

# Atelier Ten – Daylight Case Studies

Radiance Workshop 2013

Golden, CO



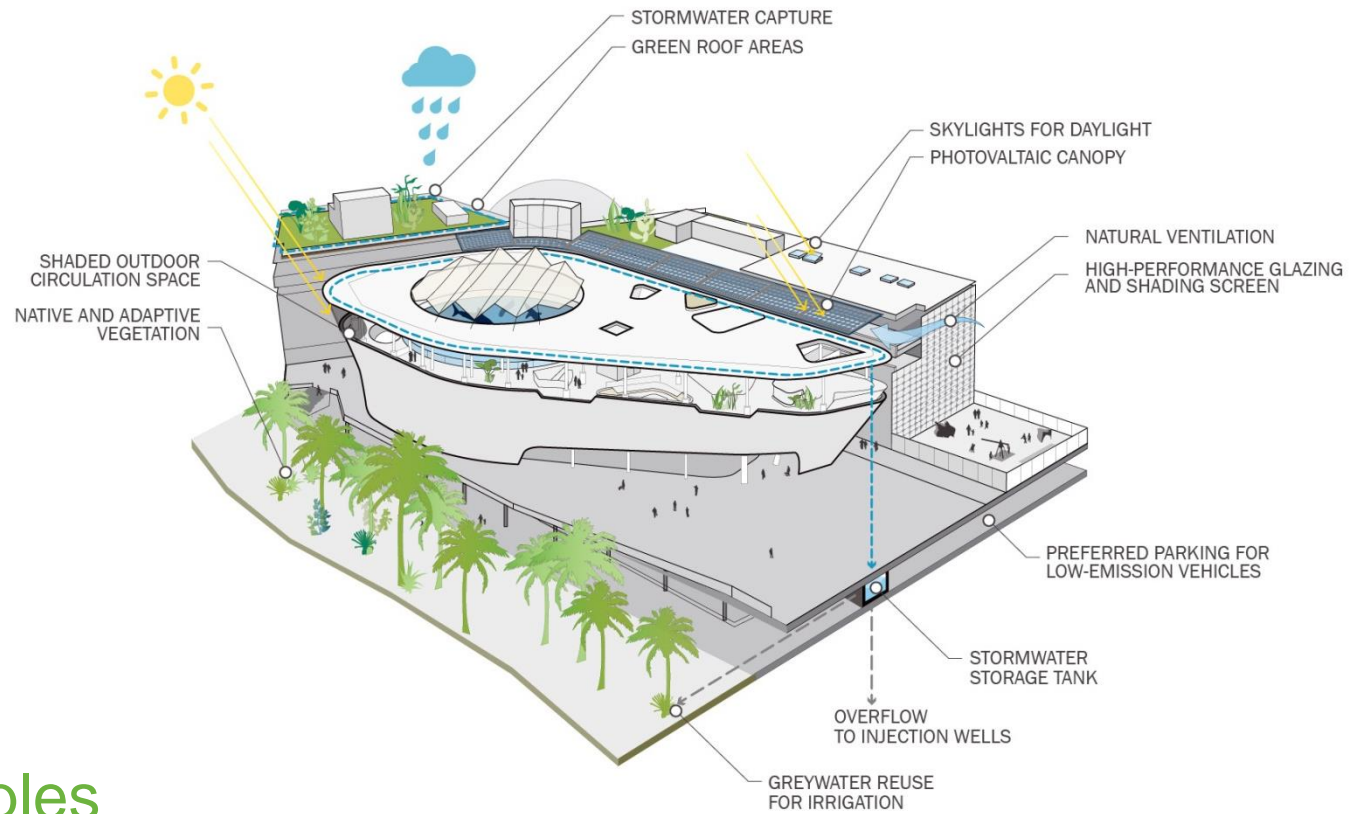
Jessica Zofchak

Senior Environmental Designer



## A legacy of positive change

We are an international team of environmental design consultants and lighting designers focused on delivering sustainability to the planned and built environment.

