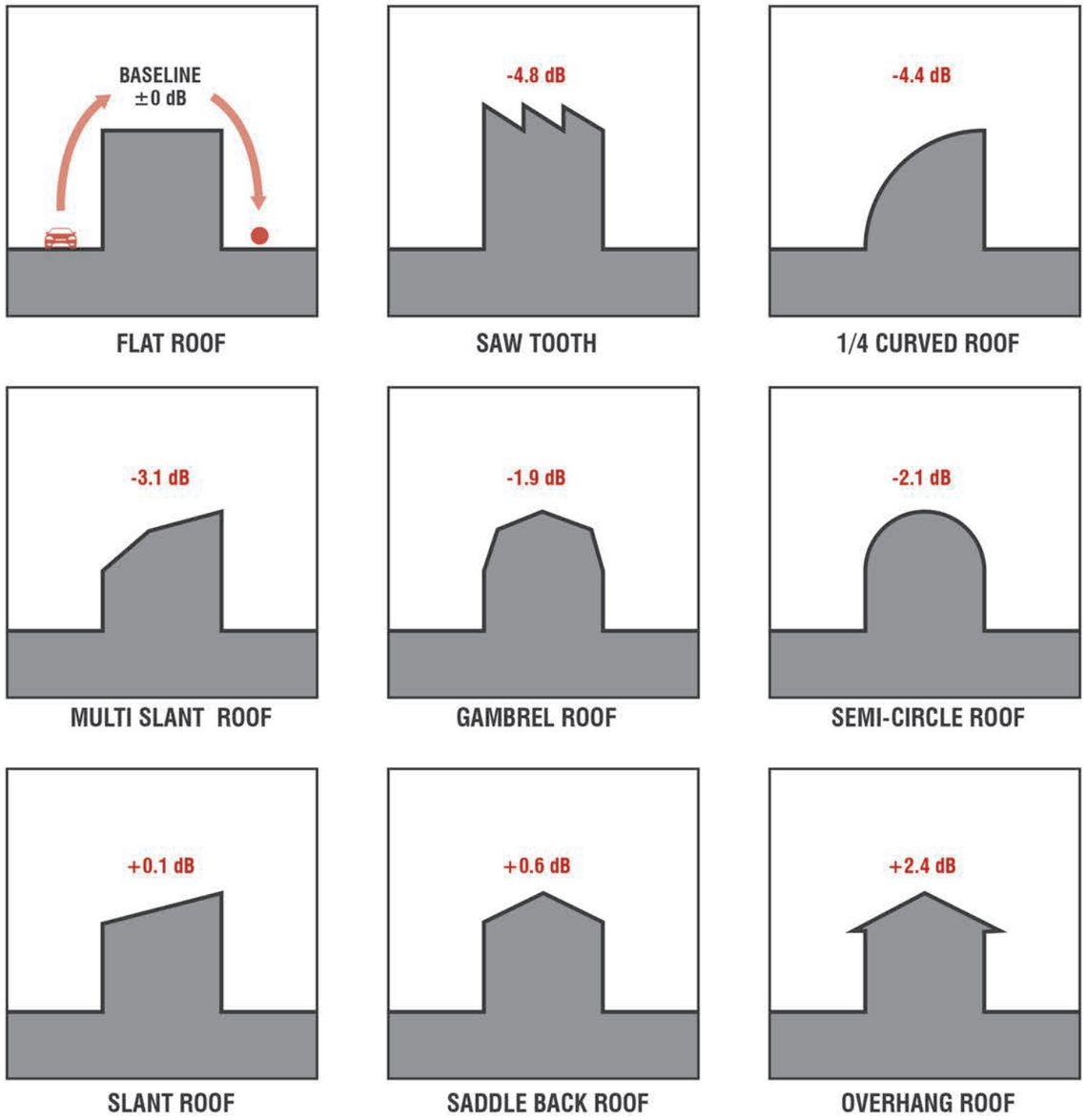
HOW TO DEAL WITH THIS NOISE PROBLEM?

BUILDING = NOISE BARRIER

BUILDING ORIENTATION vs AIRCRAFT NOISE



BUILDING GEOMETRIES vs TRAFFIC NOISE



RESEARCH QUESTION

'To what extent can building envelop and its geometry influence the propagation of aircraft noise in urban area, including both outdoor and indoor, cause by aircraft?'

RESEARCH GOAL

‘Develop an understanding of how building envelops and their geometries influence the exposeure to environmental noise caused by aircraft and put together a series of desing guideline for the architects, policy makers, and city planners for creating a healthier sound environment.’

TWO SITES WERE USED AS **CASE STUDIES**

AMSTERDAM, SCHIPHOL AIRPORT

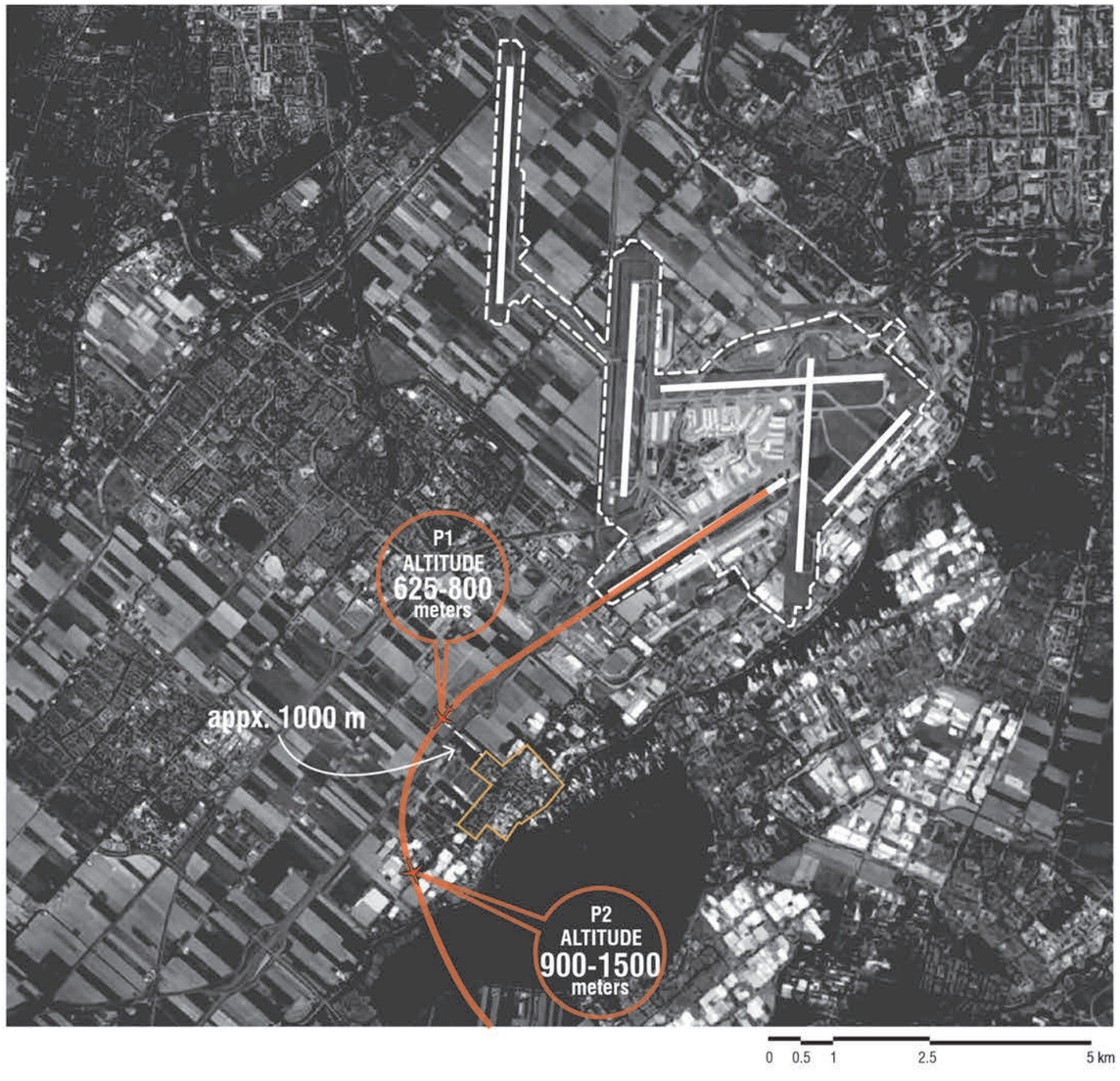
BANGKOK, SUVARNABHUMI AIRPORT

FLIGHT PATH AND MOVMENT STATISTIC

AMSTERDAM, SCHIPHOL AIRPORT

BANGKOK, SUVARNABHUMI AIRPORT

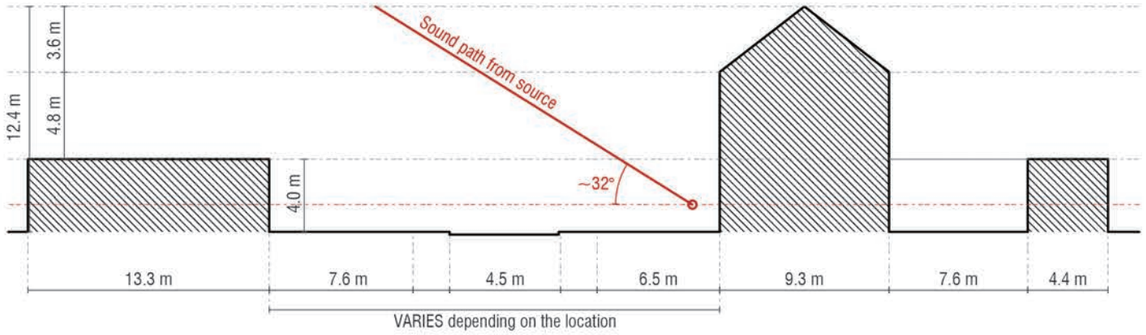
DIFFERENT IN **SOURCE POSITION**

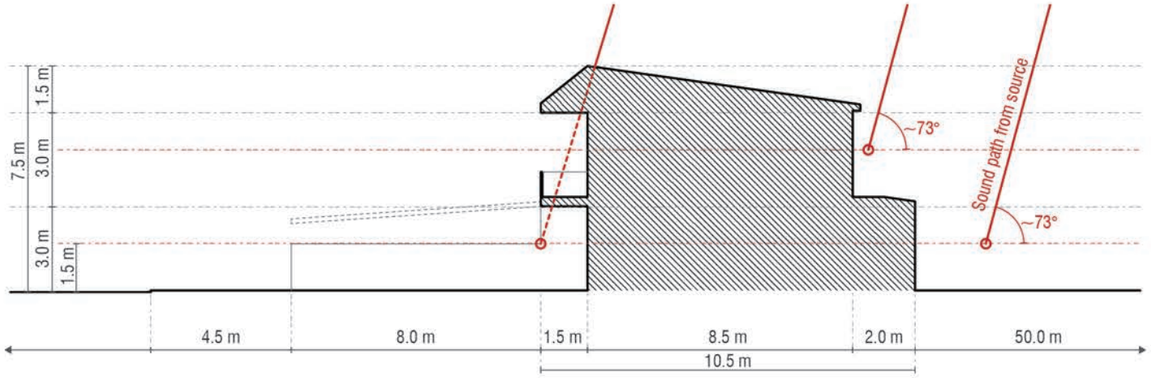


AMSTERDAM, SCHIPHOL AIRPORT

BANGKOK, SUVARNABHUMI AIRPORT

DIFFERENT IN **ANGLE OF INCIDENCE**



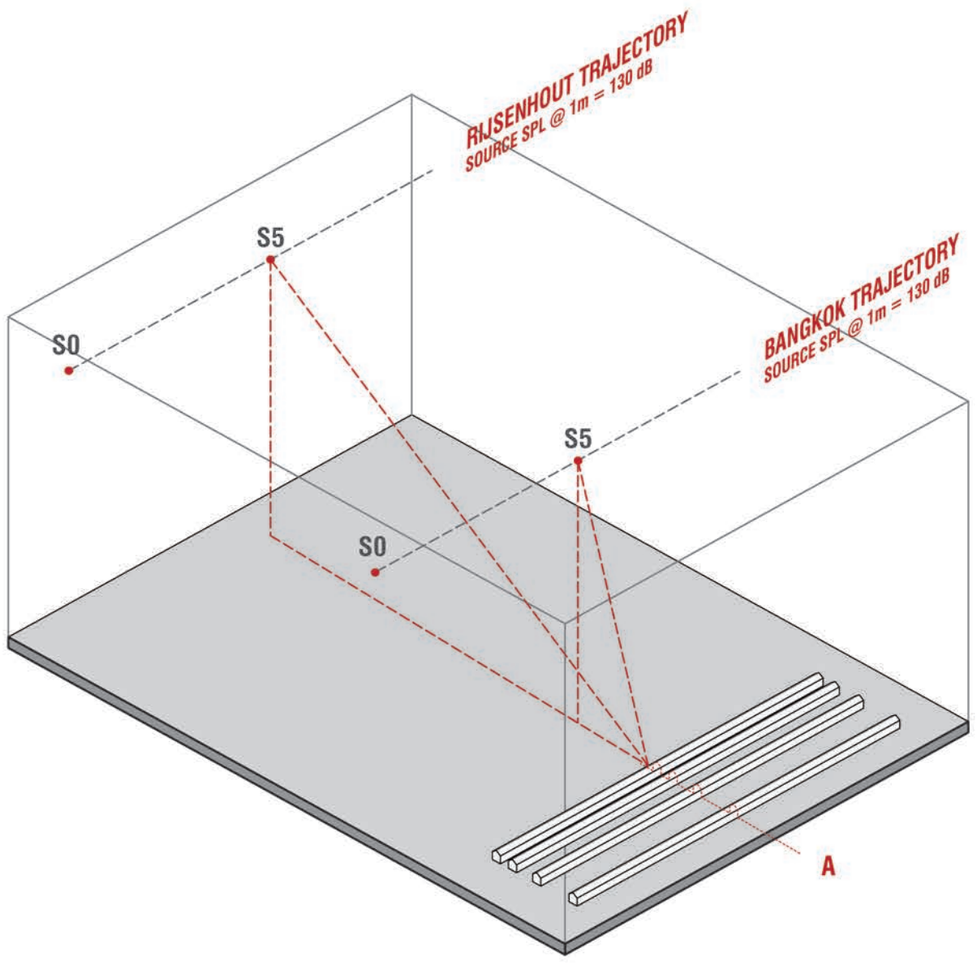


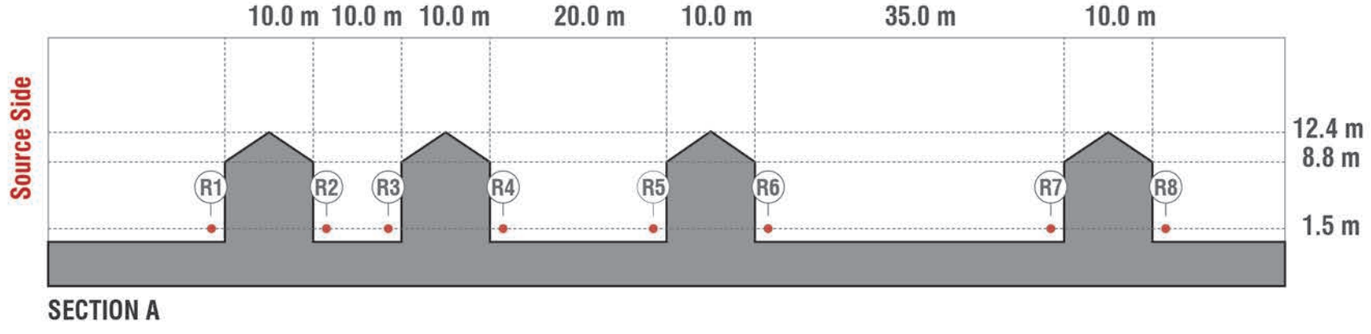
AMSTERDAM, SCHIPHOL AIRPORT

BANGKOK, SUVARNABHUMI AIRPORT

SIMULATE UNDER SIMILAR PARAMETER

CATT-ACOUSTIC v9c



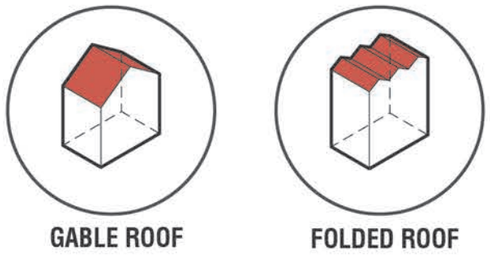


SECTION A

SOLID NOISE BARRIER

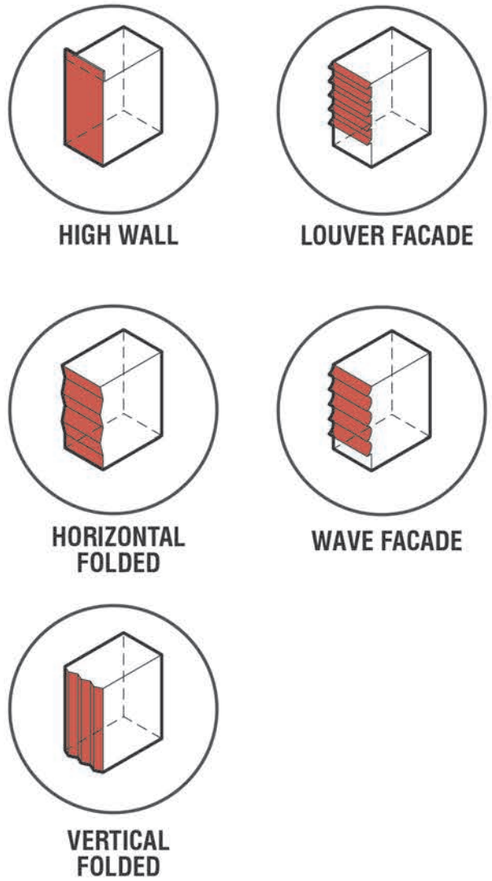
HORIZONTAL

ROOF GEOMETRIES



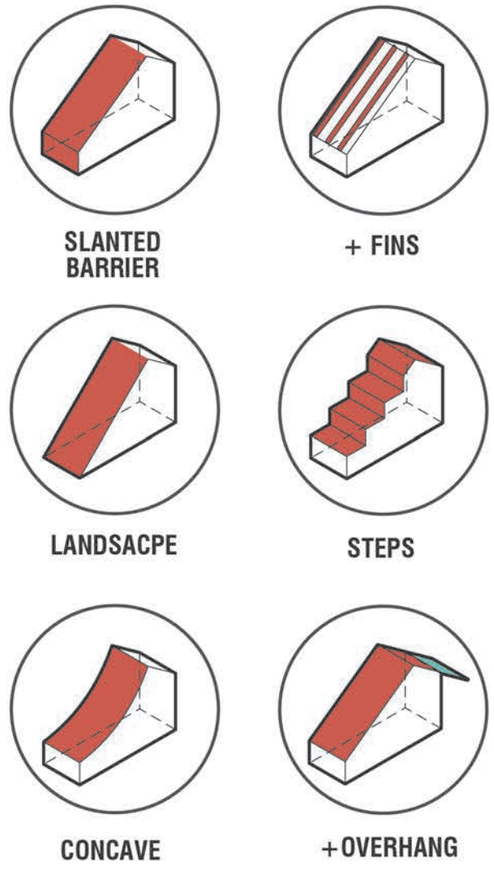
VERTICAL

FACADE GEOMETRIES



SLANTED

COMBINATION GEOMETRIES



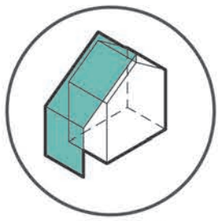
SIMULATED FOR IMPACT AGAINST NOISE PROPAGATION ON OUTDOOR

BUFFER ZONE

WINTER GARDEN/ DOUBLE SKINE FACADE

WINTER GARDEN

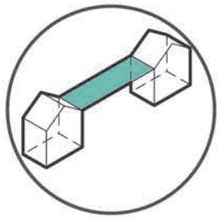
HALF DOME



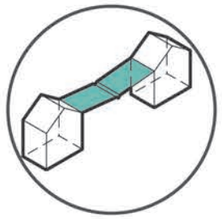
WINTER GARDEN+

DOME

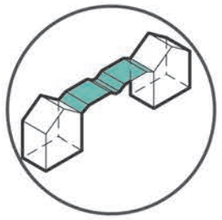
URBAN CANOPY



COVER PATH



CANOPY B



CANOPY A

MATERIALITY

SURFACE MATERIALS

GLASS

PERFORATED METAL

TIMBER

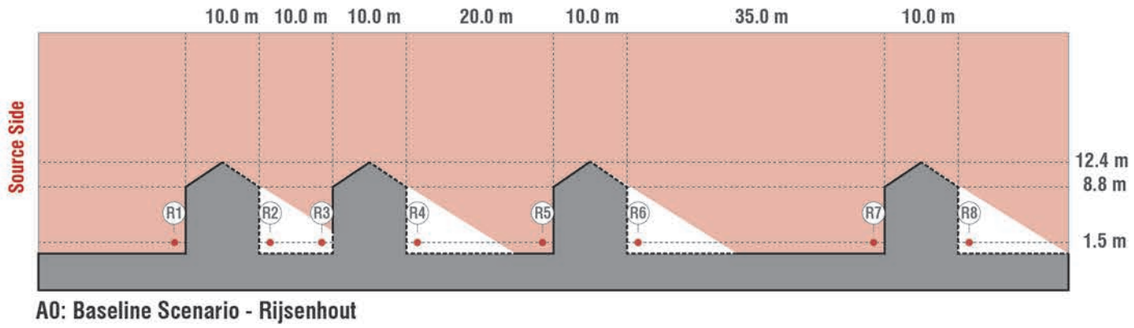
TEXTILE

VEGETATION

SIMULATED FOR IMPACT AGAINST NOISE PROPAGATION ON OUTDOOR AND INDOOR

BASELINE SCENARIO: RESULTS

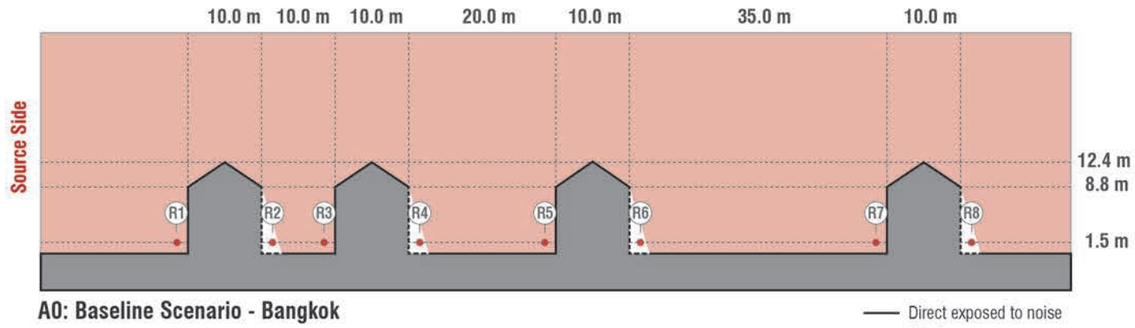
RIJSENHOUT CASE



A0: Baseline Scenario - Rijsenhout

Source Position	Receiver Position	SPL per Frequency [dB]						A-w [dB(A)]
		125	250	500	1000	2000	4000	
S0	R1	69.7	70.4	69.4	68.4	64.5	51.1	72.2
	R2	63.9	65.1	65.5	63.9	58.2	45.2	67.5
	R3	51.6	46.8	42.7	38.3	31.5	14.8	44.4
	R4	56.7	54.3	51.3	47.4	40.7	23.7	52.6
	R5	68.8	67.8	67.1	66.3	62.1	47.5	70.0
	R6	52.0	47.7	43.5	39.0	31.8	12.3	45.1
	R7	67.8	70.9	68.5	67.2	62.6	47.9	71.1
	R8	34.6	33.9	32.7	31.2	26.4	10.4	35.1
S5	R1	70.4	71.3	70.1	69.0	65.3	53.0	73.0
	R2	64.6	65.8	66.3	64.4	59.4	46.8	68.2
	R3	52.0	47.1	43.0	38.7	32.0	15.7	44.8
	R4	57.2	54.7	51.6	47.8	41.1	24.1	53.0
	R5	68..9	68.3	67.8	67.1	63.0	49.2	70.7
	R6	52.3	48.1	44.1	39.9	33.2	15.7	45.8
	R7	68.5	71.3	69.1	67.8	63.4	49.4	71.7
	R8	34.9	34.3	33.2	31.7	27.1	11.7	35.6

BANGKOK CASE



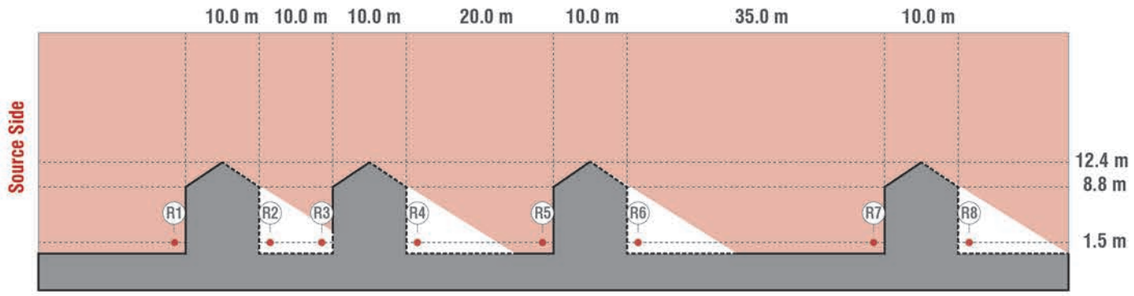
A0: Baseline Scenario - Bangkok

—— Direct exposed to noise
------ Shadow zone

Source Position	Receiver Position	SPL per Frequency [dB]						A-w [dB(A)]
		125	250	500	1000	2000	4000	
S0	R1	74.8	72.2	75.0	73.2	71.6	63.7	77.8
	R2	68.6	66.0	63.2	60.2	54.7	41.1	65.0
	R3	74.3	72.8	74.7	74.6	71.5	62.7	78.3
	R4	67.9	64.9	61.8	58.4	52.6	39.0	63.5
	R5	73.0	75.8	74.7	73.8	70.5	62.3	77.9
	R6	66.9	63.5	60.1	56.3	50.3	36.6	61.7
	R7	71.8	75.1	74.4	73.6	70.2	61.4	77.5
	R8	65.6	61.7	58.0	51.0	48.0	34.2	59.7
S5	R1	76.2	74.8	76.1	76.2	74.1	67.7	80.3
	R2	70.1	67.5	64.9	62.2	57.6	47.6	67.0
	R3	75.8	76.0	76.1	76.2	73.9	66.6	80.3
	R4	69.2	66.3	63.3	60.3	55.4	45.5	65.3
	R5	75.2	77.7	76.8	75.6	73.1	66.1	80.0
	R6	68.1	64.7	61.5	57.9	52.8	42.3	63.3
	R7	73.9	77.3	75.6	74.9	72.4	65.0	79.2
	R8	66.7	62.7	58.8	55.2	49.2	36.9	60.7

BASELINE SCENARIO: RESULTS

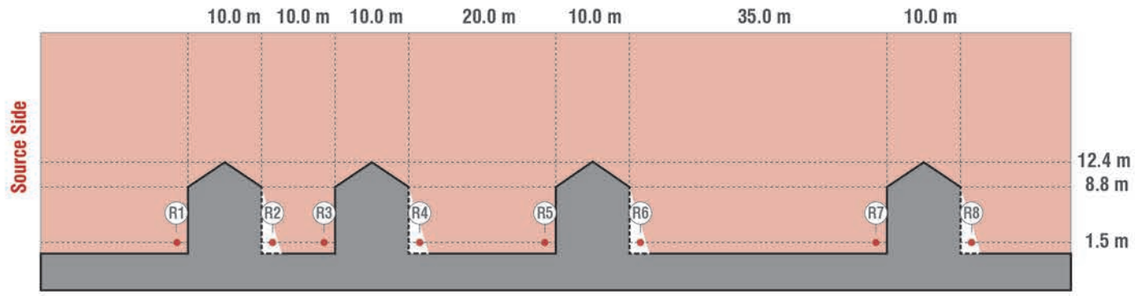
RIJSENHOUT CASE



A0: Baseline Scenario - Rijsenhout

Source Position	Receiver Position	SPL per Frequency [dB] 125	250	500	1000	2000	4000	A-w [dB(A)]	
S0	R1	69.7	70.4	69.4	68.4	64.5	51.1	72.2	
	R2	63.9	65.1	65.5	63.9	58.2	45.2	67.5	
	R3	51.6	46.8	42.7	38.3	31.5	14.8	44.4	
	R4	56.7	54.3	51.3	47.4	40.7	23.7	52.6	!
	R5	68.8	67.8	67.1	66.3	62.1	47.5	70.0	
	R6	52.0	47.7	43.5	39.0	31.8	12.3	45.1	!
	R7	67.8	70.9	68.5	67.2	62.6	47.9	71.1	
	R8	34.6	33.9	32.7	31.2	26.4	10.4	35.1	!
S5	R1	70.4	71.3	70.1	69.0	65.3	53.0	73.0	
	R2	64.6	65.8	66.3	64.4	59.4	46.8	68.2	
	R3	52.0	47.1	43.0	38.7	32.0	15.7	44.8	
	R4	57.2	54.7	51.6	47.8	41.1	24.1	53.0	!
	R5	68..9	68.3	67.8	67.1	63.0	49.2	70.7	
	R6	52.3	48.1	44.1	39.9	33.2	15.7	45.8	!
	R7	68.5	71.3	69.1	67.8	63.4	49.4	71.7	
	R8	34.9	34.3	33.2	31.7	27.1	11.7	35.6	!

BANGKOK CASE

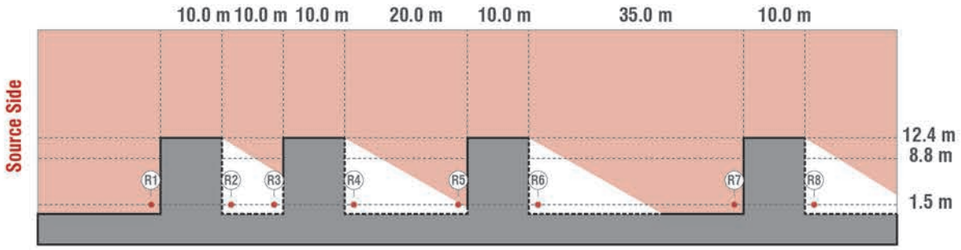


A0: Baseline Scenario - Bangkok

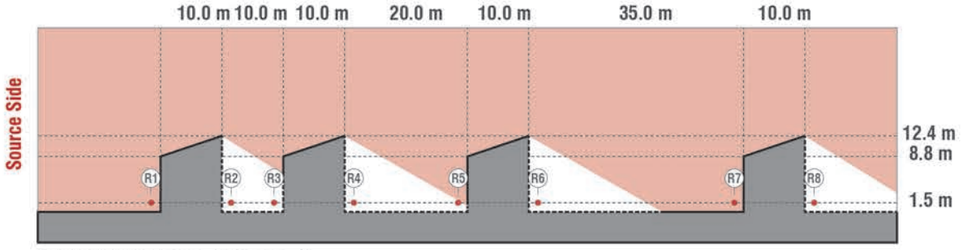
—— Direct exposed to noise
------ Shadow zone

Source Position	Receiver Position	SPL per Frequency [dB] 125	250	500	1000	2000	4000	A-w [dB(A)]	
S0	R1	74.8	72.2	75.0	73.2	71.6	63.7	77.8	
	R2	68.6	66.0	63.2	60.2	54.7	41.1	65.0	
	R3	74.3	72.8	74.7	74.6	71.5	62.7	78.3	
	R4	67.9	64.9	61.8	58.4	52.6	39.0	63.5	!
	R5	73.0	75.8	74.7	73.8	70.5	62.3	77.9	
	R6	66.9	63.5	60.1	56.3	50.3	36.6	61.7	!
	R7	71.8	75.1	74.4	73.6	70.2	61.4	77.5	
	R8	65.6	61.7	58.0	51.0	48.0	34.2	59.7	!
S5	R1	76.2	74.8	76.1	76.2	74.1	67.7	80.3	
	R2	70.1	67.5	64.9	62.2	57.6	47.6	67.0	
	R3	75.8	76.0	76.1	76.2	73.9	66.6	80.3	
	R4	69.2	66.3	63.3	60.3	55.4	45.5	65.3	!
	R5	75.2	77.7	76.8	75.6	73.1	66.1	80.0	
	R6	68.1	64.7	61.5	57.9	52.8	42.3	63.3	!
	R7	73.9	77.3	75.6	74.9	72.4	65.0	79.2	
	R8	66.7	62.7	58.8	55.2	49.2	36.9	60.7	!

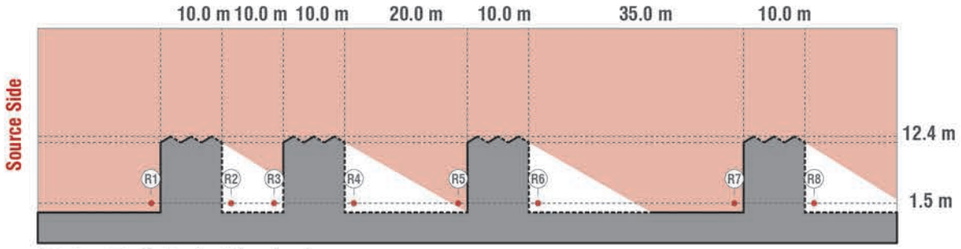
RESULTS & ANALYSIS: HORIZONTAL BARRIER (ROOF) - RIJSENHOUT



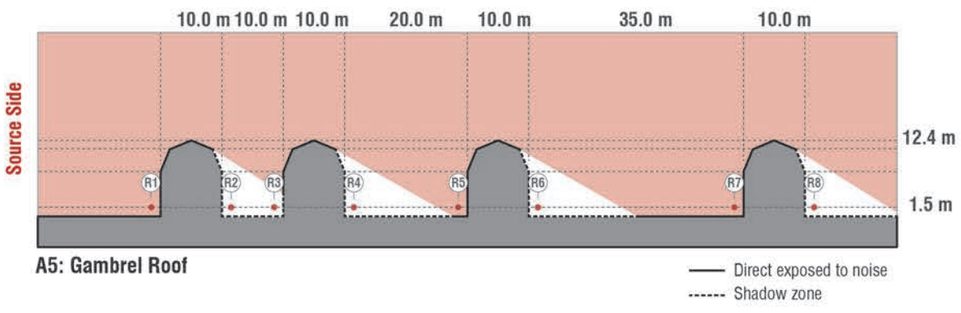
A1: Flat Roof - Rijsenhout



A2-1: Slanted Roof - Rijsenhout

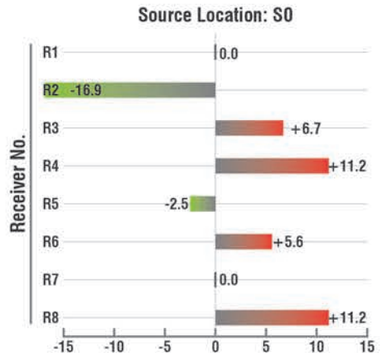


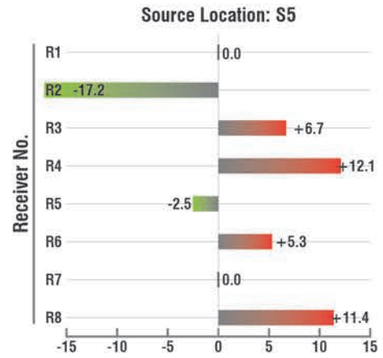
A3: Saw-Tooth Roof - Rijsenhout

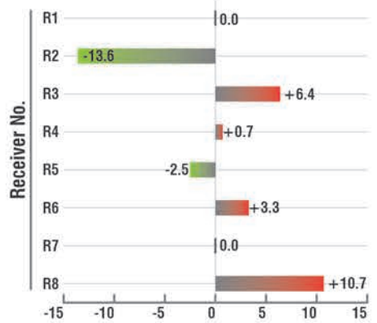


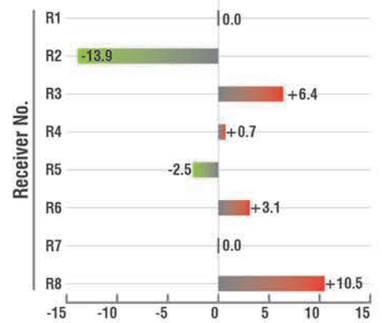
A5: Gambrel Roof

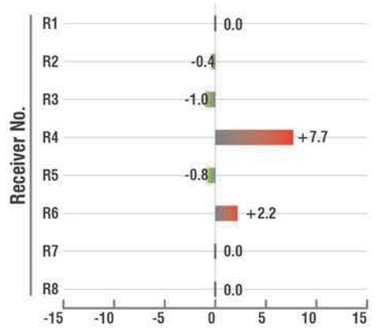
Direct exposed to noise
Shadow zone

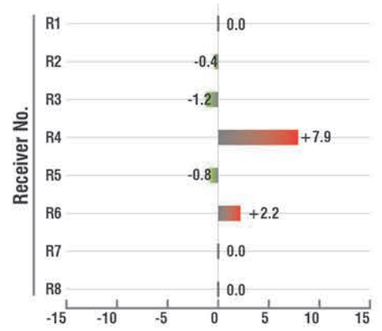


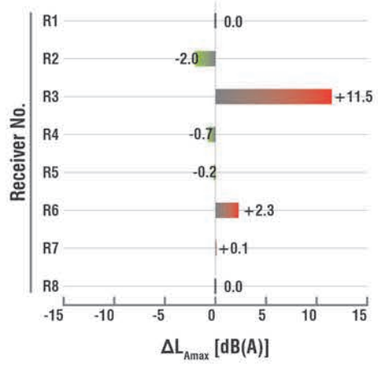


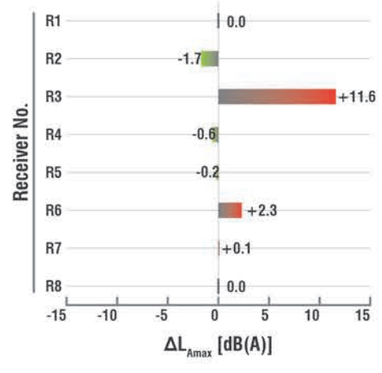




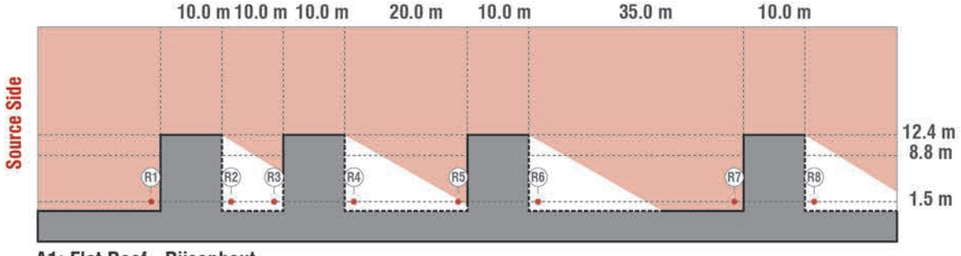




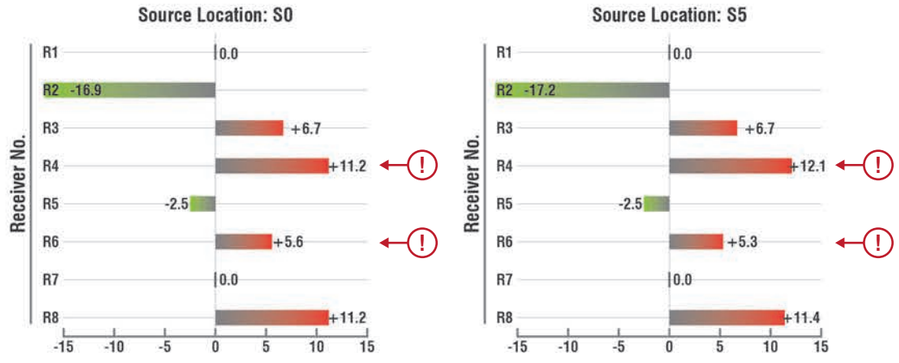


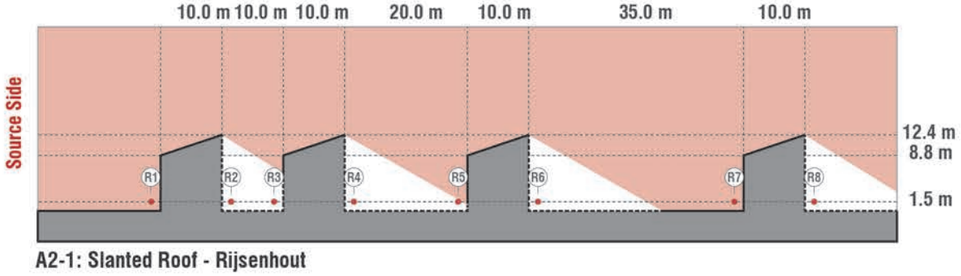


RESULTS & ANALYSIS: HORIZONTAL BARRIER (ROOF) - RIJSENHOUT

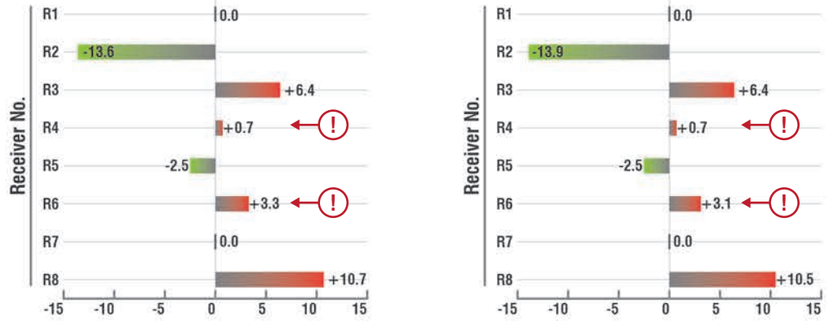


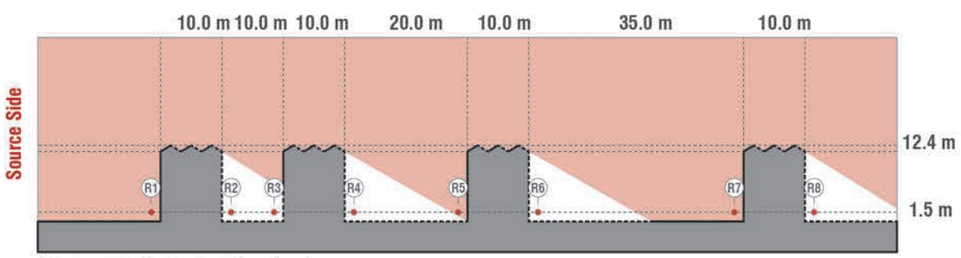
A1: Flat Roof - Rijsenhout



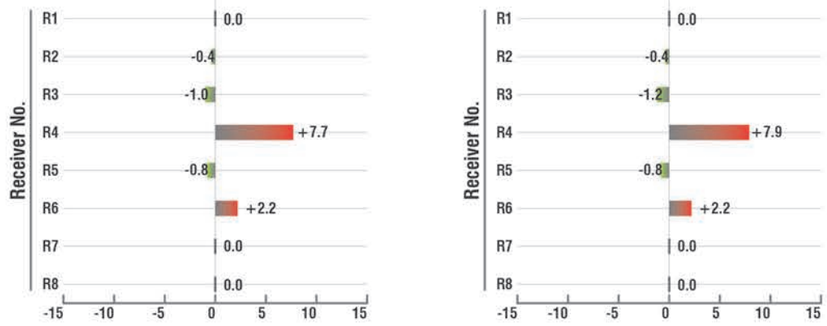


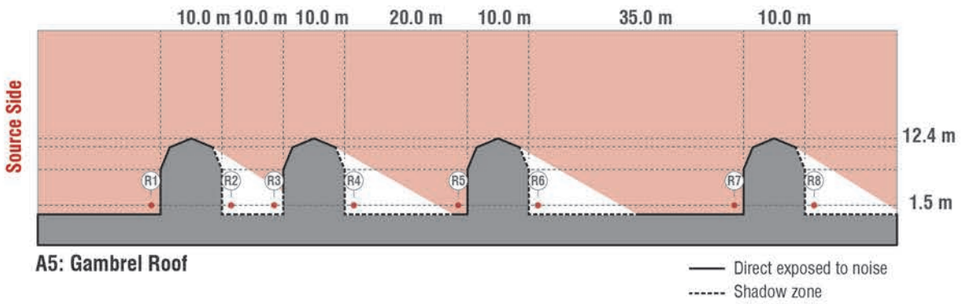
A2-1: Slanted Roof - Rijsenhout





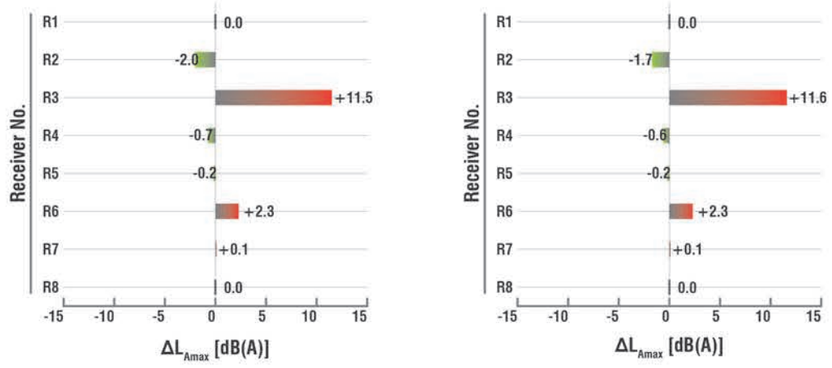
A3: Saw-Tooth Roof - Rijsenhout



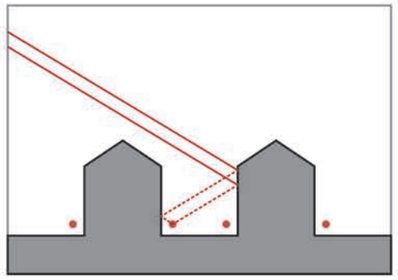


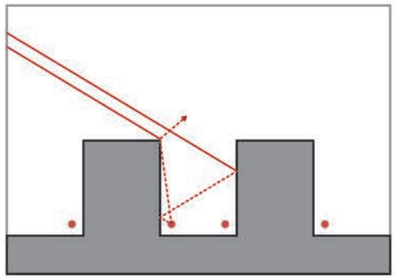
A5: Gambrel Roof

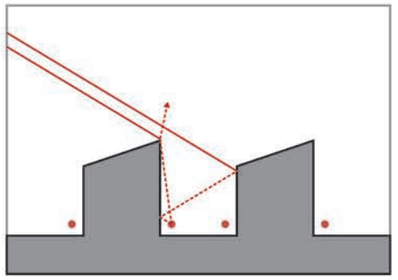
Direct exposed to noise
Shadow zone

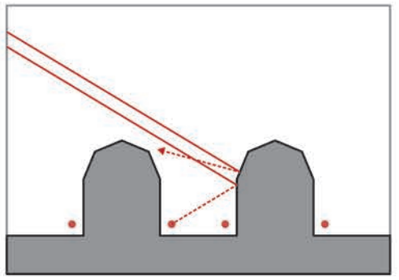


PORPAGATION PATH ON QUIET FACADE

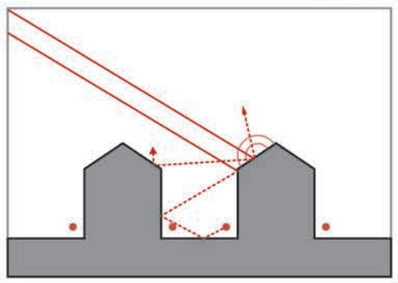




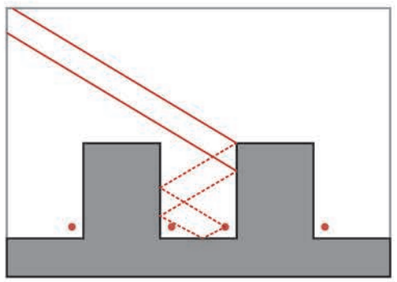




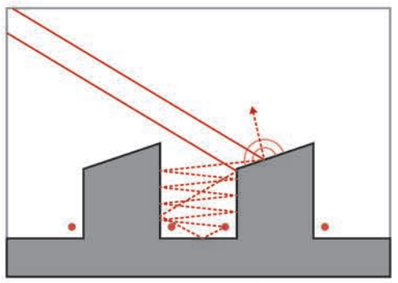
PORPAGATION PATH ON EXPOSED FACADE



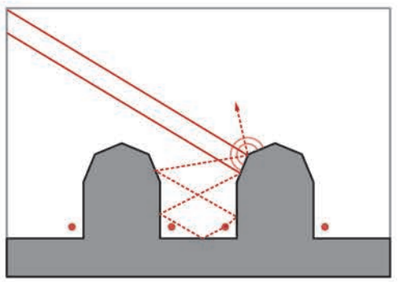
A0: GABEL ROOF



A1: FLAT ROOF



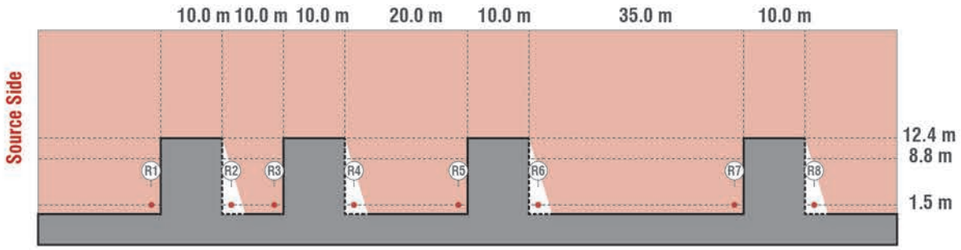
A2-1: SLANTED ROOF



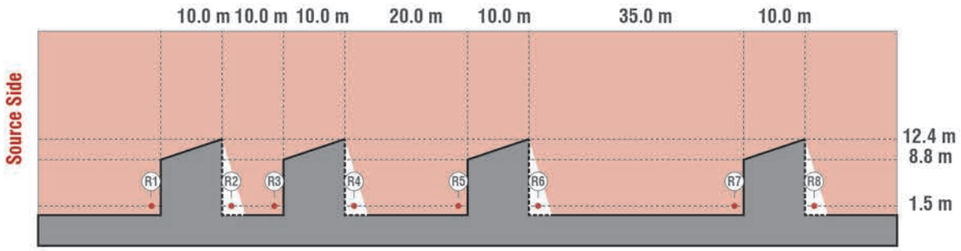
A5: FLAT ROOF

Direct sound path
Reflected sound

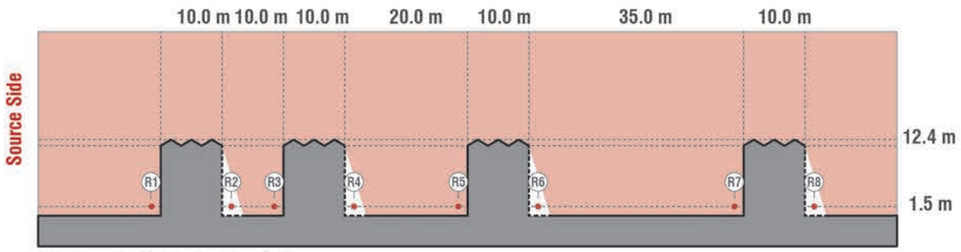
RESULTS & ANALYSIS: HORIZONTAL BARRIER (ROOF) - BANGKOK



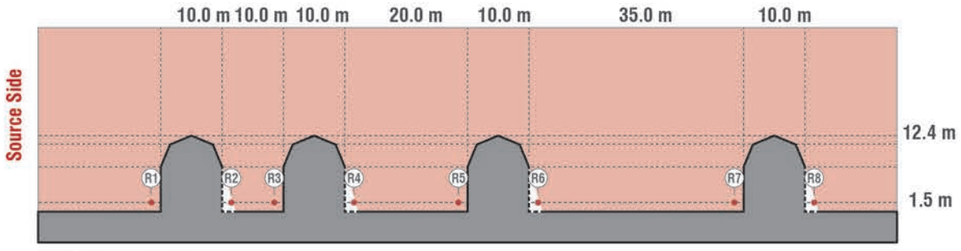
A1: Flat Roof - Bangkok



A2-1: Slanted Roof - Bangkok

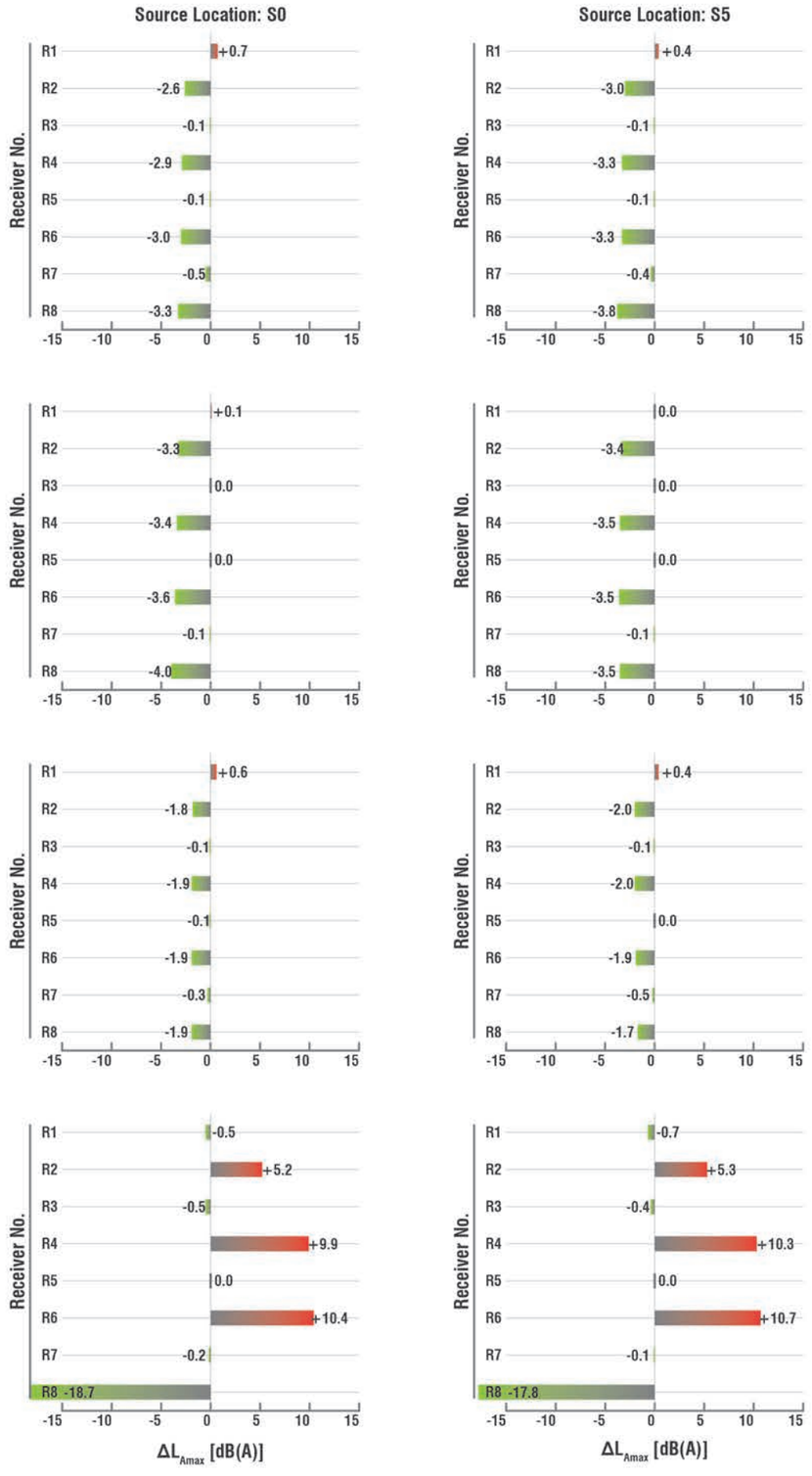


A3: Saw-Tooth Roof - Bangkok

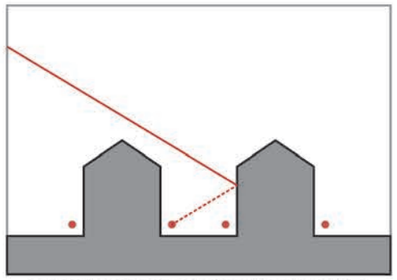


A5: Gambrel Roof

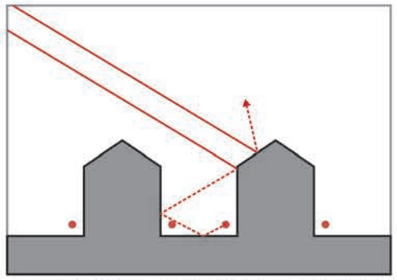
Direct exposed to noise
Shadow zone



RIJSENHOUT: 32° ANGLE OF INCIDENCE

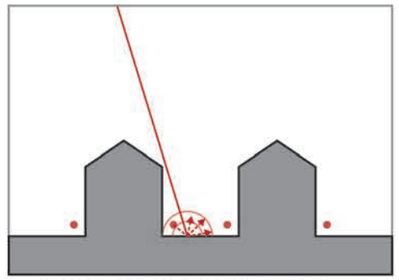


SOUND PATH ON QUIET FACADE

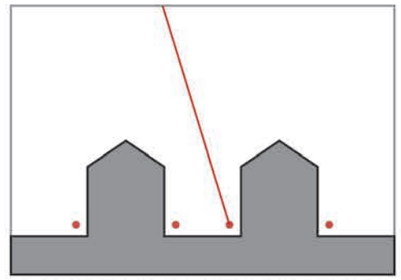


SOUND PATH ON EXPOSED FACADE

BANGKOK: 73° ANGLE OF INCIDENCE

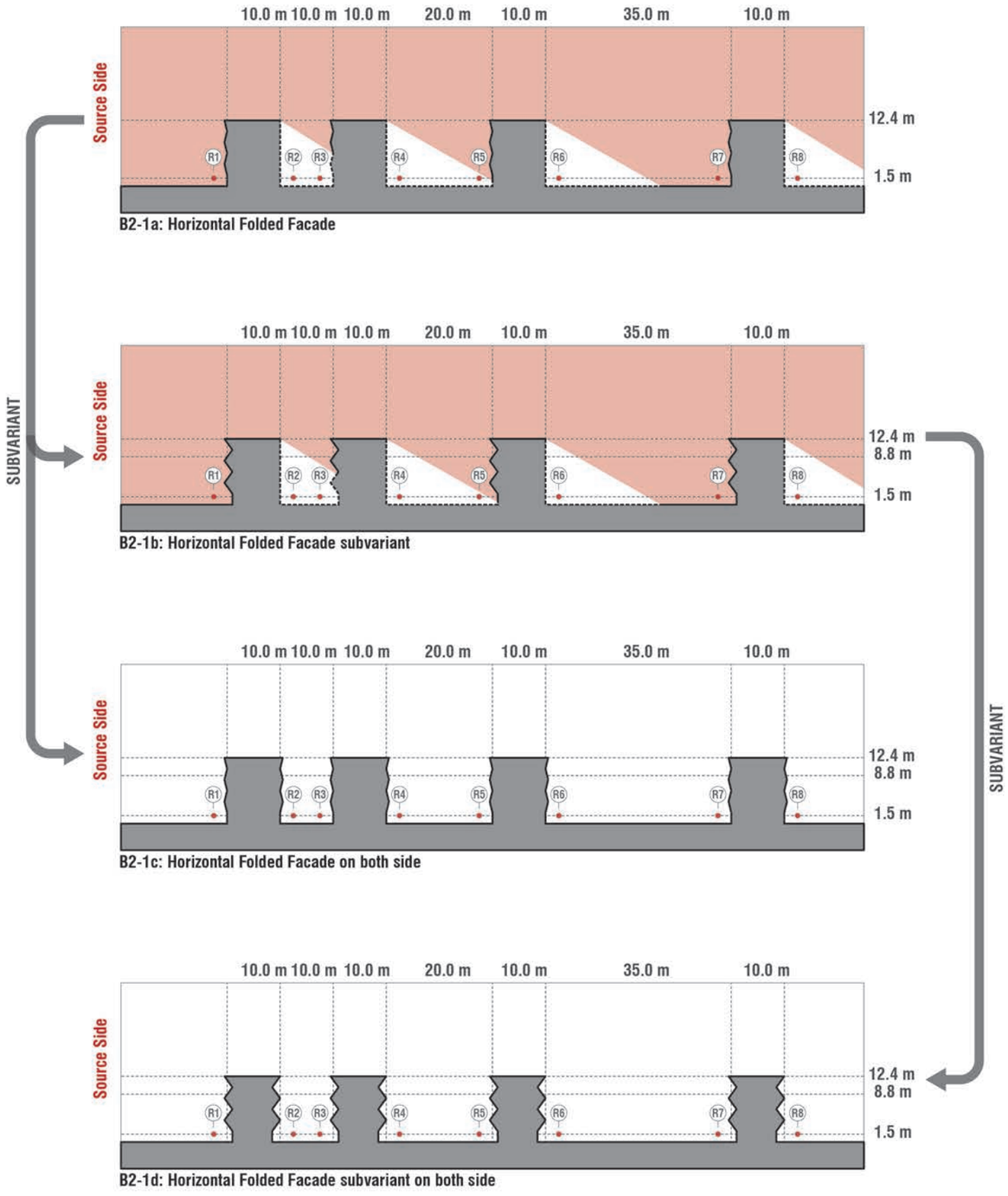


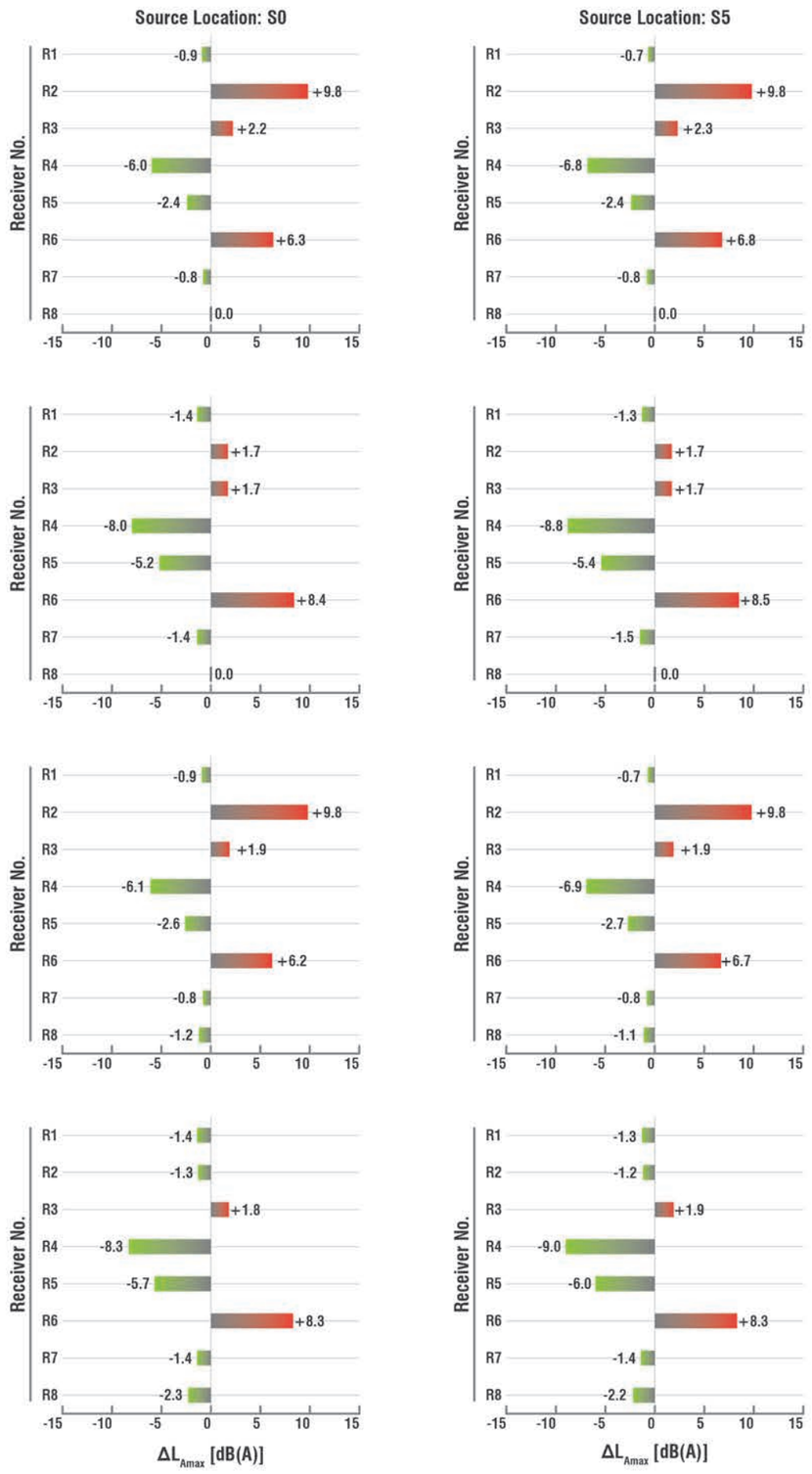
SOUND PATH ON QUIET FACADE



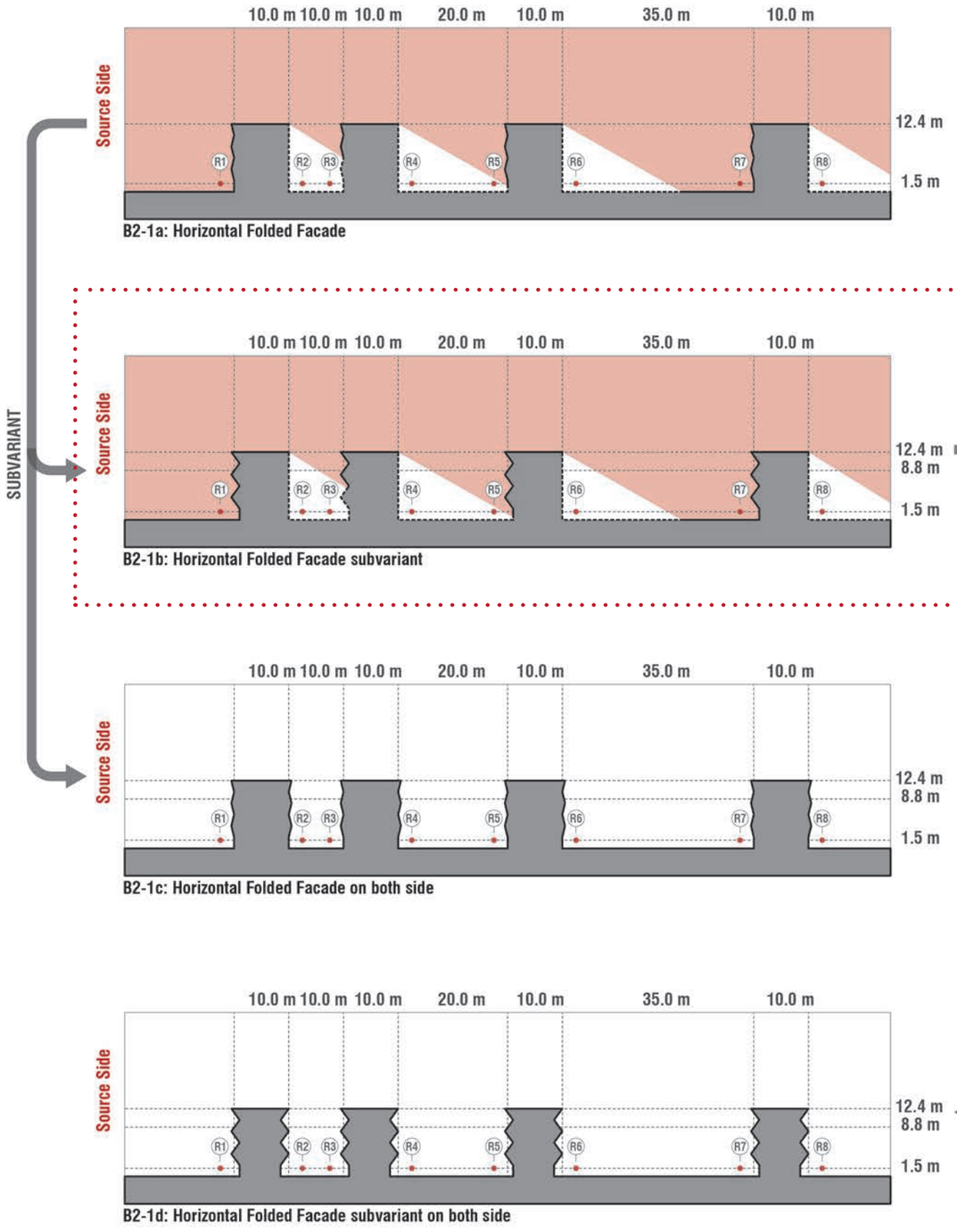
SOUND PATH ON EXPOSED FACADE

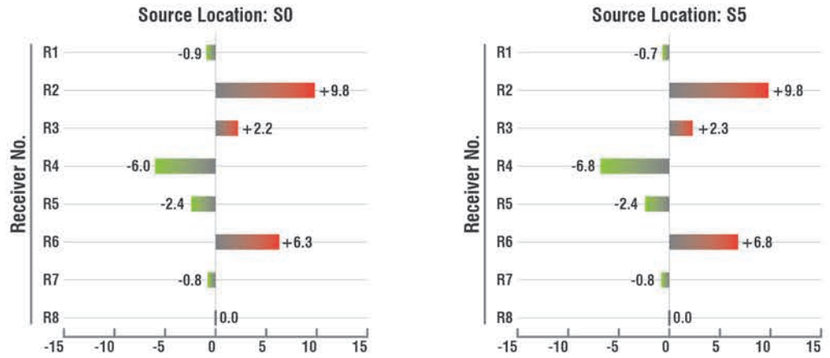
RESULTS & ANALYSIS: VERTICAL BARRIER (FACADE) - RIJSENHOUT

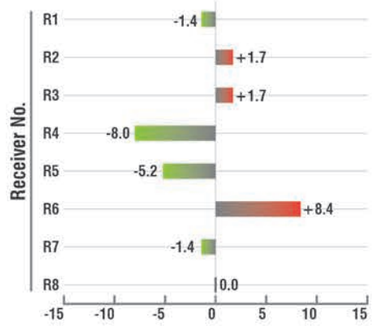


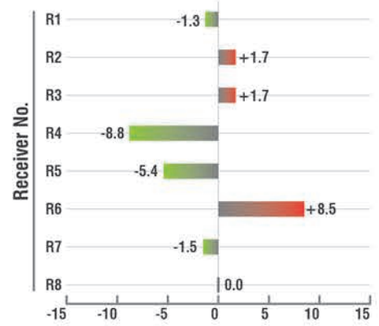


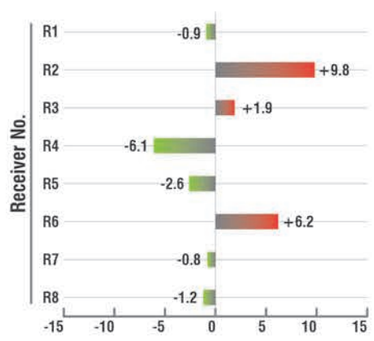
RESULTS & ANALYSIS: VERTICAL BARRIER (FACADE) - RIJSENHOUT

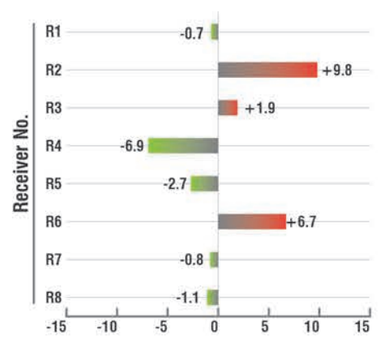


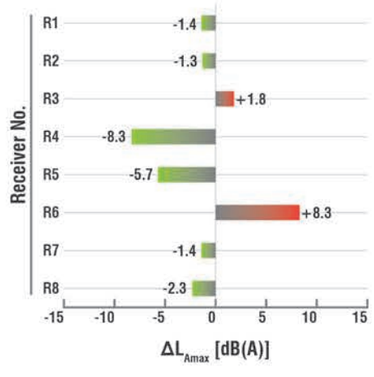


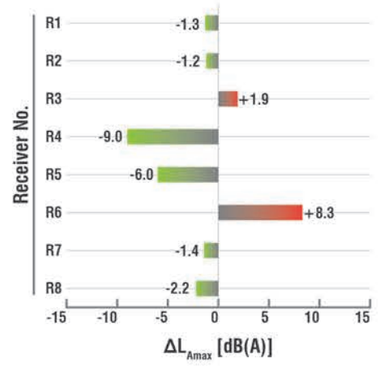




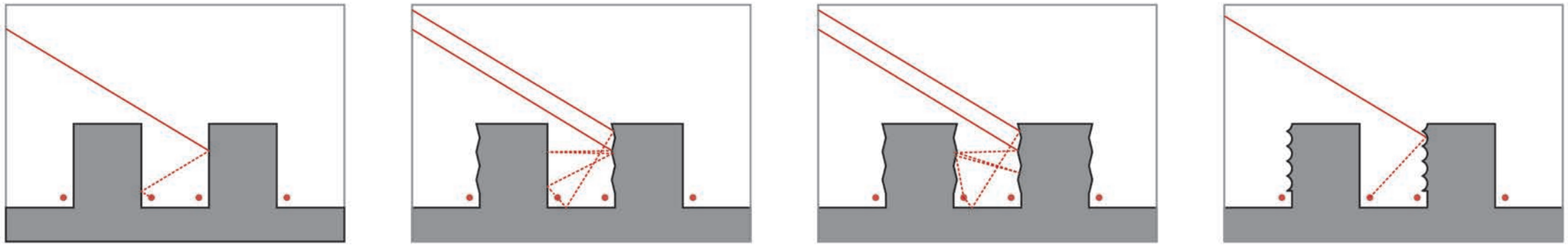




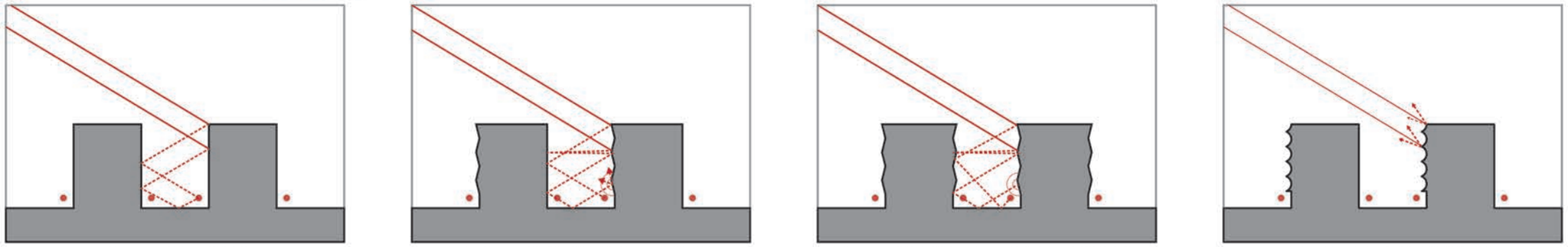




PORPAGATION PATH ON **QUIET** FACADE



PORPAGATION PATH ON **EXPOSED** FACADE



A1: FLAT ROOF | B2-1a: HORIZONTAL FOLDED | B2-1d: HORIZONTAL FOLED BOTH SIDE | B5-1a: WAVE FACADE

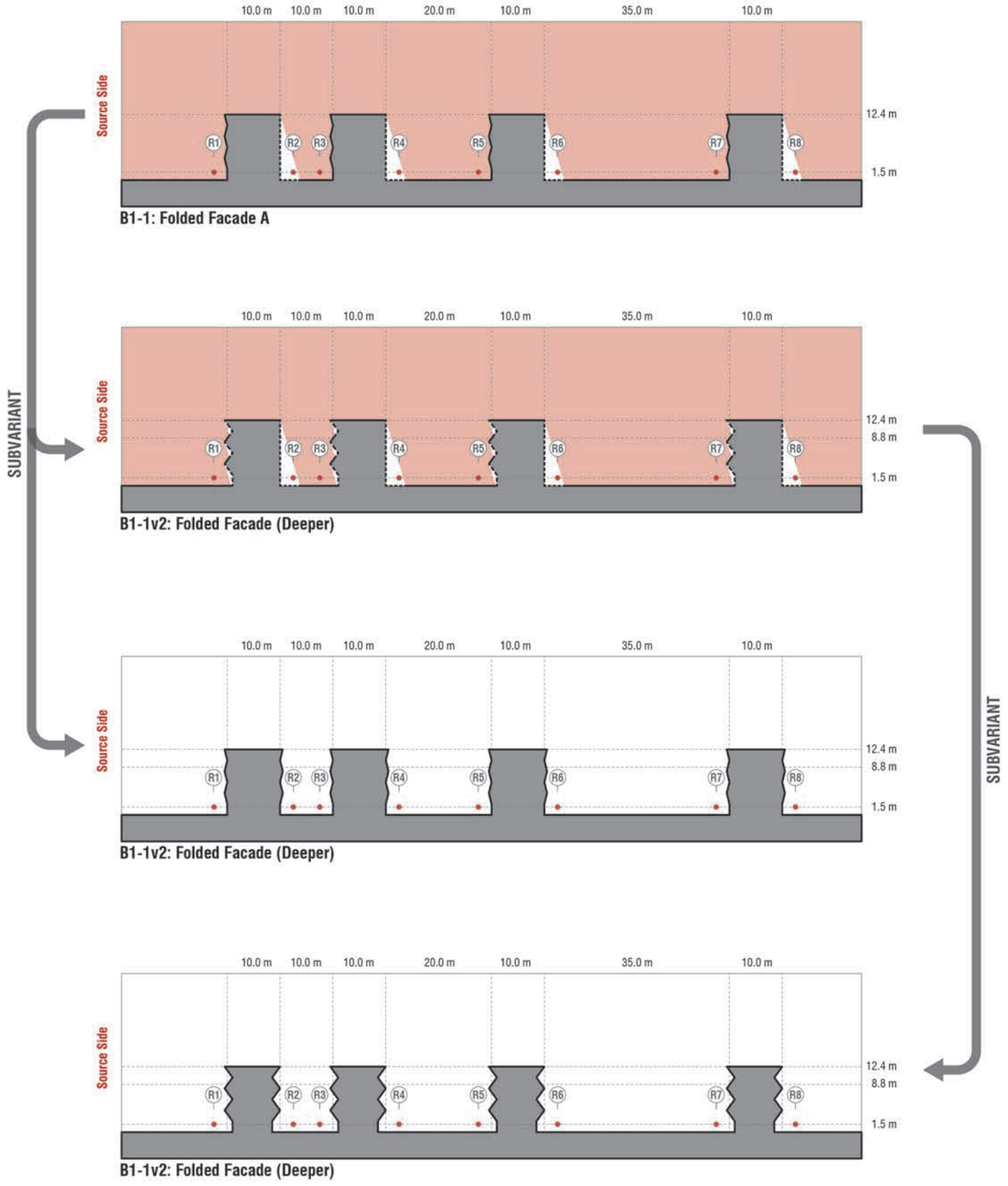
— Direct sound
------ Reflected sound

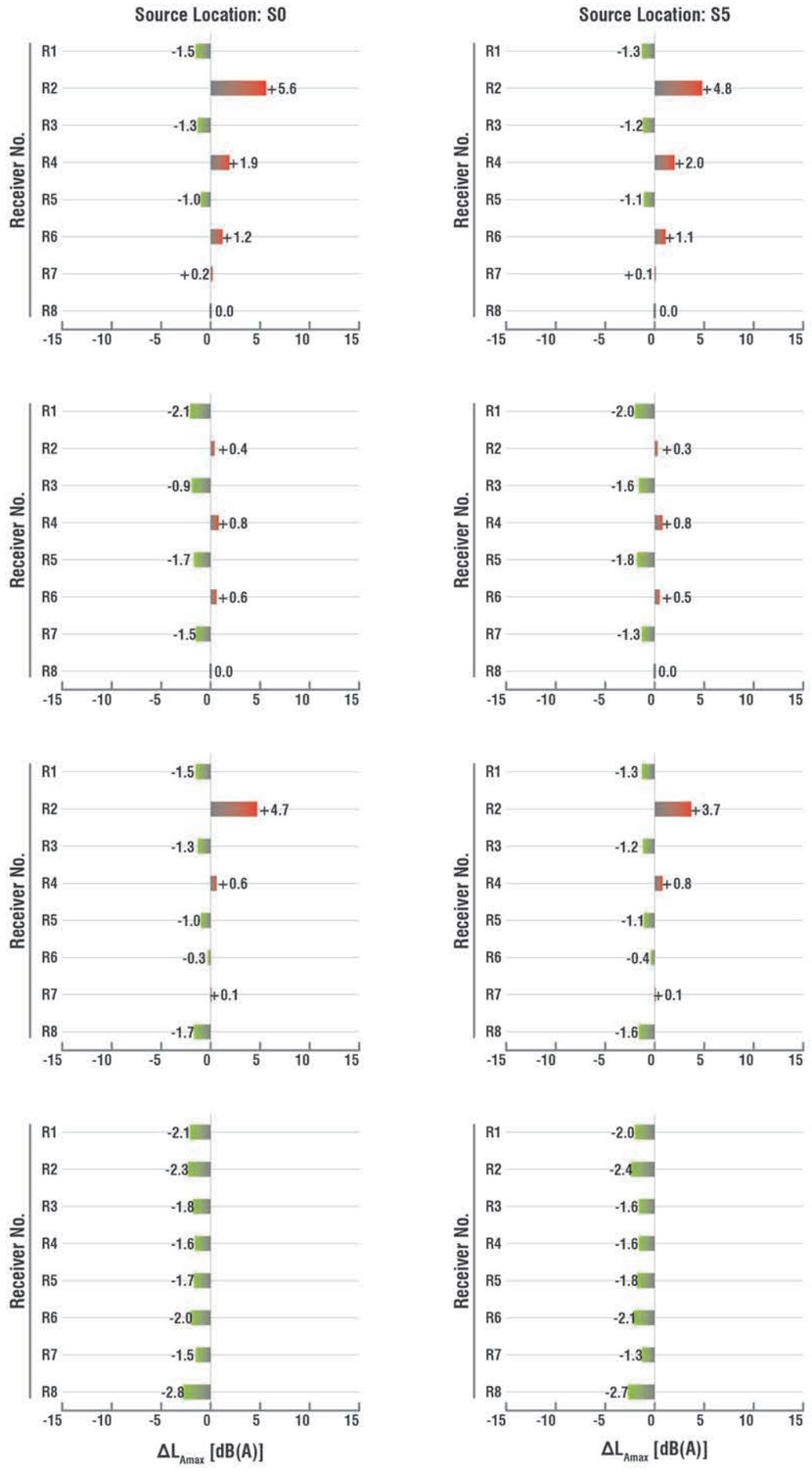
A5 | B2-1a | B2-1b | B3-1 | B5-1

SCATTERING COEFFICIENT ACCORDING TO PANELS SIZE

Surface Width [m]	Angle of Incidence [°]	Frequency [Hz]					
		125	250	500	1000	2000	4000
1.22 m		0.12	0.43	0.93	0.81	0.89	0.94
1.90 m*		0.16	0.39	0.94	0.79	0.88	0.95
2.44 m		0.19	0.36	0.96	0.77	0.88	0.95
2.80 m*	56.9 °	0.20	0.30	0.96	0.76	0.88	0.96
3.66 m		0.20	0.24	0.97	0.75	0.87	0.97
4.20 m*		0.18	0.20	0.97	0.75	0.88	0.95
7.32 m		0.15	0.12	0.97	0.74	0.90	0.93

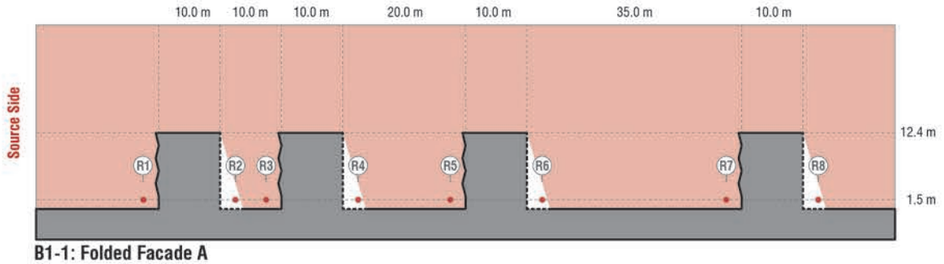
RESULTS & ANALYSIS: VERTICAL BARRIER (FACADE) - BANGKOK



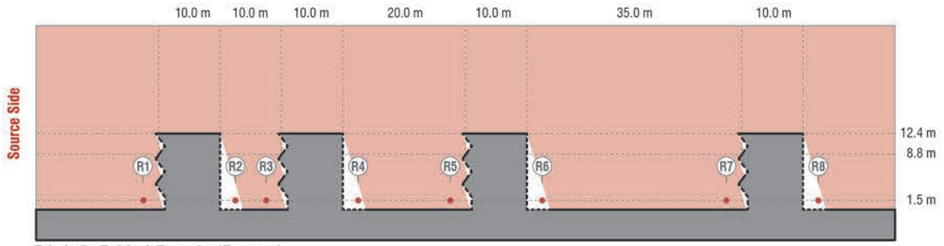


RESULTS & ANALYSIS: VERTICAL BARRIER (FACADE) - BANGKOK

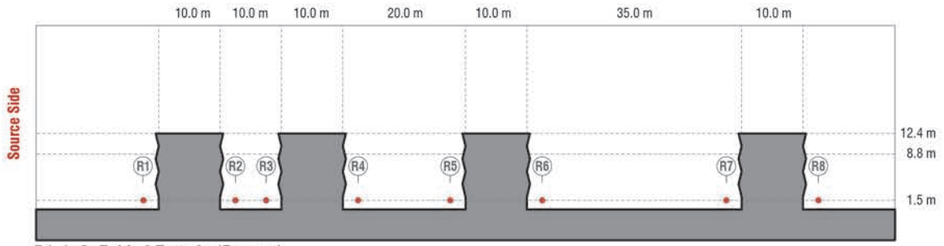
SUBVARIANT



B1-1: Folded Facade A

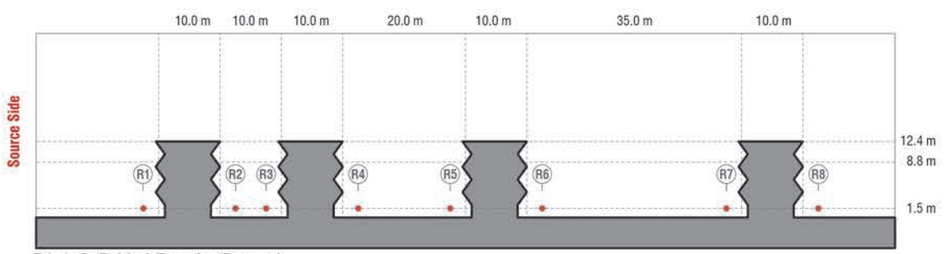


B1-1v2: Folded Facade (Deeper)

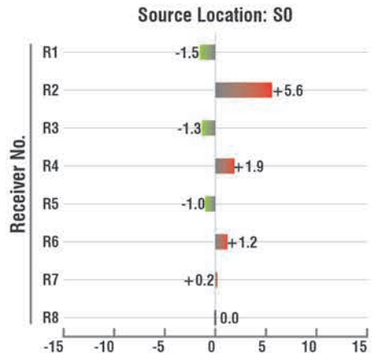


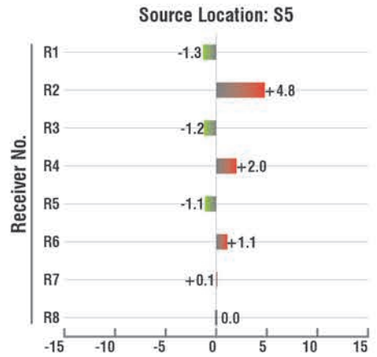
B1-1v2: Folded Facade (Deeper)

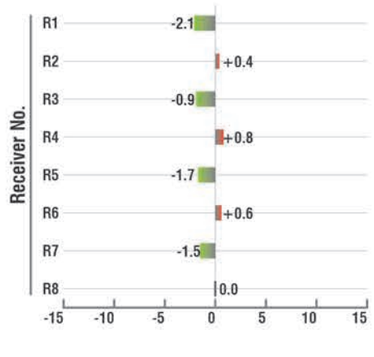
SUBVARIANT

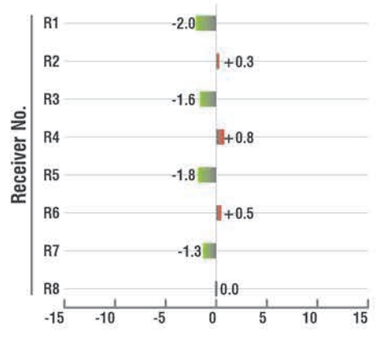


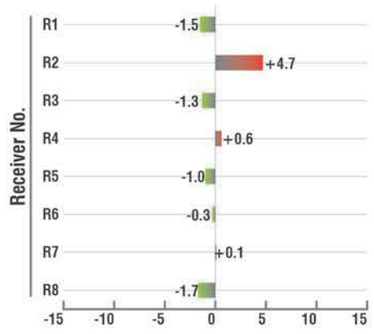
B1-1v2: Folded Facade (Deeper)

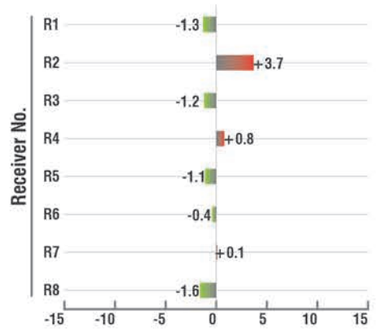


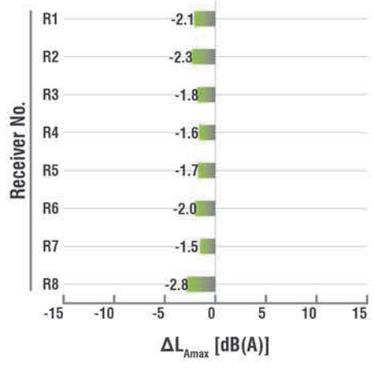


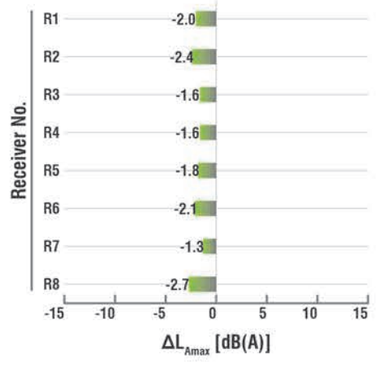




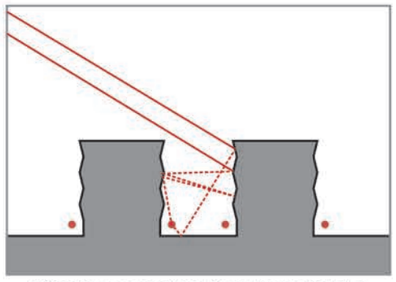




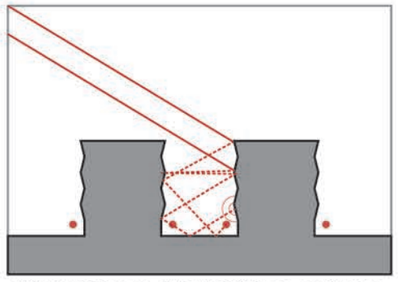




RIJSENHOUT: 32° ANGLE OF INCIDENCE

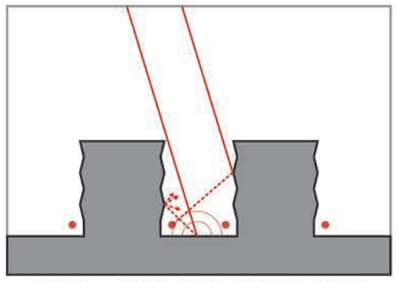


SOUND PATH ON QUIET FACADE

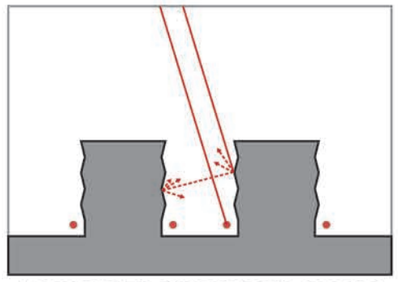


SOUND PATH ON EXPOSED FACADE

BANGKOK: 73° ANGLE OF INCIDENCE

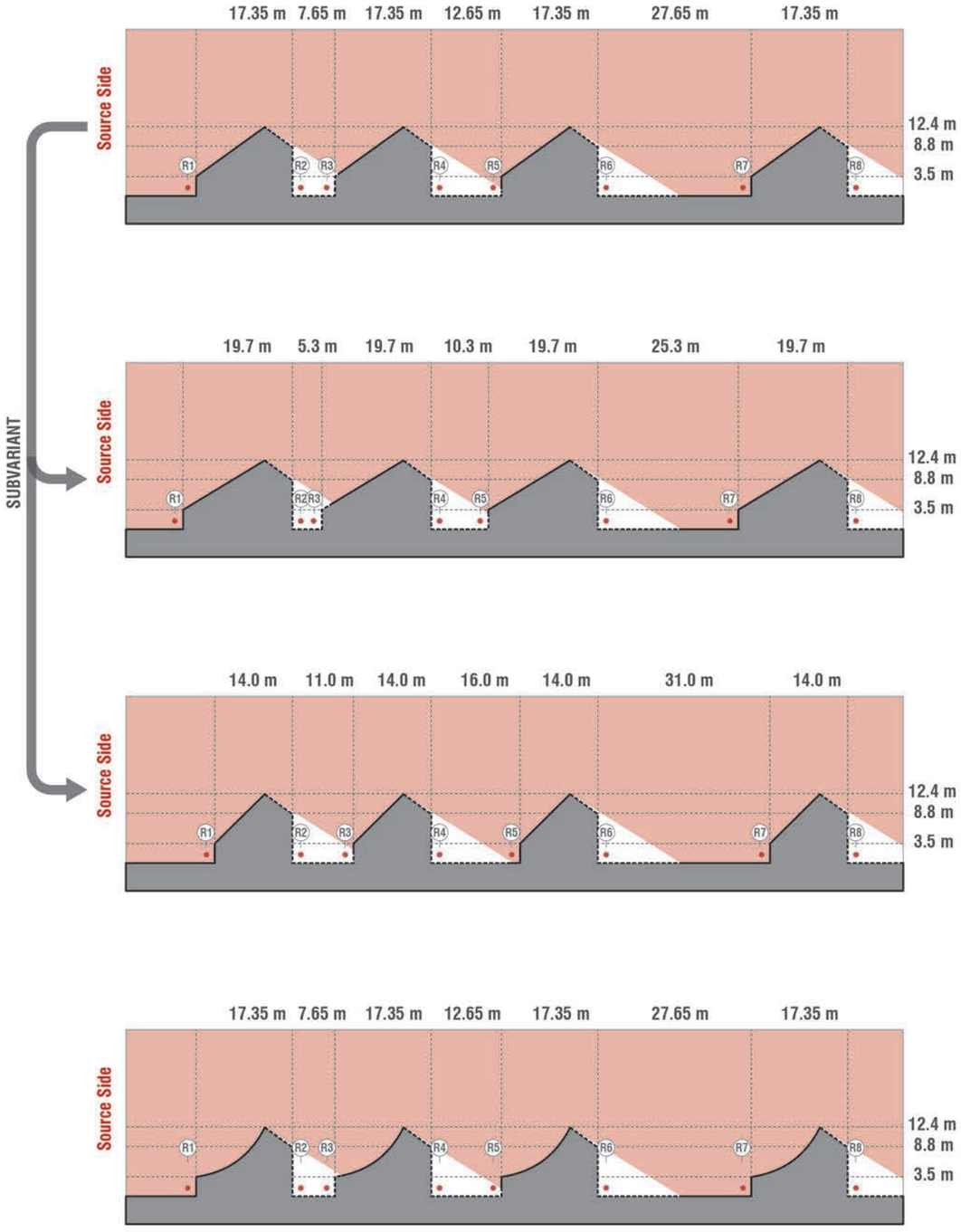


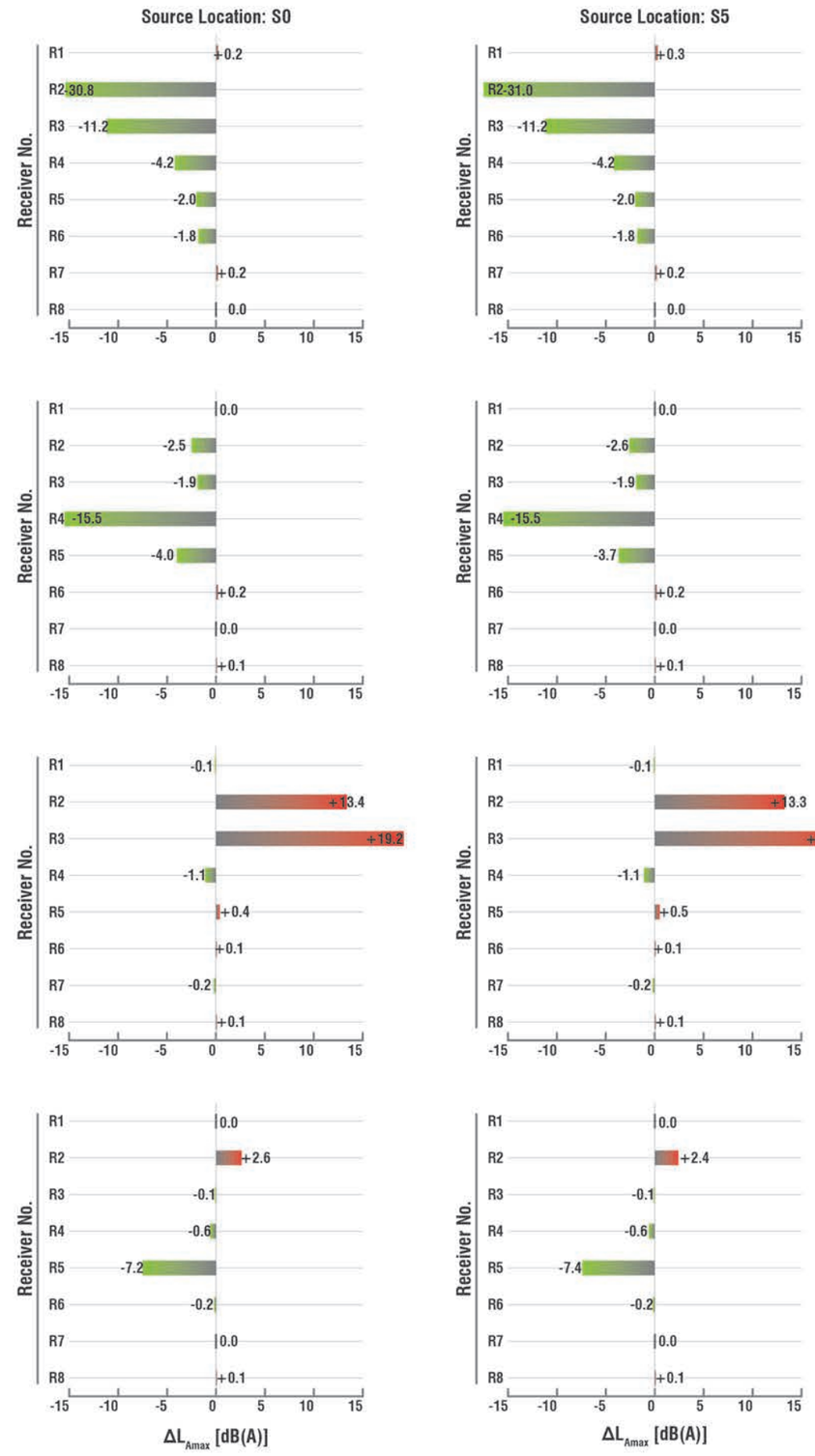
SOUND PATH ON QUIET FACADE



SOUND PATH ON EXPOSED FACADE

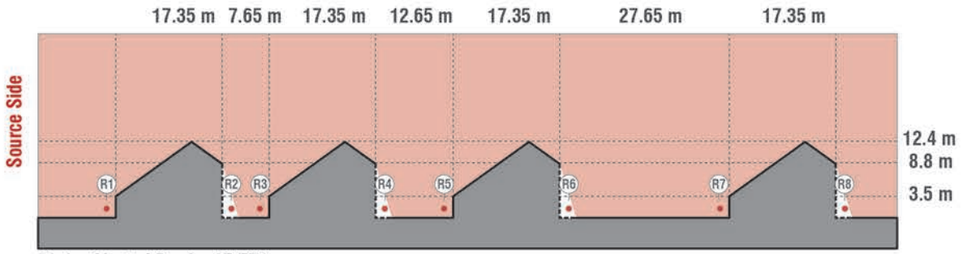
RESULTS & ANALYSIS: SLANTED BARRIER - RIJSENHOUT



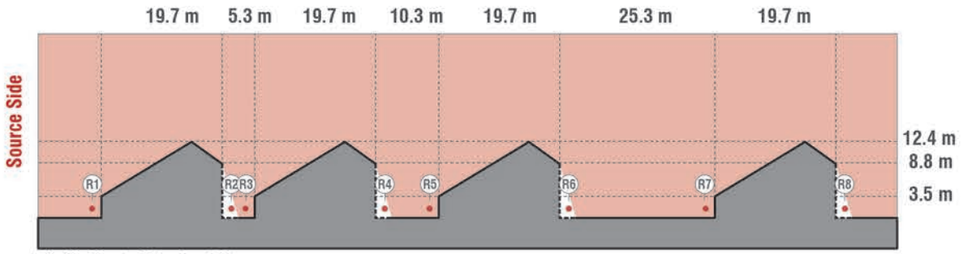


RESULTS & ANALYSIS: SLANTED BARRIER - BANGKOK

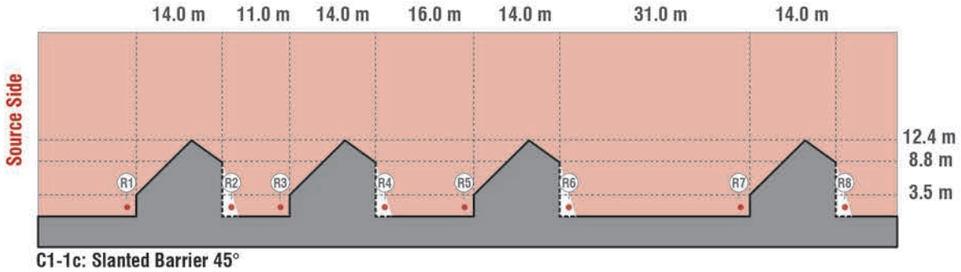
SUBVARIANT



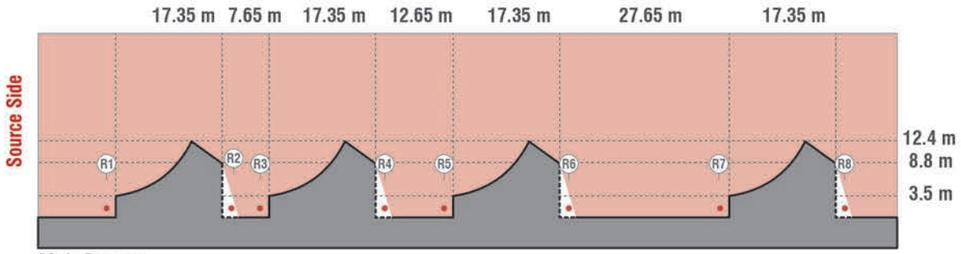
C1-1a: Slanted Barrier 35.75°



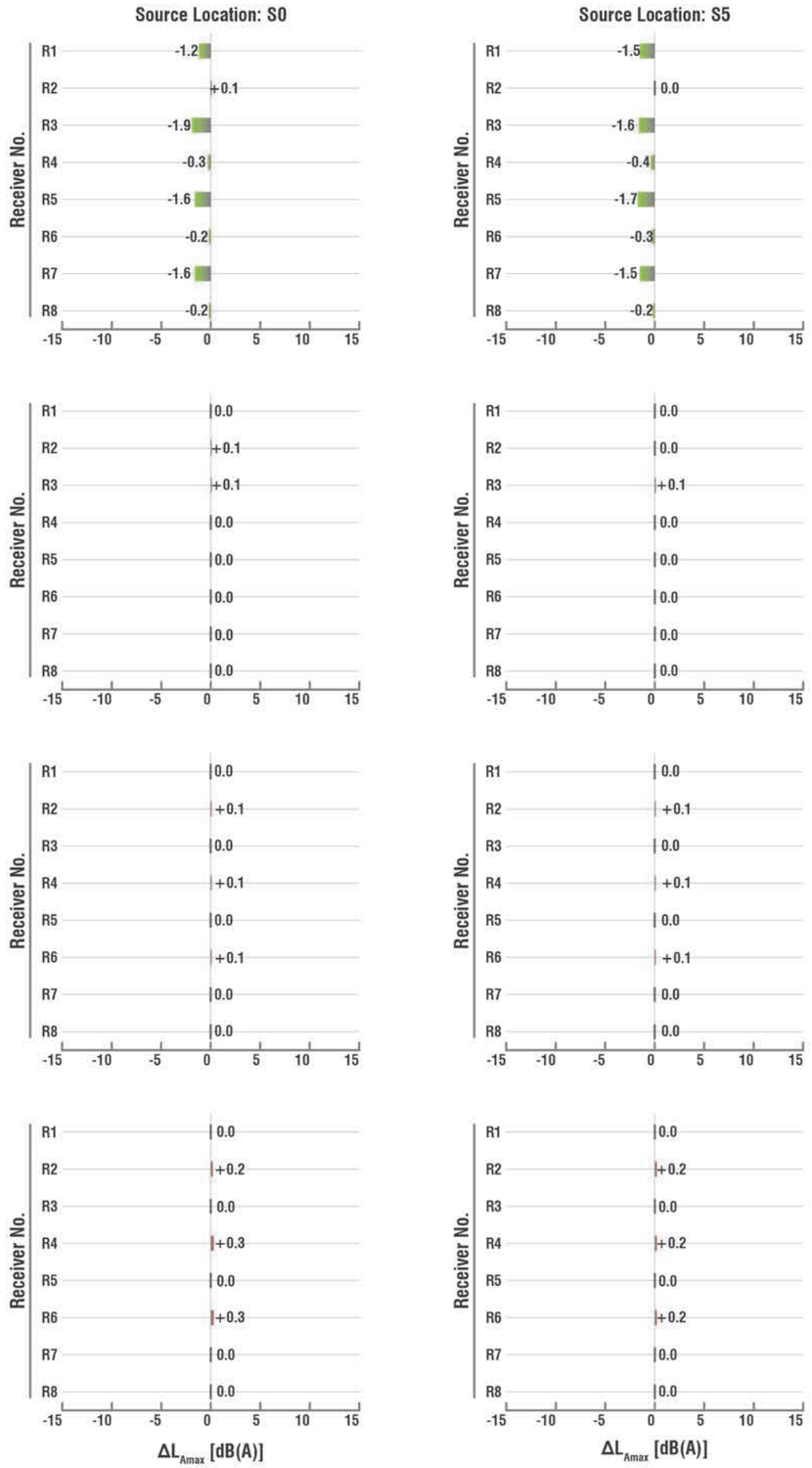
C1-1b Slanted Barrier 30°



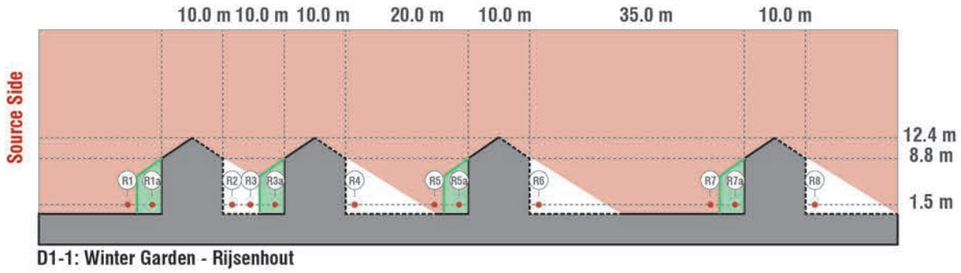
C1-1c: Slanted Barrier 45°



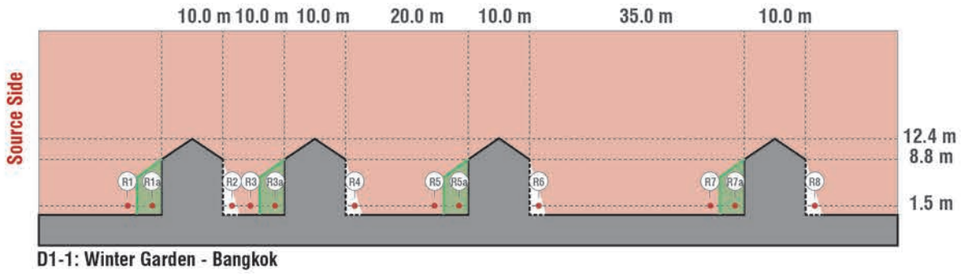
C3-1: Concave



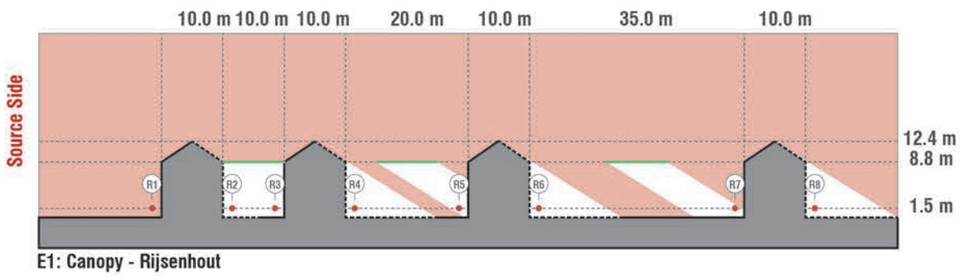
RESULTS & ANALYSIS: BUFFER ZONE



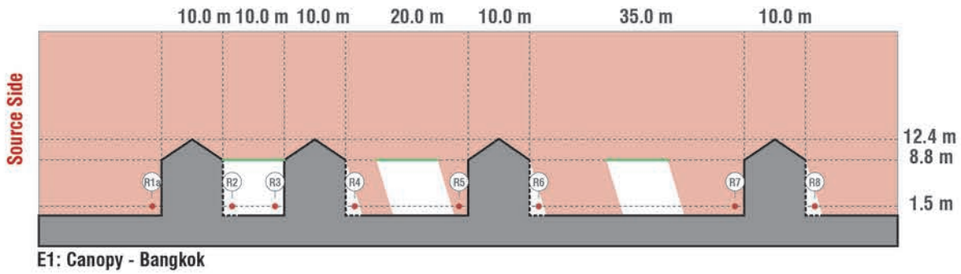
D1-1: Winter Garden - Rijsenhout



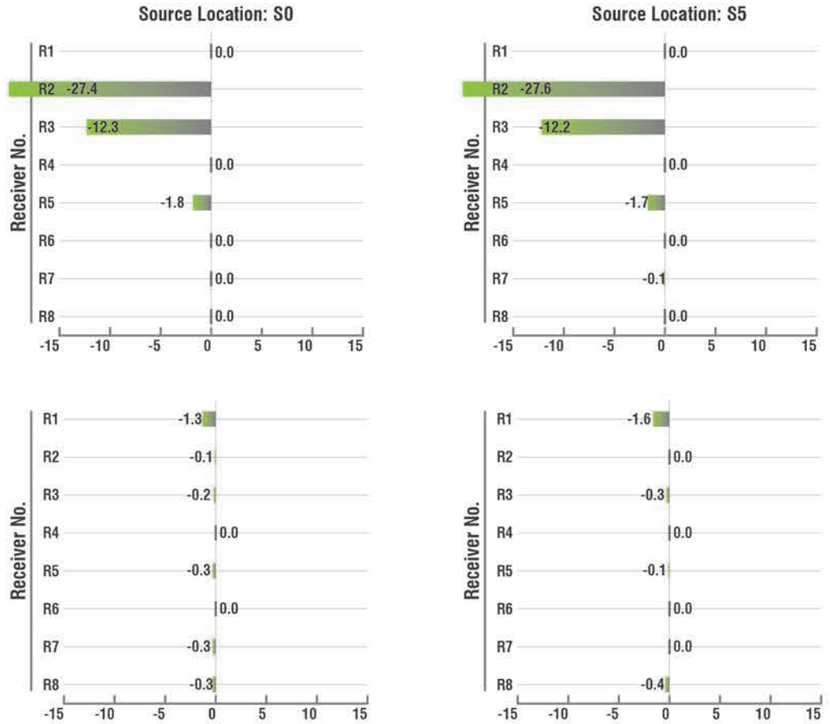
D1-1: Winter Garden - Bangkok

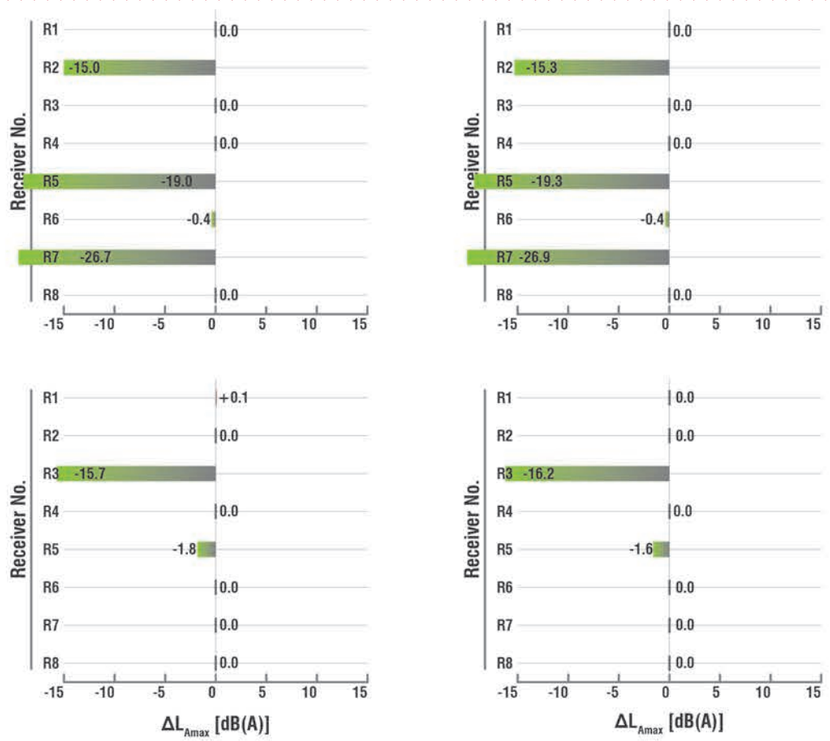


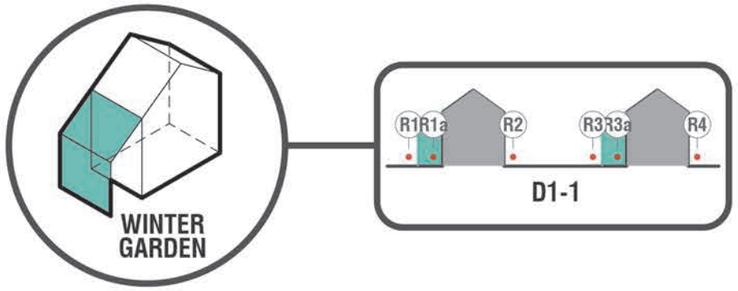
E1: Canopy - Rijsenhout



E1: Canopy - Bangkok



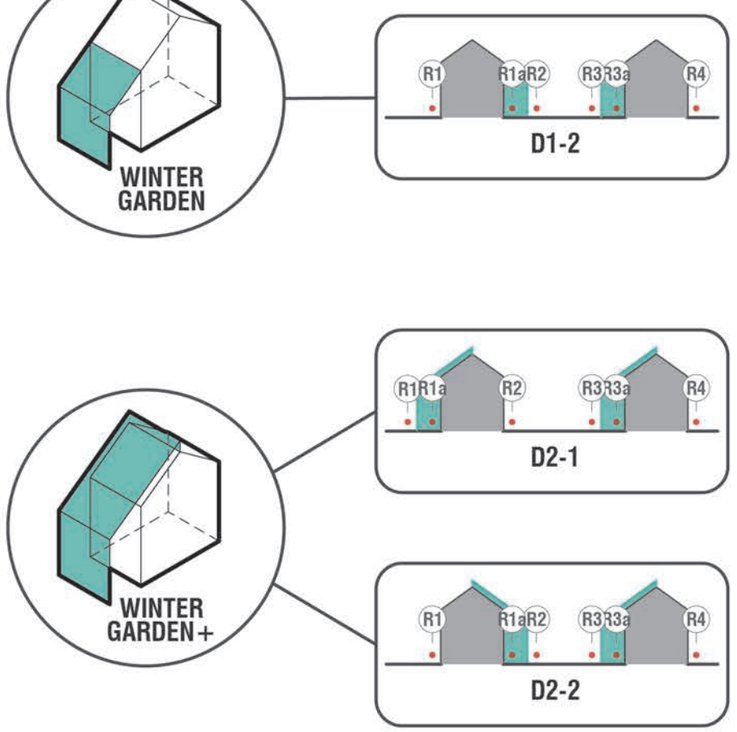




Receiver Position	SPL per frequency [dB]						A-w [dB(A)]
	125	250	500	1000	2000	4000	
R1	70.2	70.9	70.0	69.1	65.5	53.2	73.0
R1a	52.5	47.7	43.6	39.2	32.5	16.1	45.3
R2	56.9	54.3	51.0	47.2	40.6	24.0	52.5
R3	68.1	67.3	66.5	65.4	61.7	49.3	69.3
R3a	51.9	47.1	42.9	38.5	31.7	15.0	44.7
R4	35.3	34.7	33.6	32.2	27.7	16.0	36.1

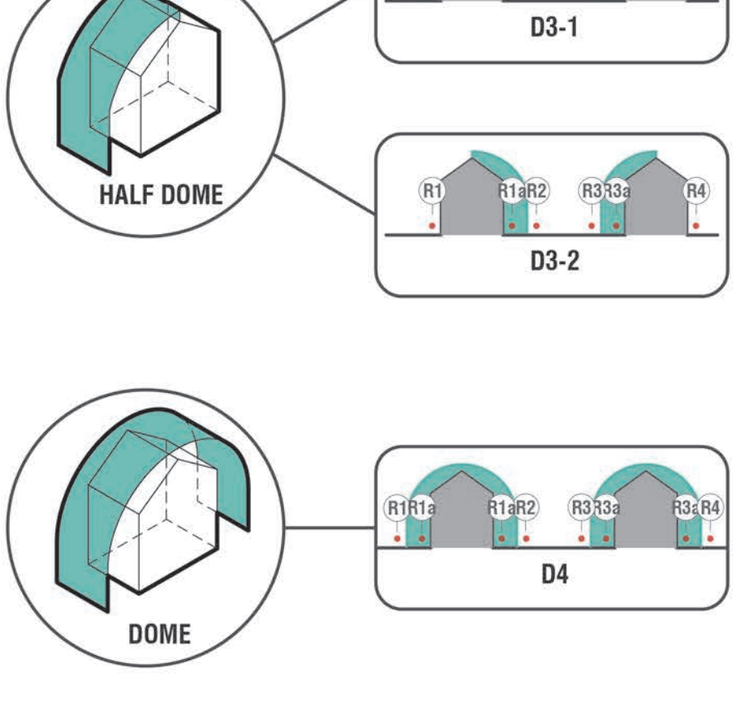
ΔLAmax *[dB(A)]* when compared to D1-1

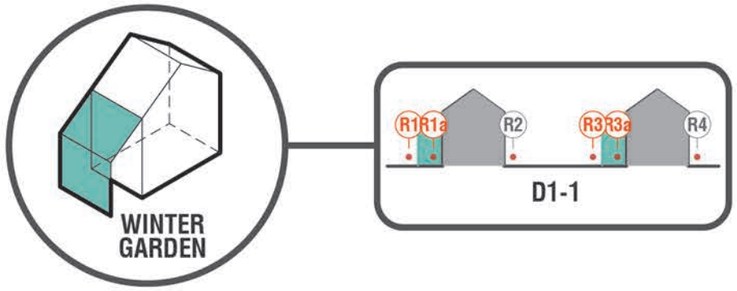
SIMULATION NO.	R1	R1a	R2	R3	R3a	R4
D1-2	0.0	-	-17.8	0.0	0.0	0.0
D2-1	0.0	-	+26.9	-1.8	-	0.0
D2-2	0.0	-	+26.9	-1.8	-	0.0



ΔLAmax *[dB(A)]* when compared to D1-1

SIMULATION NO.	R1	R1a	R2	R3	R3a	R4
D3-1	0.0	-	+26.7	-1.8	-	0.0
D3-2	0.0	-	+29.5	-32.2	-	0.0
D4	0.0	-	+14.9	-32.4	-	+0.1





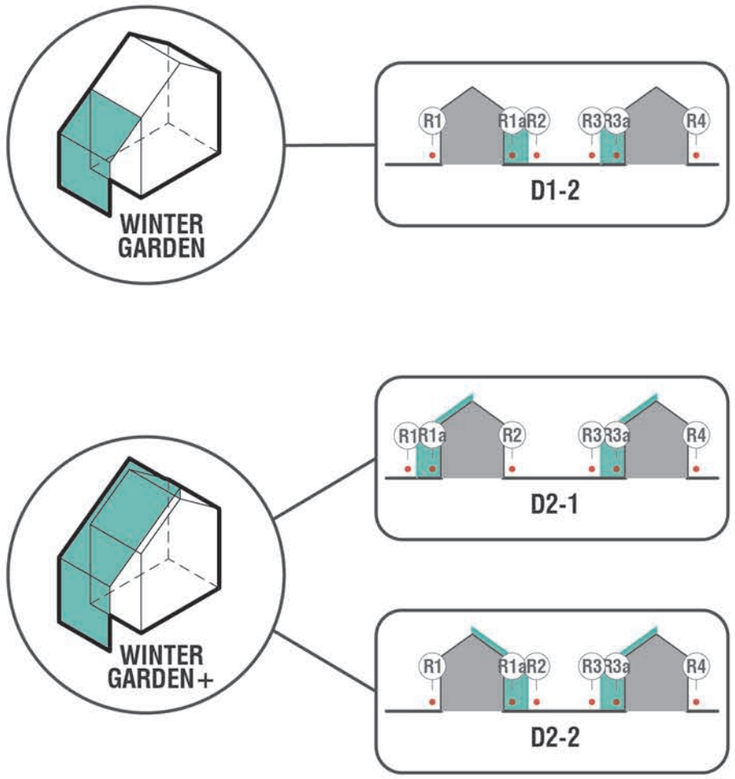
Receiver Position	SPL per frequency [dB] 125	250	500	1000	2000	4000	A-w [dB(A)]
R1	70.2	70.9	70.0	69.1	65.5	53.2	73.0
R1a	52.5	47.7	43.6	39.2	32.5	16.1	45.3
R2	56.9	54.3	51.0	47.2	40.6	24.0	52.5
R3	68.1	67.3	66.5	65.4	61.7	49.3	69.3
R3a	51.9	47.1	42.9	38.5	31.7	15.0	44.7
R4	35.3	34.7	33.6	32.2	27.7	16.0	36.1

27.7 dB(A)

24.6 dB(A)

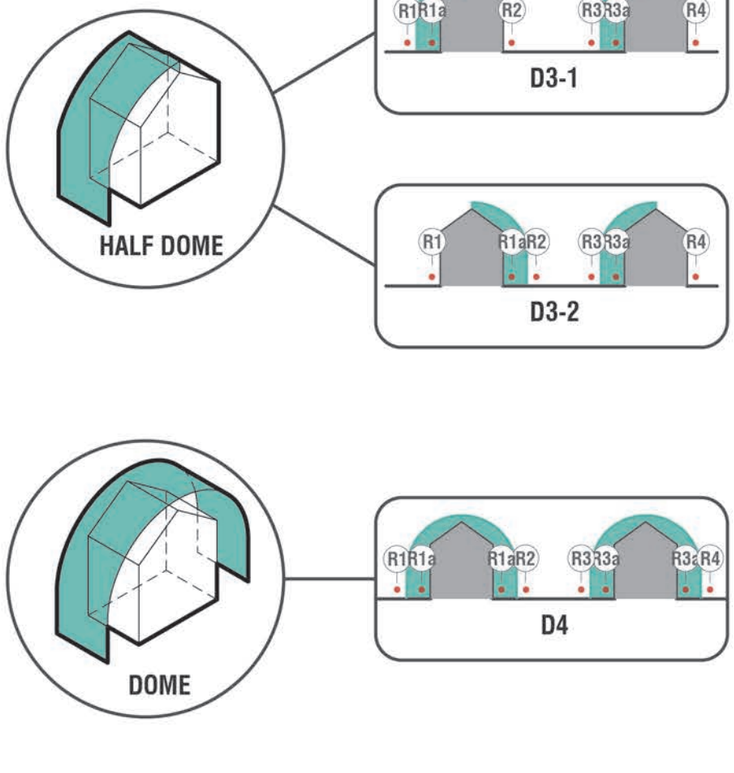
ΔLAmax *[dB(A)]* when compared to D1-1

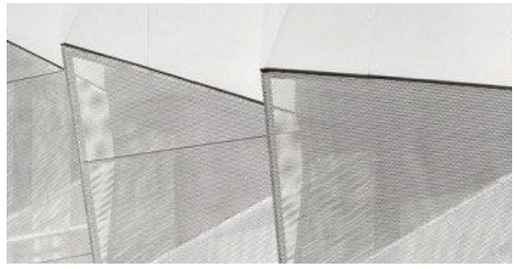
SIMULATION NO.	R1	R1a	R2	R3	R3a	R4
WINTER GARDEN / D1-2	0.0	-	-17.8	0.0	0.0	0.0
WINTER GARDEN+ / D2-1	0.0	-	+26.9	-1.8	-	0.0
WINTER GARDEN+ / D2-2	0.0	-	+26.9	-1.8	-	0.0



ΔLAmax *[dB(A)]* when compared to D1-1

SIMULATION NO.	R1	R1a	R2	R3	R3a	R4
HALF DOME / D3-1	0.0	-	+26.7	-1.8	-	0.0
HALF DOME / D3-2	0.0	-	+29.5	-32.2	-	0.0
DOME / D4	0.0	-	+14.9	-32.4	-	+0.1





ANALYSIS: MATERIALITY NOISE REDUCTION

MASS LAW FORMULA:

$$R = 10 \log \left[1 + \left(\frac{\omega \cdot m \cdot \cos \theta}{2 \cdot \rho_{air} \cdot c_{air}} \right)^2 \right]$$

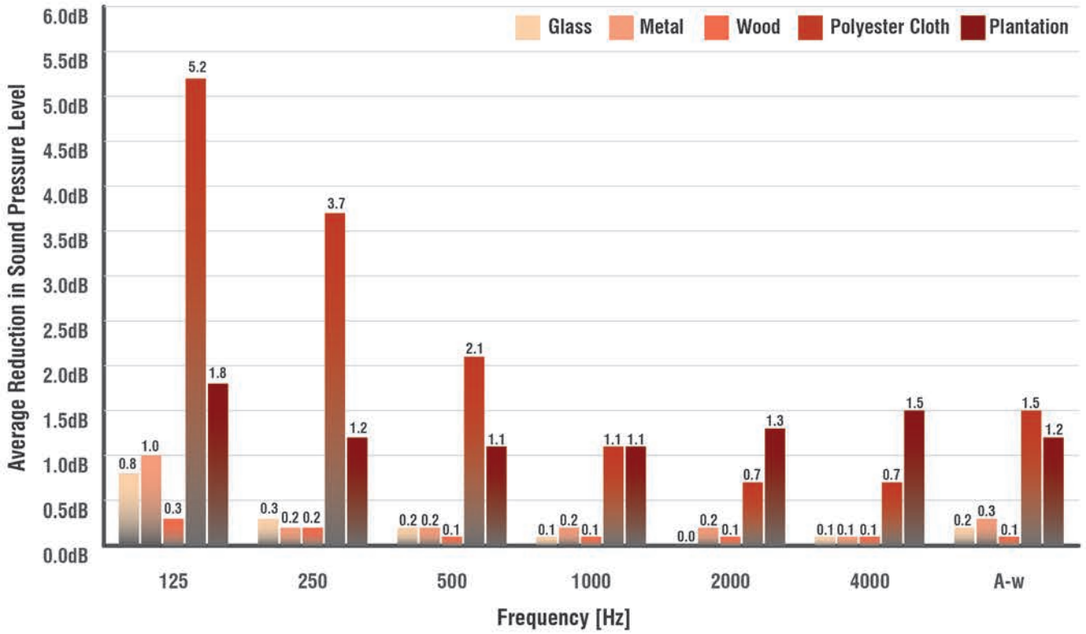
SOUND REDUCTION AT RANDOM INCIDENCE

Surface material	Sound reduction index (R)					
	125	250	500	1000	2000	4000
Glazing: Double glazing, 2 -3 mm thk glass, 10 mm air gap *	22	24	28	38	45	50
Metal sheet: perforated steel deck, 0.75 mm thk	15.3	21.2	27.2	33.2	39.2	45.2
Wood: Plywood board, 10 mm thk	16.3	22.2	28.2	34.2	40.3	46.3
Membrane: Latex membrane, 0.58 mm thk with 15 mm air gap	1.4	3.9	8.3	13.9	19.7	25.7
Textile: Polyester cloth, 3.5 mm thk with 15 mm air gap	0.2	0.7	2.3	5.8	10.8	16.6
Vegetation: Green wall module system, total thk = 120 mm **	13.3	14.6	16.4	14.7	13.5	14.8

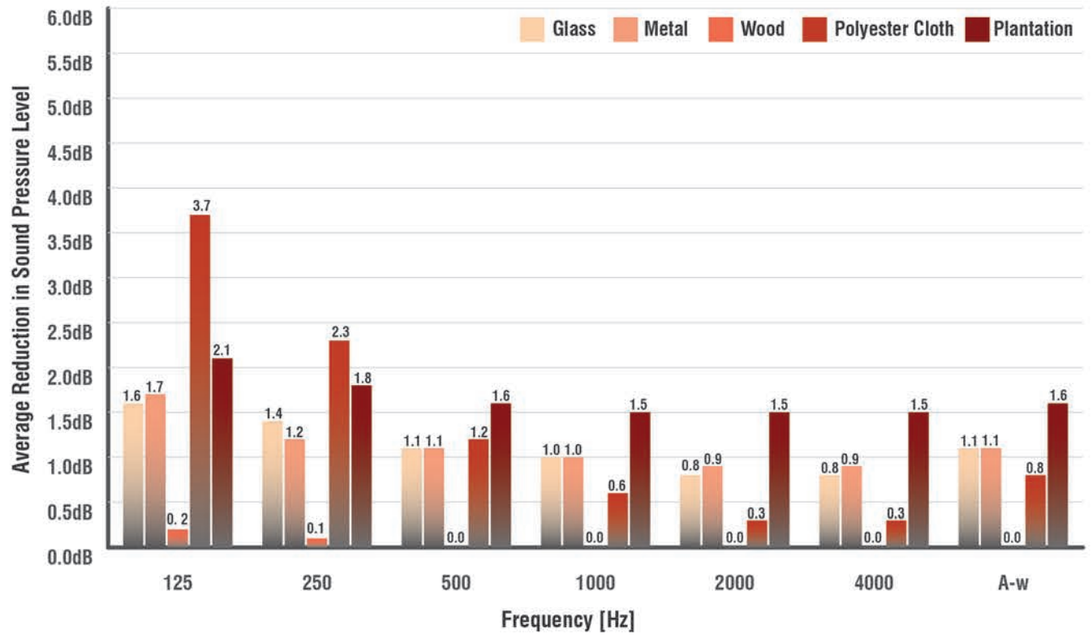
SOUND REDUCTION AT 32° & 73° ANGLE OF INCIDENCE

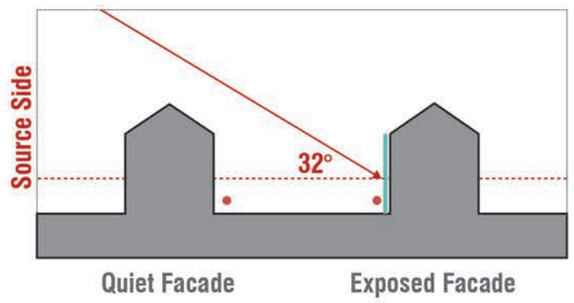
Surface material	Angle of incidence (°)	Sound reduction index (R)					
		125	250	500	1000	2000	4000
Metal sheet: perforated steel deck, 0.75 mm thk	Random	15.3	21.2	27.2	33.2	39.2	45.2
	32°	13.9	19.8	25.8	31.8	37.8	43.8
	73°	5.8	10.8	16.6	22.5	28.5	34.6
Wood: Plywood board, 10 mm thk	Random	16.3	22.2	28.2	34.2	40.3	46.3
	32°	14.9	20.8	26.8	32.8	38.8	44.8
	73°	6.6	11.8	17.6	23.6	29.6	35.6
Membrane: Latex membrane, 0.58 mm thk with 15 mm air gap	Random	1.4	3.9	8.3	13.9	19.7	25.7
	32°	1.0	3.1	7.2	12.5	18.3	24.3
	73°	0.0	0.0	0.0	0.0	0.0	0.0
Textile: Polyester cloth, 3.5 mm thk with 15 mm air gap	Random	0.2	0.7	2.3	5.8	10.8	16.6
	32°	0.1	0.5	1.8	4.8	9.5	15.2
	73°	0.0	0.0	0.0	0.0	0.0	0.0

SOUND REDUCTION ON EXPOSED FACADE - RIJSENHOUT

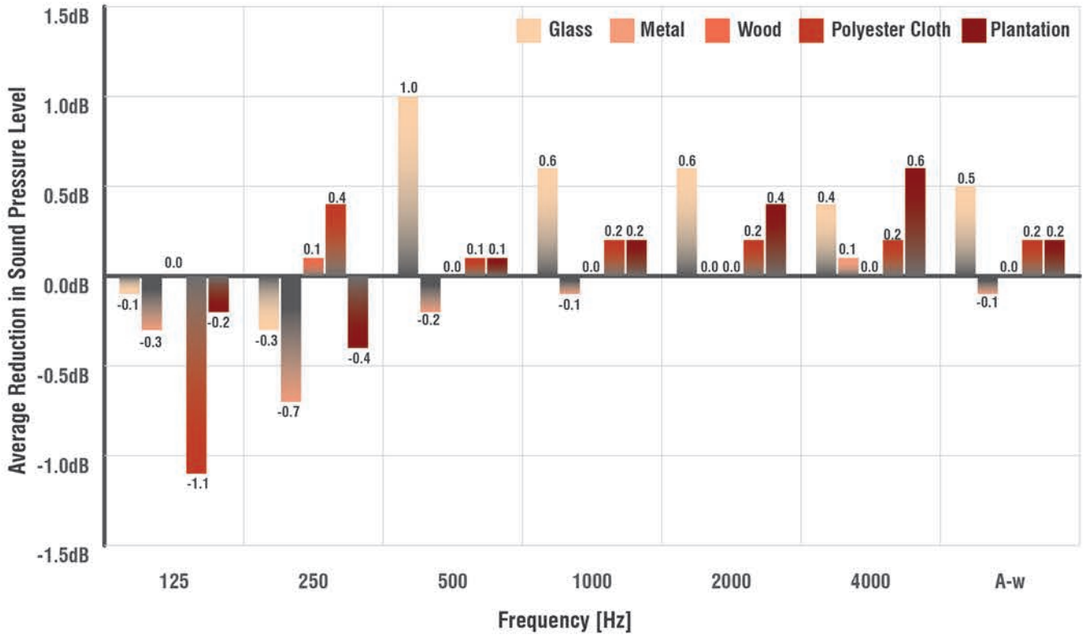


SOUND REDUCTION ON QUIET FACADE - RIJSENHOUT

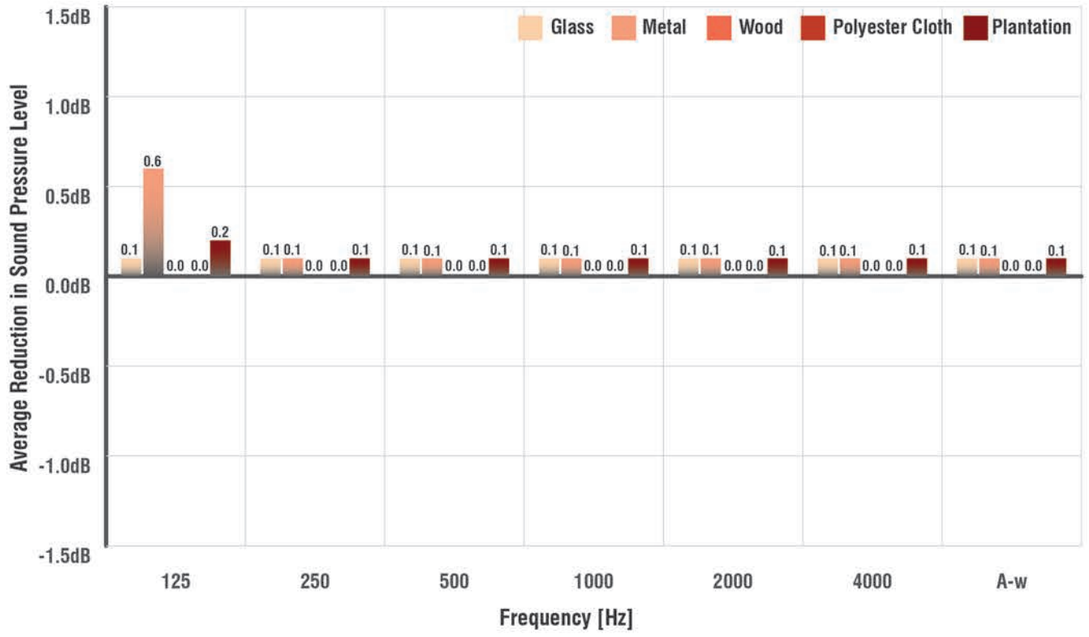


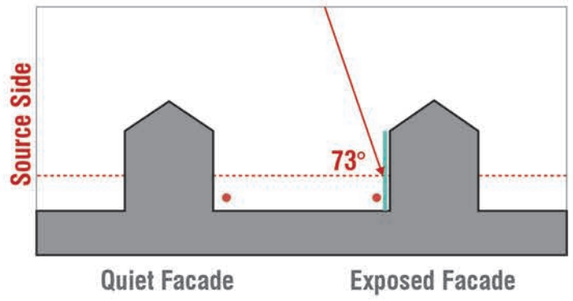


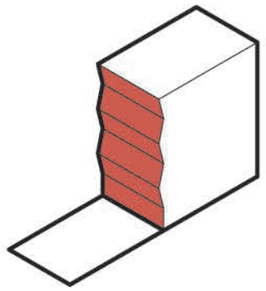
SOUND REDUCTION ON EXPOSED FACADE - BANGKOK



SOUND REDUCTION ON QUIET FACADE - BANGKOK

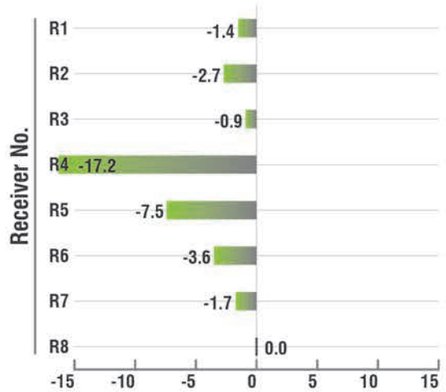




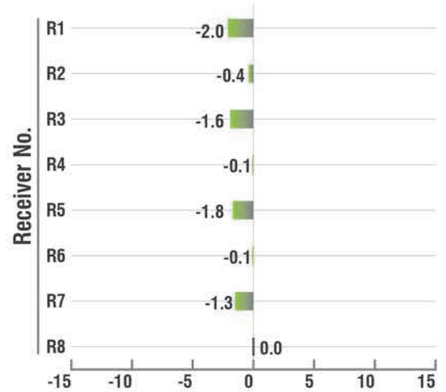


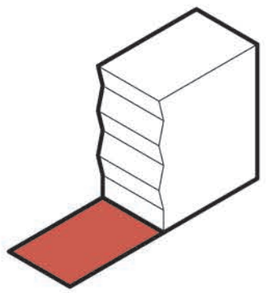
APPLIED TO FACADE

RIJSENHOUT: 32° ANGLE OF INCIDENCE

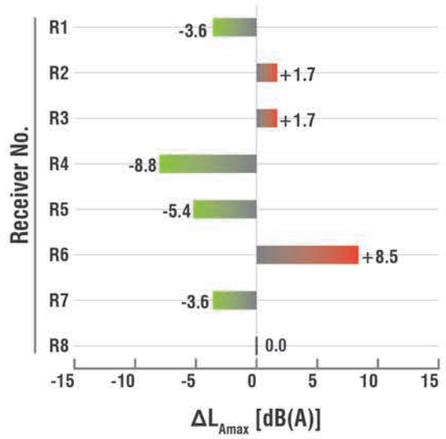


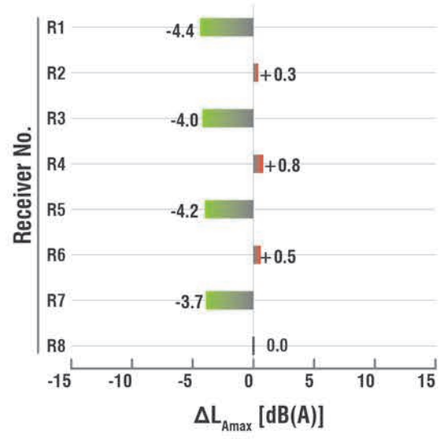
BANGKOK: 73° ANGLE OF INCIDENCE



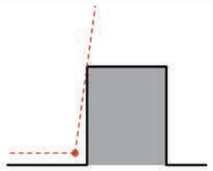
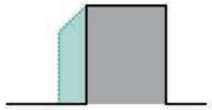
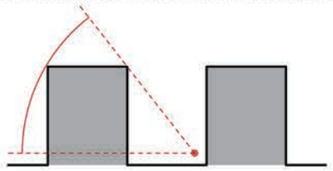
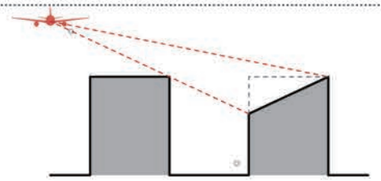
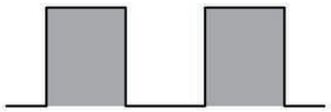
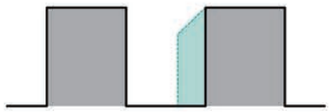
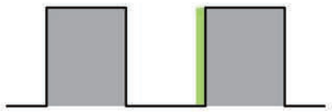
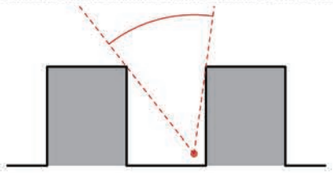
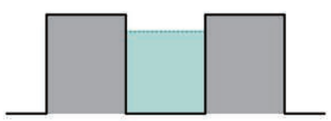
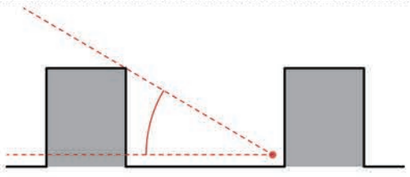
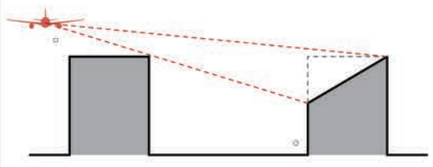
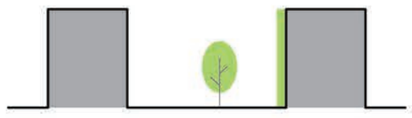
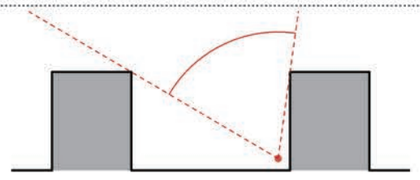
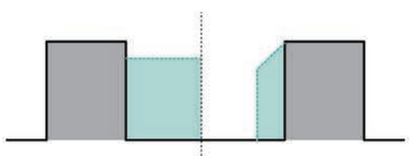
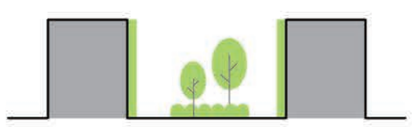


APPLIED TO HORIZONTAL SURFACE

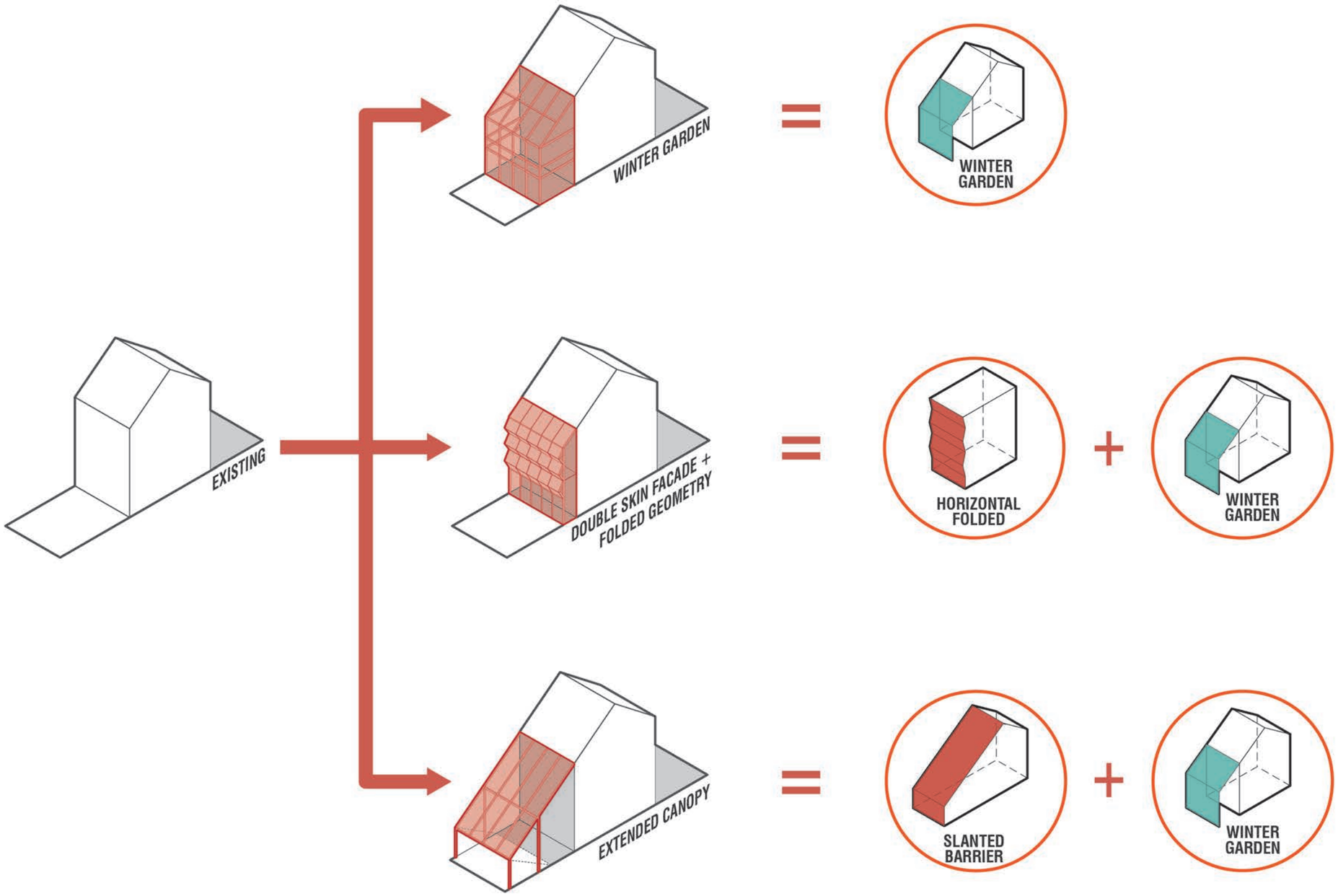




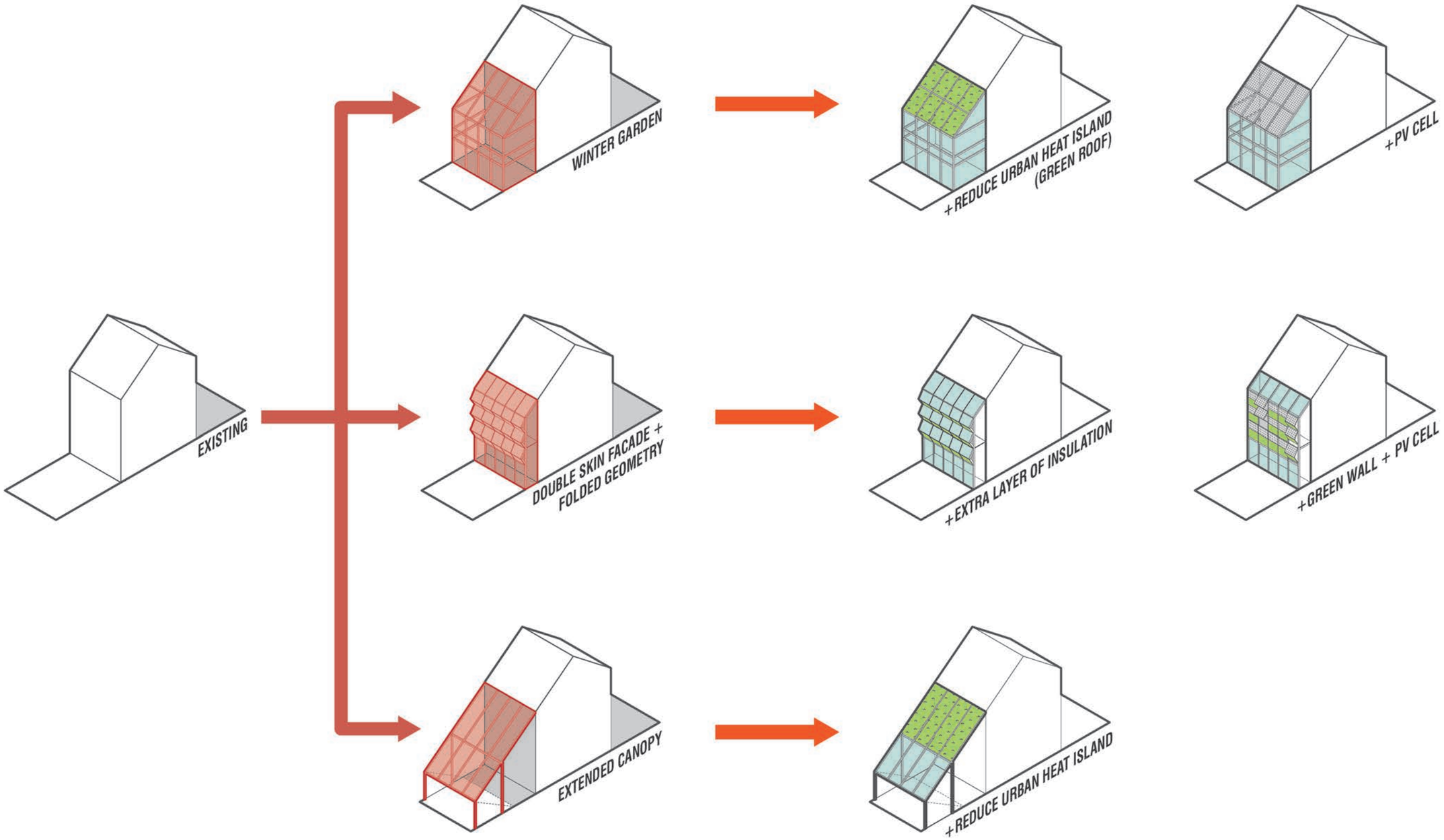
GERNERAL **URBAN PLANNING GUIDELINE**

Urban Typology	Roof Geometry	Facade Geometry	Buffer Zone	Materiality
 **L-Shpae Canyon**	✕ *Have small imapct*	**Use protursion elements** **Effect:** *Noise dispersion due to scattering effect* **Result:** *Reduce outdoor noise*	 **Use double skin facade/winter garden** **Effect:** *Add extra layer of noise insulation* **Result:** *Reduce indoor noise*	**Add absorbing materials, ex. Vegetation** **Effect:** *Increase absorbing surface in the canyon* **Result:** *Reduce outdoor and indoor noise*
 **U-Shape Canyon ≤10 m** [with **indirect transmission**]	 **Use tilted roof** **Effect:** *Part of noise is being reflect away* **Result:** *Reduce outdoor noise*	 **Use flat facade** **Effect:** *Avoid trapping sound by protrude element* **Result:** -	 **Use double skin facade/ winter garden** **Effect:** *Add extra layer of noise insulation* **Result:** *Reduce indoor noise*	 **Add absorbing materials, ex. Vegetation** **Effect:** *Increase absorbing surface in the canyon* **Result:** *Reduce outdoor and indoor noise*
 **U-Shape Canyon ≤10 m** [*with* **direct transmission**]	✕ *Have small imapct*	**Use protursion elements on both side** **Effect:** *Noise dispersion due to scattering effect* **Result:** *Reduce outdoor noise*	 **Use urban canopy** **Effect:** *Creating noise barrier on top of the canyon* **Result:** *Reduce outdoor and indoor noise*	**Add vegetation on street level** **Effect:** *Reducing hard reflective surface* **Result:** *Reduce outdoor noise*
 **U-Shape Canyon ≥20 m** [with **indirect transmission**]	 **Use tilted roof** **Effect:** *Part of noise is being reflect away* **Result:** *Reduce outdoor noise*	**Use protursion elements** **Effect:** *Noise dispersion due to scattering effect* **Result:** *Reduce outdoor noise*	**Use double skin facade/winter garden** **Effect:** *Add extra layer of noise insulation* **Result:** *Reduce indoor noise*	 **Add vegetation and absorbing materials** **Effect:** *Increase absorbing surface in the canyon* **Result:** *Reduce outdoor and indoor noise*
 **U-Shape Canyon ≥20 m** [with **direct transmission**]	✕ *Have small imapct*	**Use protursion elements on both side** **Effect:** *Noise dispersion due to scattering effect* **Result:** *Reduce outdoor noise*	 **Use double skin facade or urban canopy** **Effect:** *Add extra layer of noise insulation* **Result:** *Reduce outdoor and indoor noise*	 **Add vegetation and absorbing materials** **Effect:** *Increase absorbing surface in the canyon* **Result:** *Reduce outdoor and indoor noise*

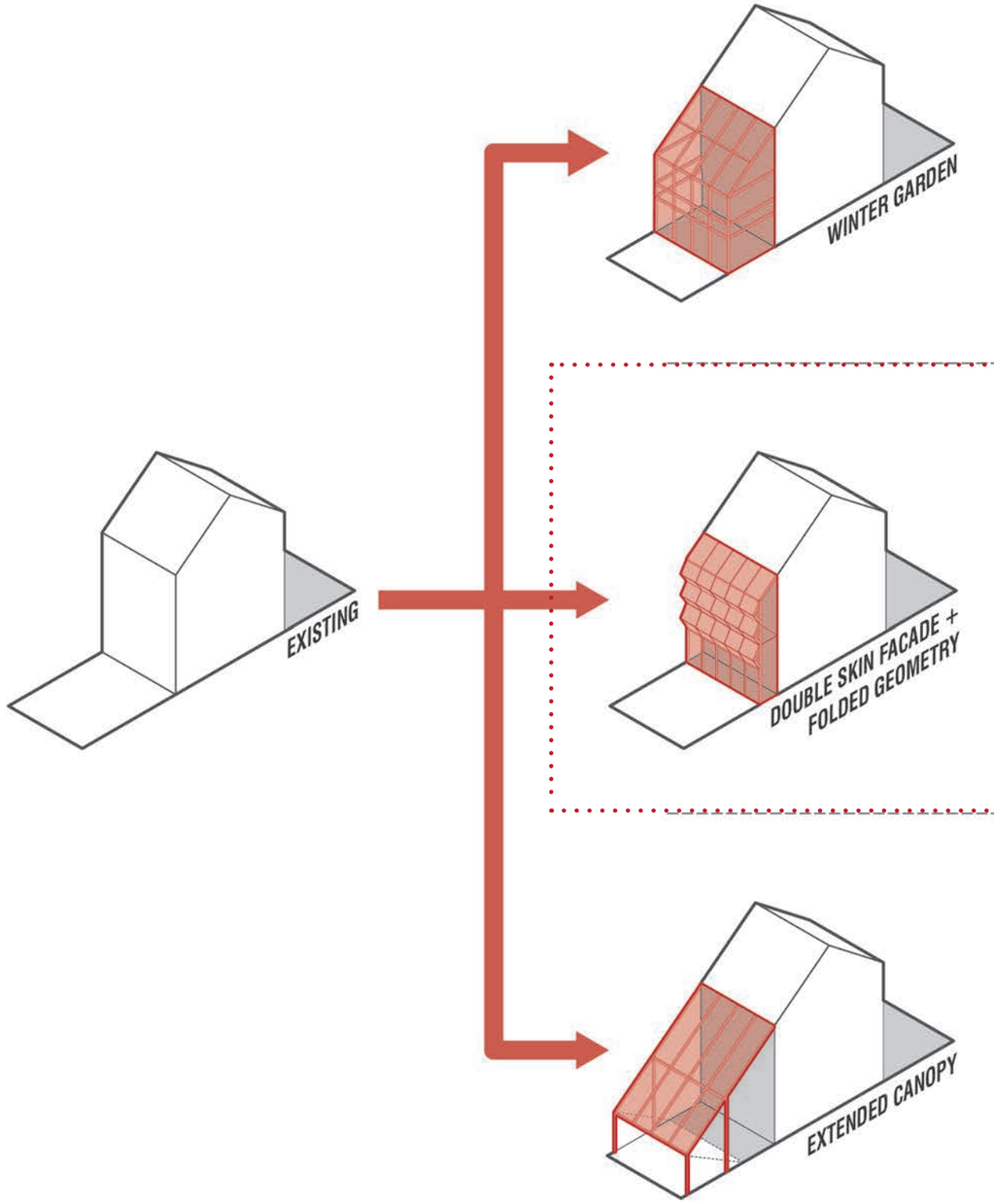
DESIGN CASE: RIJSENHOUT



DESIGN CASE: RIJSENHOUT

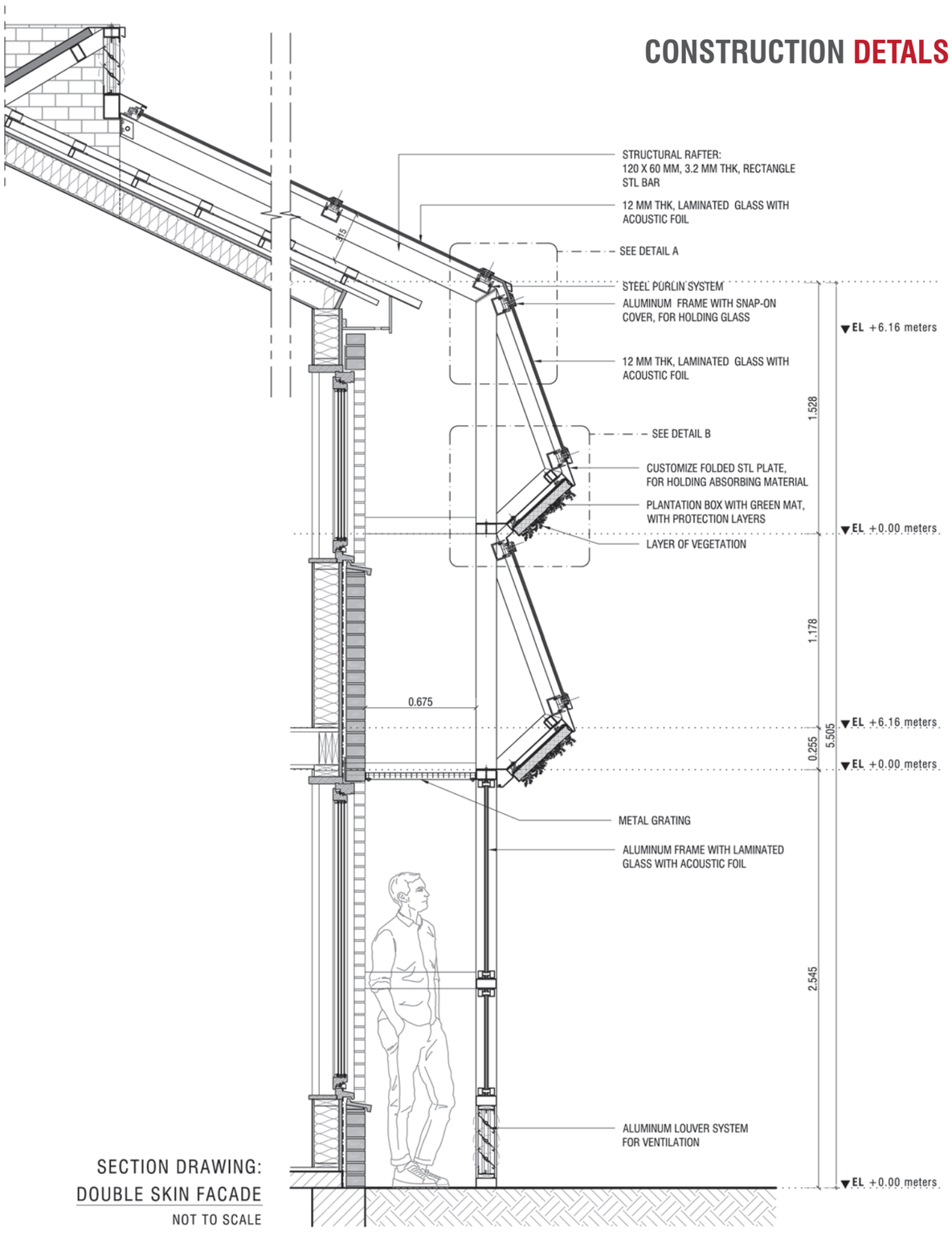


DESIGN CASE: RIJSENHOUT

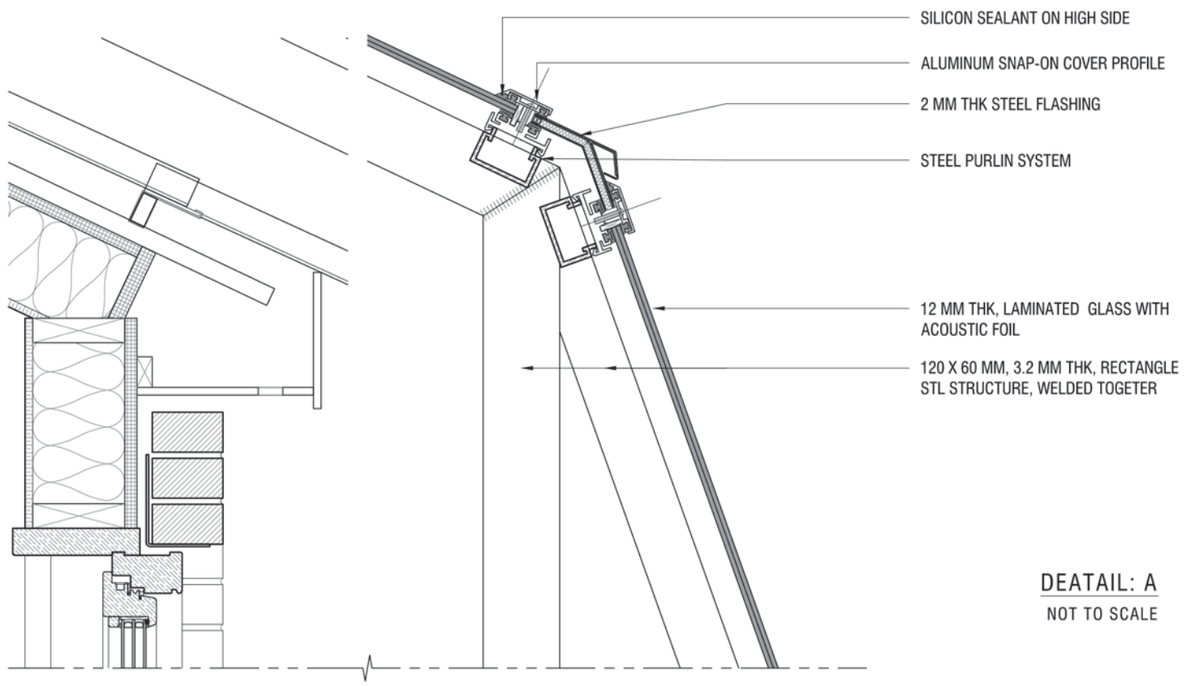


	ADVANTAGES:	DISADVANTAGES:
WINTER GARDEN	• Improve indoor sound insulation • Imporve thermal insulation [in winter] • Possible integration: Green roof / PV-cell • Extra semi-outdoor space	• Overheat [in summer] • Sound insulation depend on opening size • Construction area
DOUBLE SKIN FACADE + FOLDED GEOMETRY	• Improved outdoor and indoor acoutic environment • Improve thermal insulation and ventilation system • Possible integration: Green wall / PV-cell • Requried less space to build	• Overheat [in summer] • Sound insulation depend on opening size
EXTENDED CANOPY	• Improved sound impact on both outdoor and indoor • Provide outdoor rain shelter • Possible integration: Green roof / Pv-cell / raincollection	• Lesser impact for indoor sound • Large space for constuction • Affordability

CONSTRUCTION DETALS

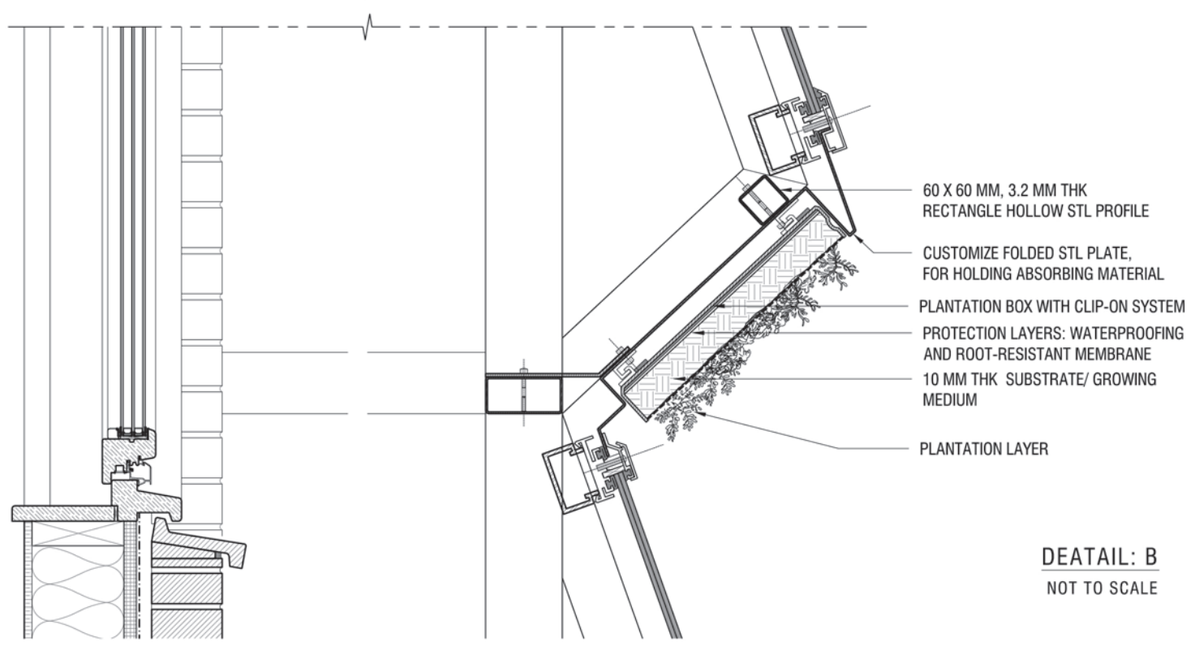


SECTION DRAWING:
DOUBLE SKIN FACADE
NOT TO SCALE



DEATAIL: A

NOT TO SCALE



DEATAIL: B

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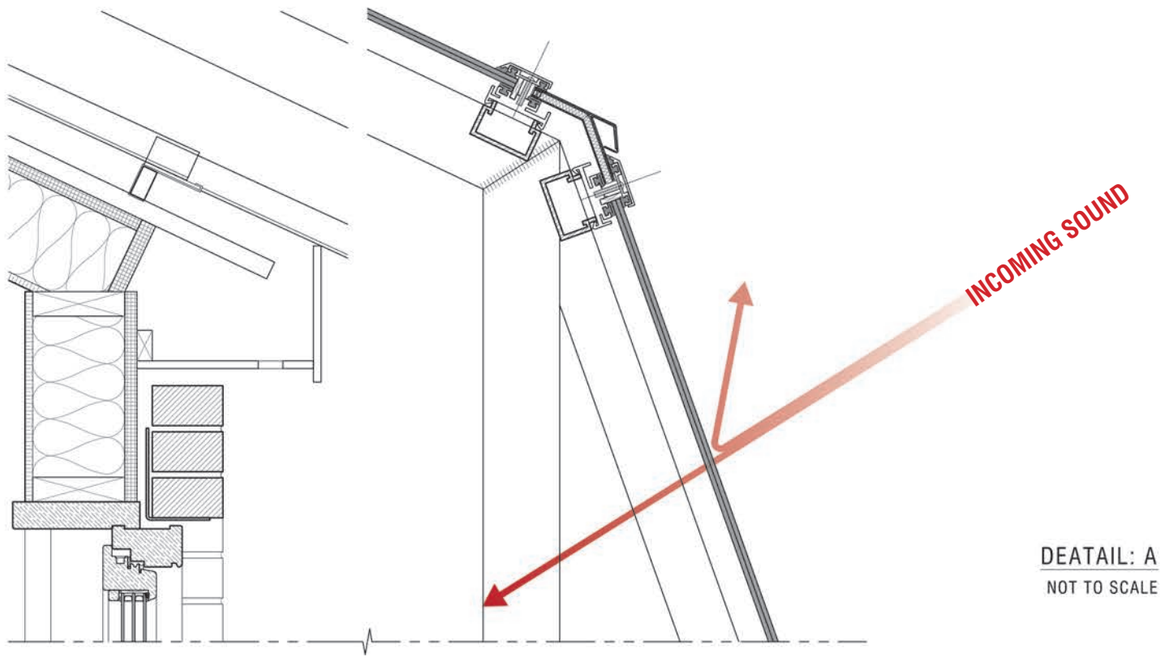
SCATTERING AND REDUCING THE REFLECITON OF SOUND TOWARD STREET



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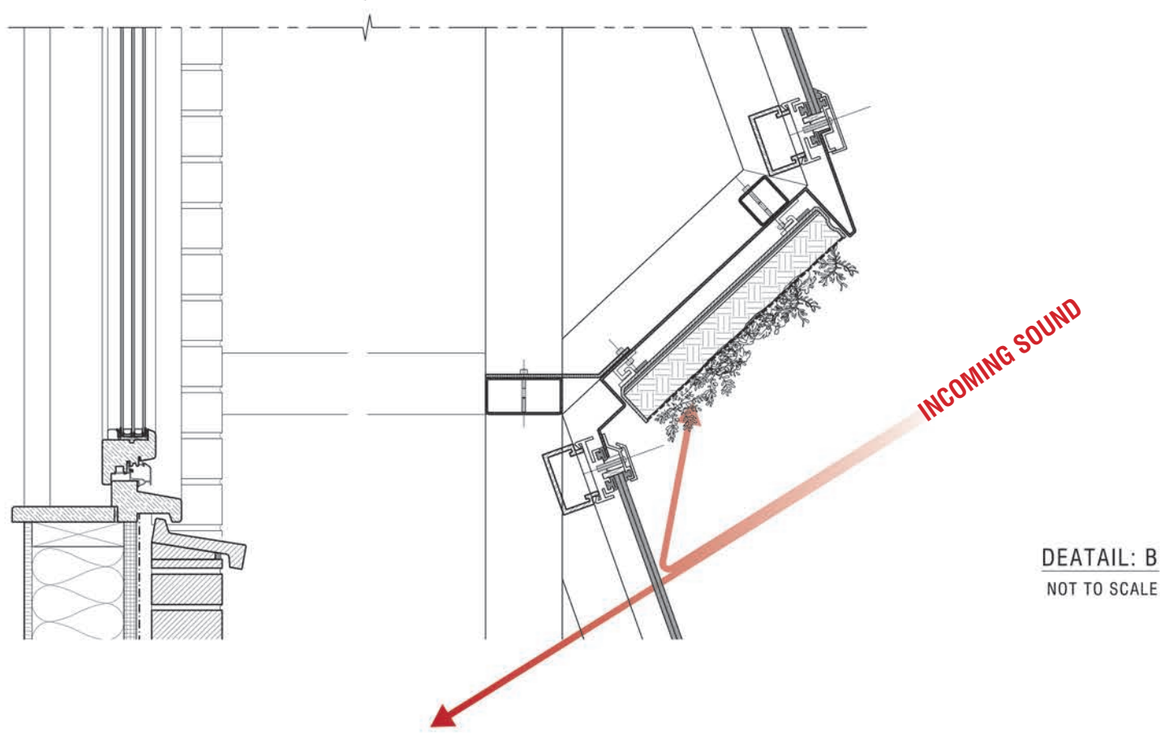

DEATAIL: B
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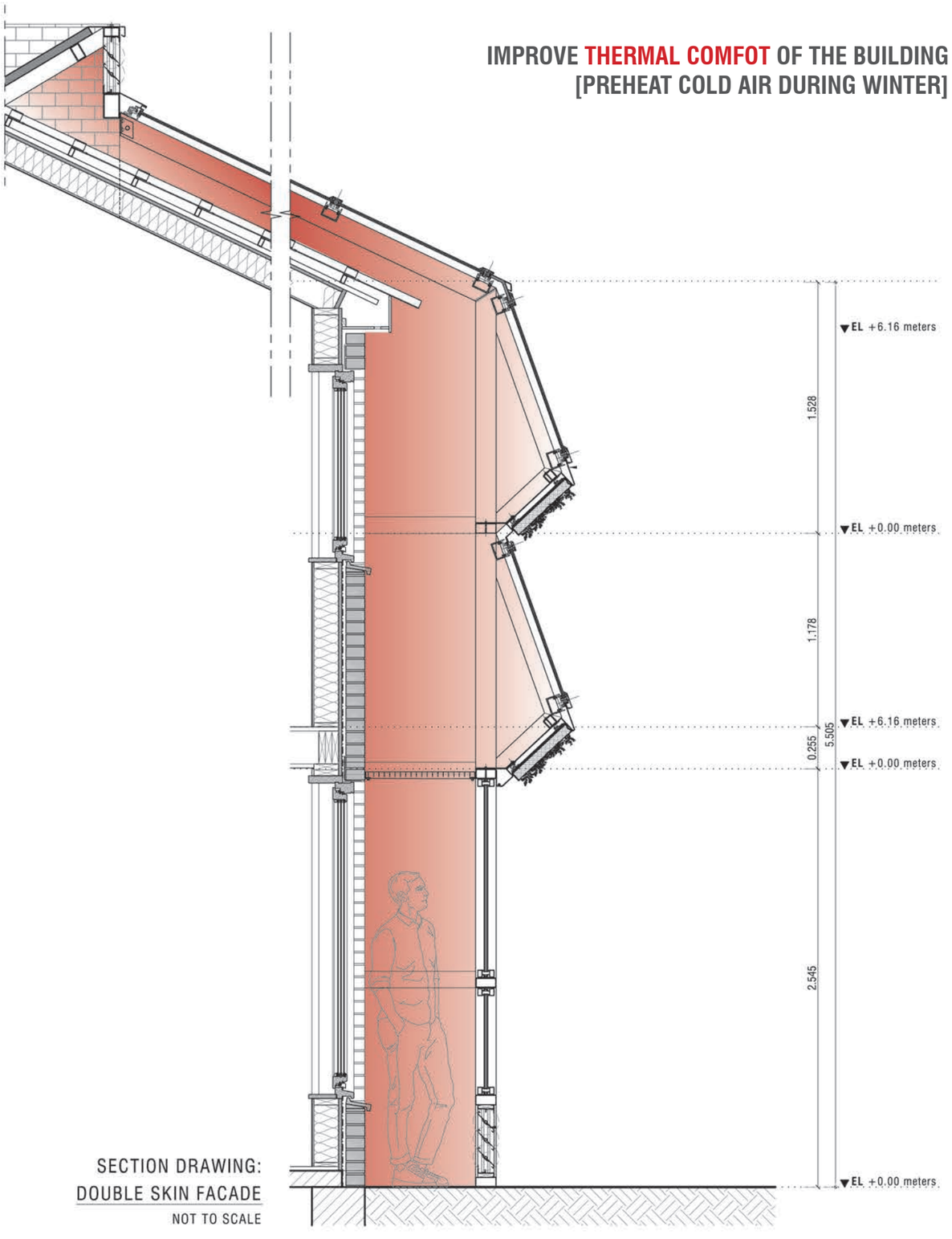
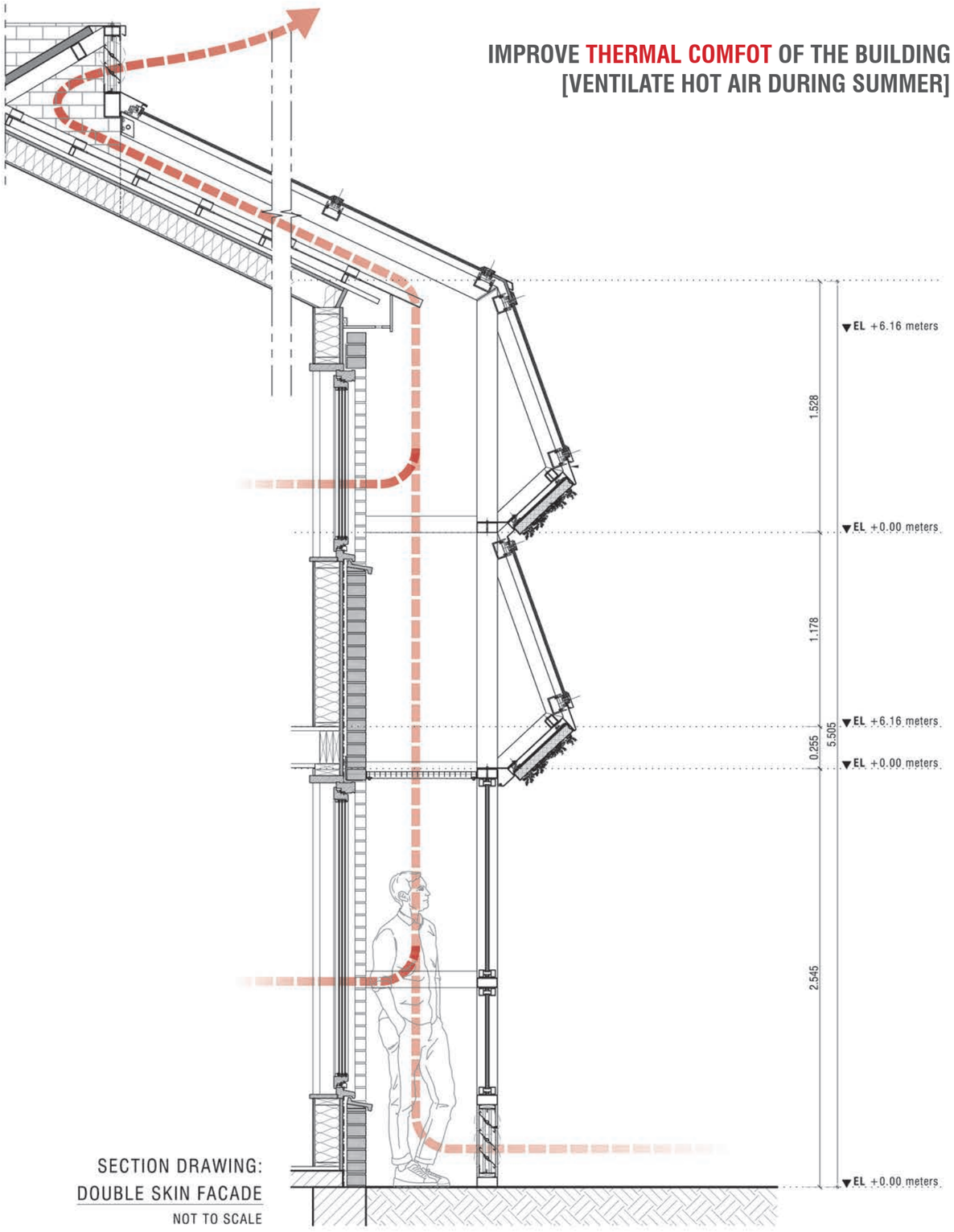
IMPROVE THERMAL COMFOT OF THE BUILDING
[PREHEAT COLD AIR DURING WINTER]



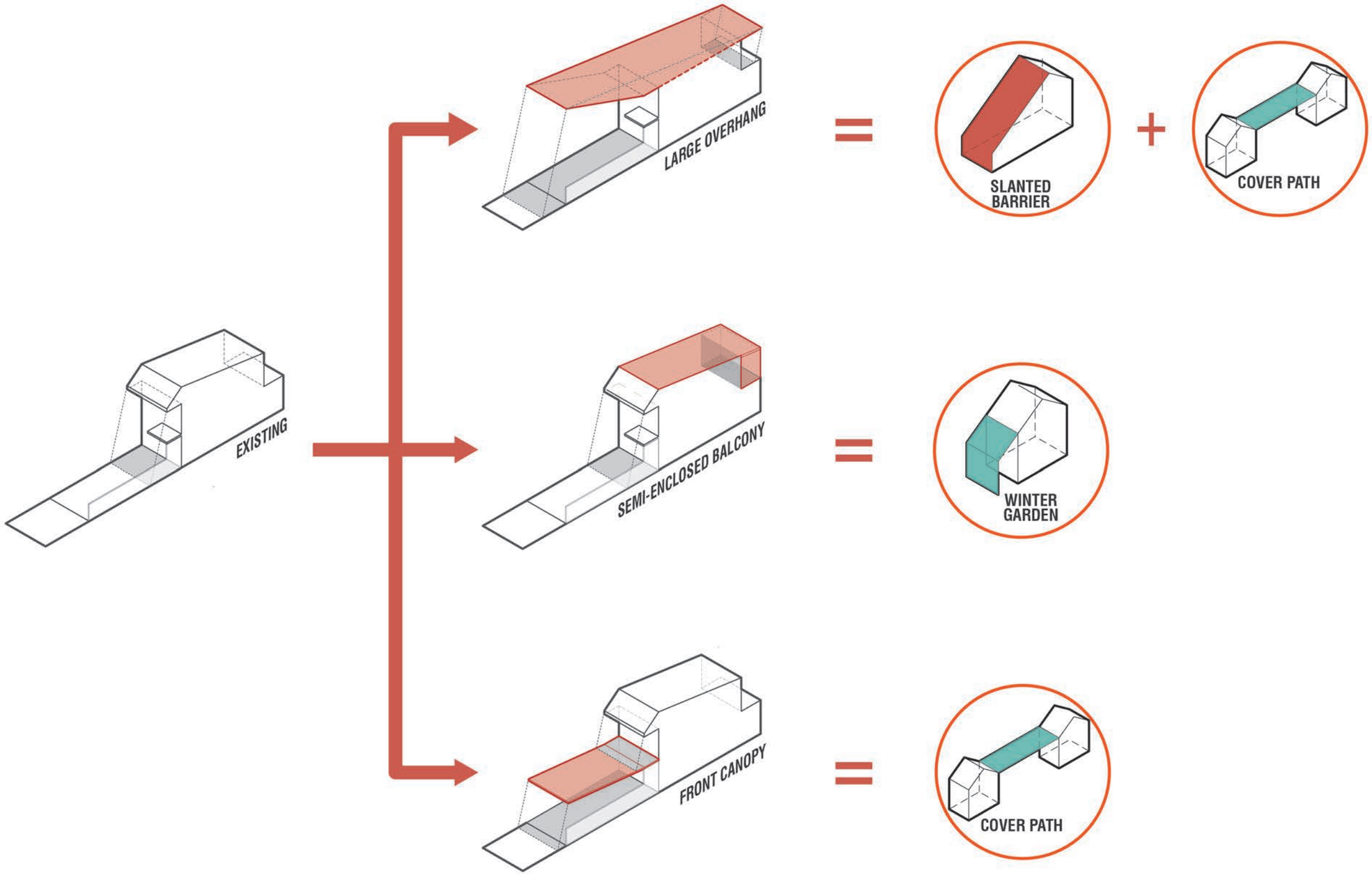
SECTION DRAWING:
DOUBLE SKIN FACADE
NOT TO SCALE

IMPROVE THERMAL COMFOT OF THE BUILDING
[VENTILATE HOT AIR DURING SUMMER]

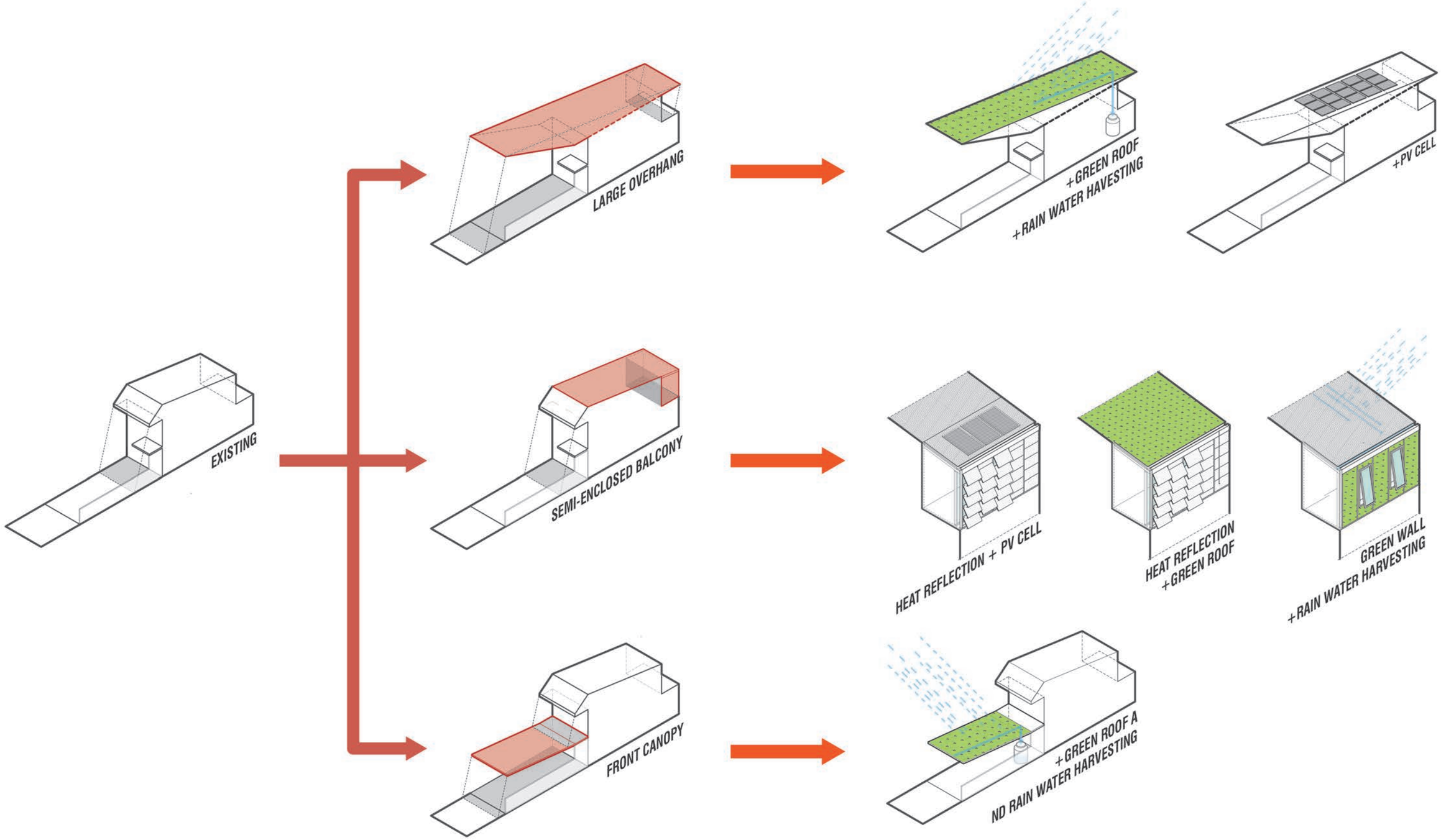


SECTION DRAWING:
DOUBLE SKIN FACADE
NOT TO SCALE

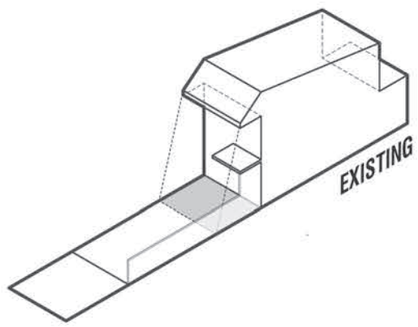
DESIGN CASE: **BANGKOK**

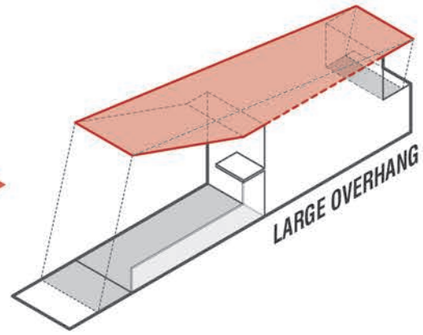


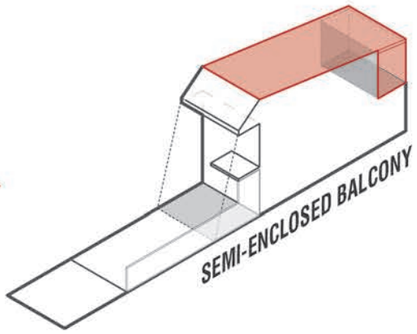
DESIGN CASE: BANGKOK

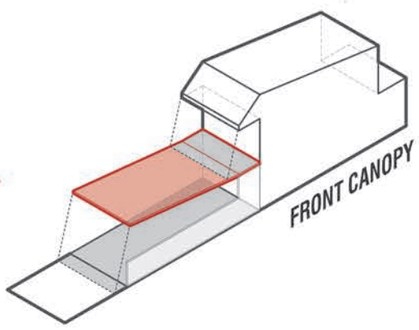


DESIGN CASE: BANGKOK



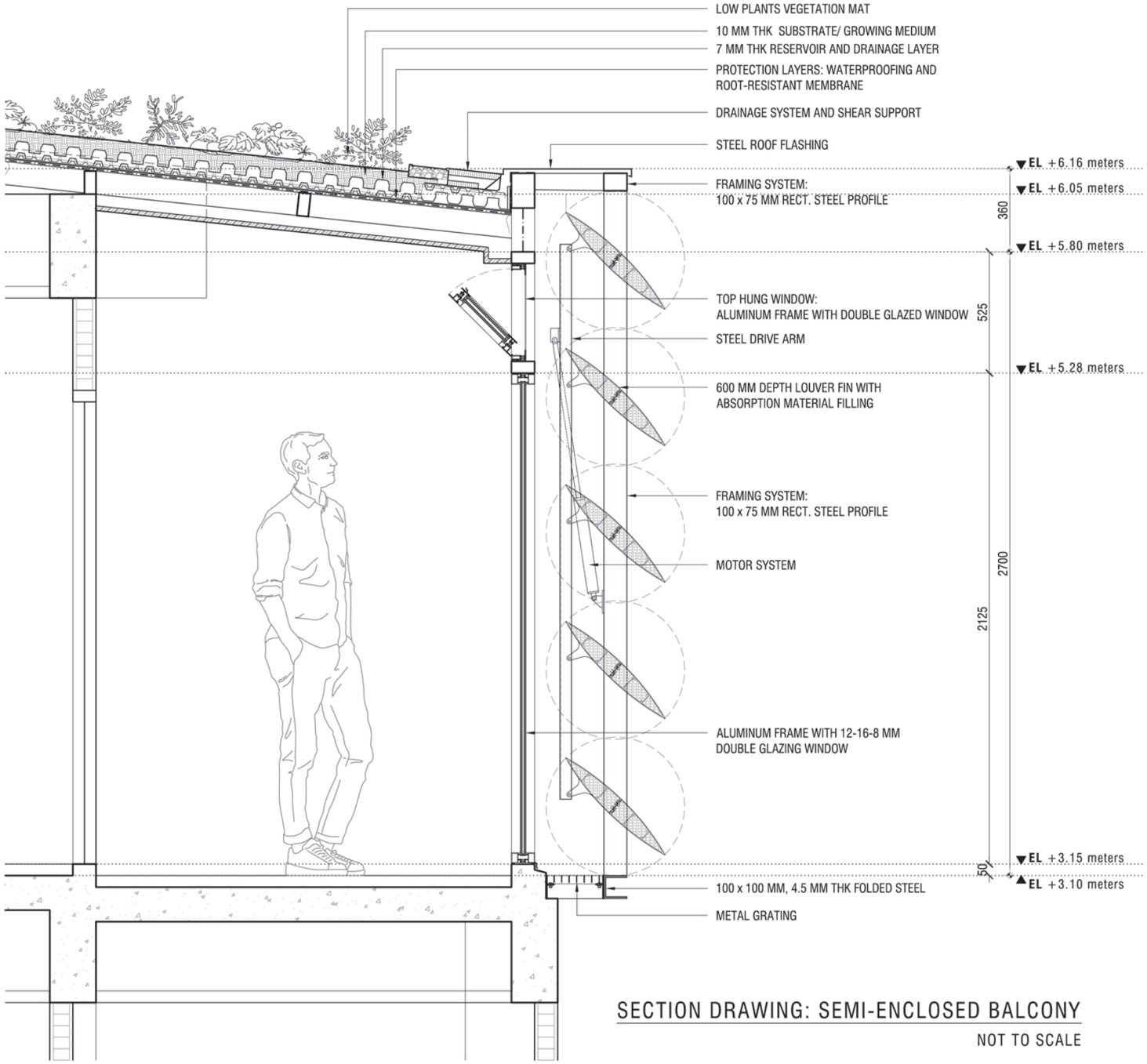






	ADVANTAGES:	DISADVANTAGES:
LARGE OVERHANG	• Improved outdoor and indoor sound • Provide outdoor shading • Possible integration: Green roof/ PV-cell/ rainwater collection	• Affordability • Need to be applied in large scale
SEMI-ENCLOSED BALCONY	• Improved indoor sound • Extra floor area • More Affordable • Possible integration: Green facade / PV-cell/ rainwater collection	• Sound insulation depend on opening size
FRONT CANOPY	• Improved outdoor sound environment • Provide outdoor shading • Possible integration: Green roof/ Rainwater collection	• Less effective for indoor noise • Need to be applied in large scale

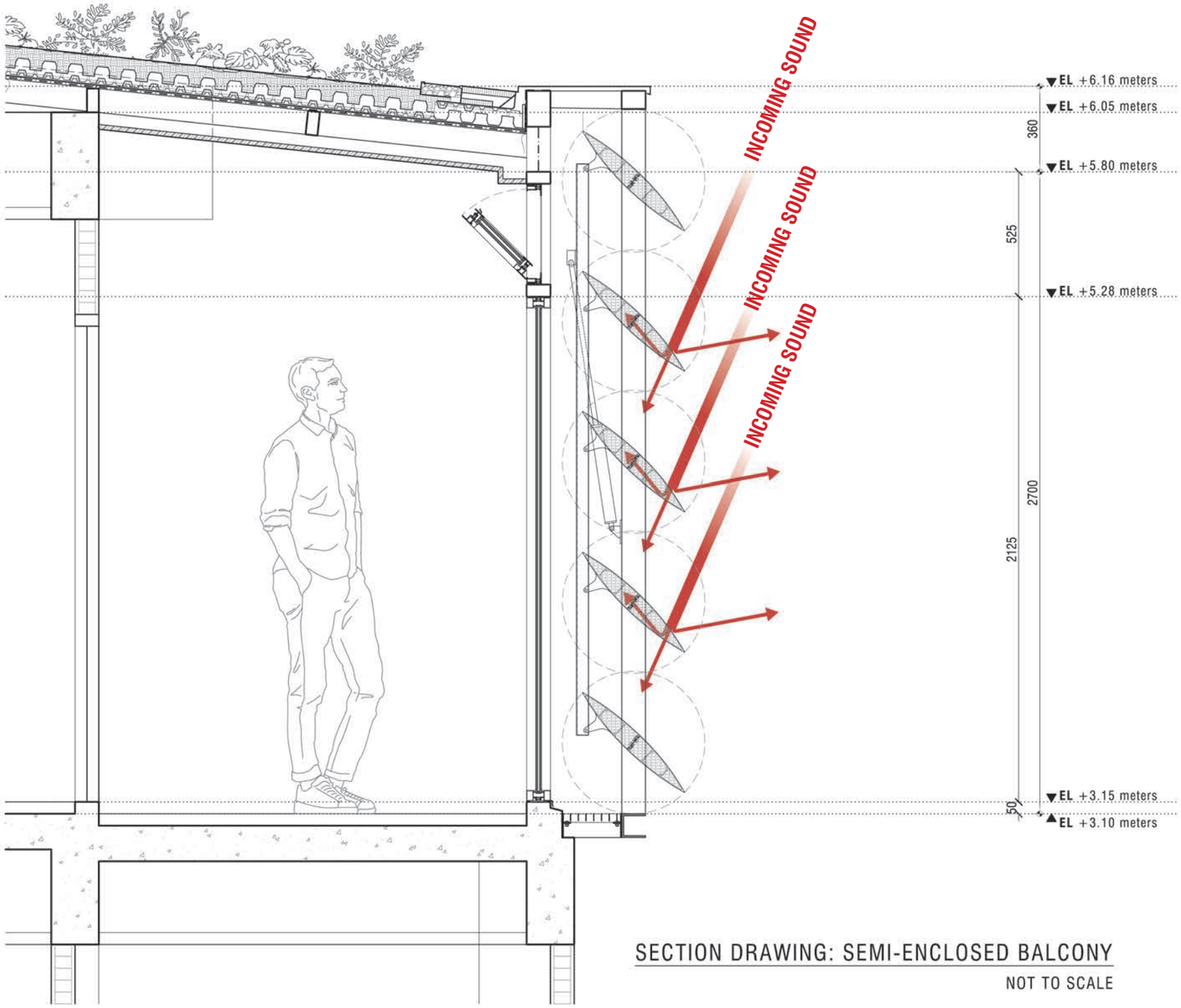
CONSTRUCTION DETALS



SECTION DRAWING: SEMI-ENCLOSED BALCONY

NOT TO SCALE

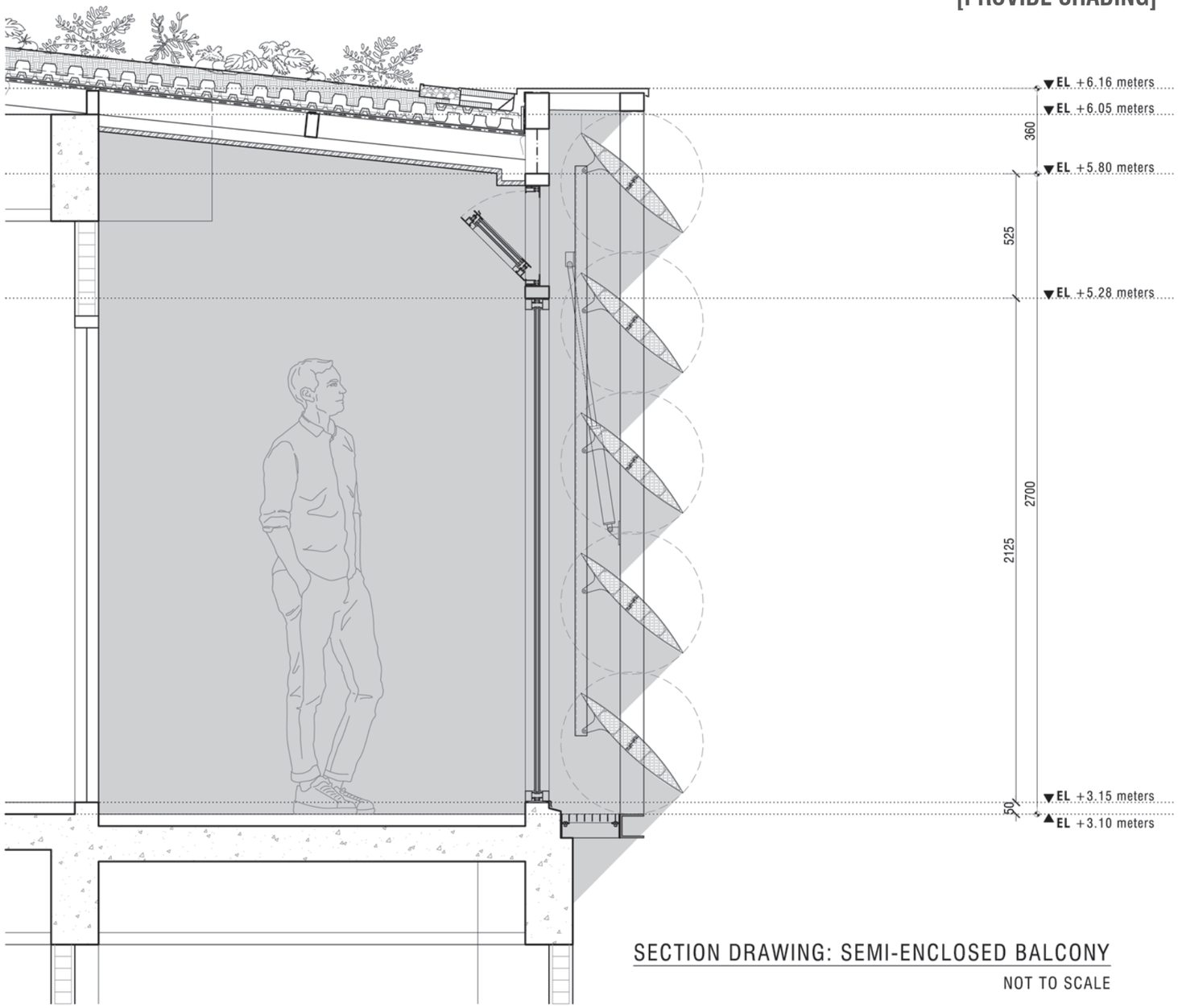
SCATTERING AND REDUCING AND ABSORBING SOUND TOWARD STREET



SECTION DRAWING: SEMI-ENCLOSED BALCONY

NOT TO SCALE

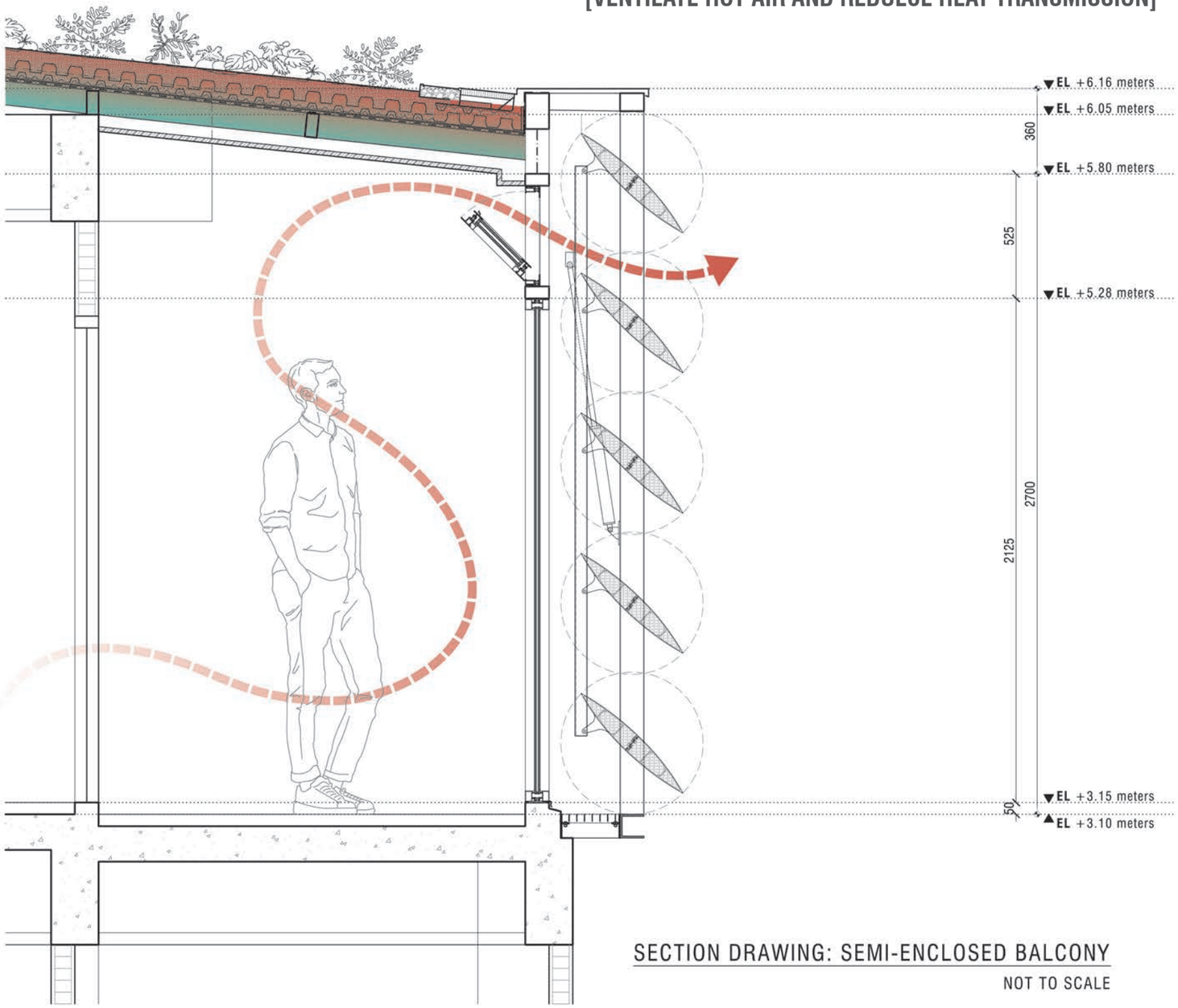
IMPROVE THERMAL COMFOT OF THE BUILDING [PROVIDE SHADING]



SECTION DRAWING: SEMI-ENCLOSED BALCONY

NOT TO SCALE

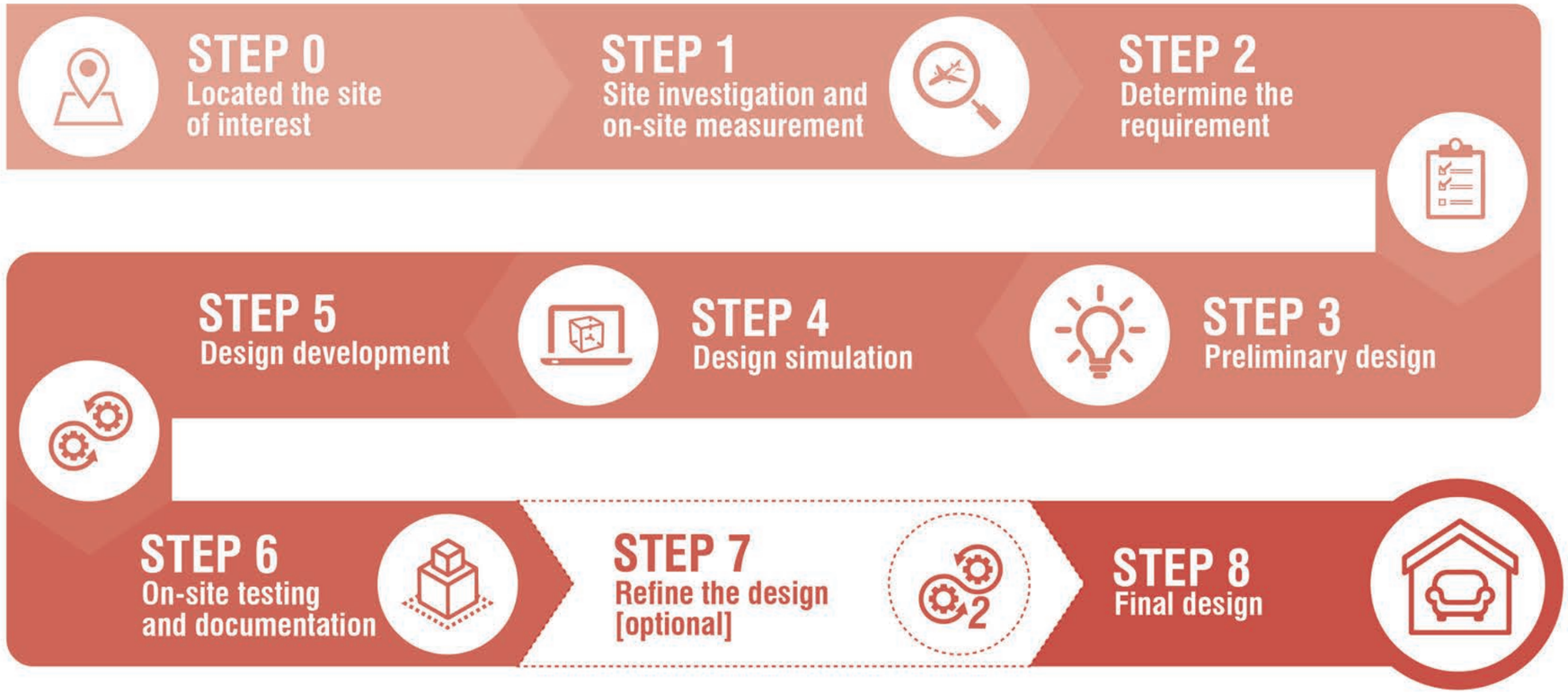
IMPROVE THERMAL COMFOT OF THE BUILDING
[VENTILATE HOT AIR AND REDUECE HEAT TRANSMISSION]



SECTION DRAWING: SEMI-ENCLOSED BALCONY

NOT TO SCALE

8 STPES FOR DESIGNING IN AIRPORT REGION



RESEARCH LIMITATION

- COMPATABILITY OF THE SIMULATION PROGRAMS
- LIMITED AVIALABLE DATA AND HUMAN ERROR
- LIMITED TIME CONSTRAINT
- FARMILARITY TO THE SUBJECT