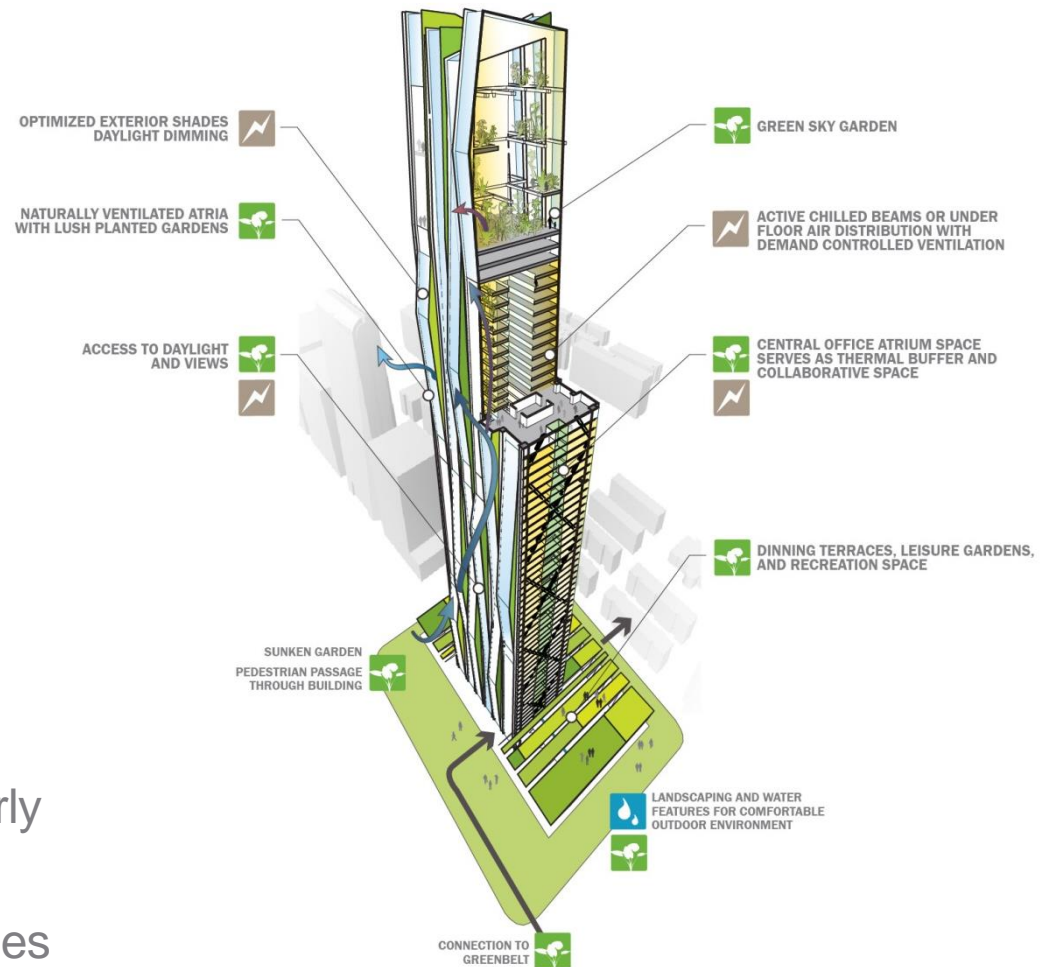


## Practice Principles

- Buildings and landscapes do more, systems do less
- Design from first principles
- Integrated design process and solutions
- Pragmatic strategies

## Strategy

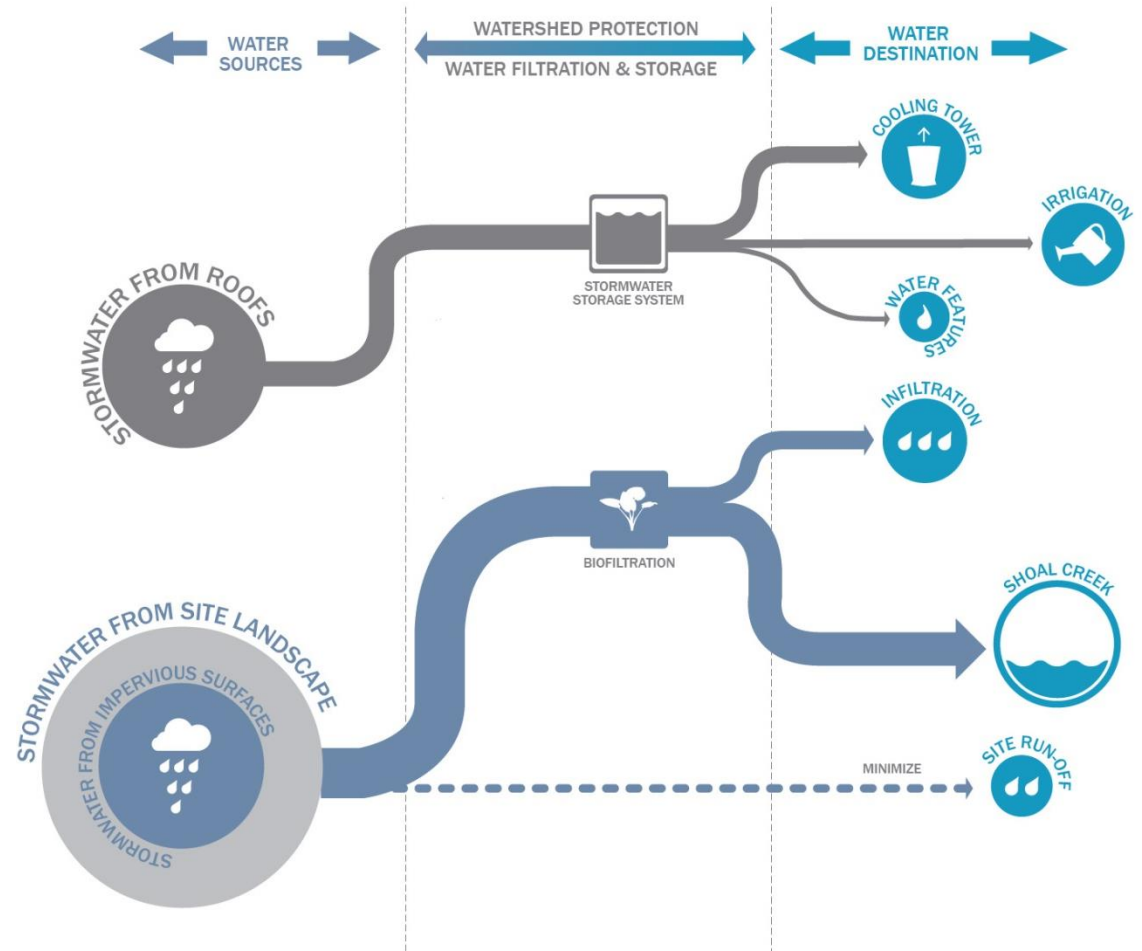
- Establish sustainability goals early
- Set performance targets
- Develop and test design strategies
- Select technologies to support strategies
- Monitor progress against benchmarks



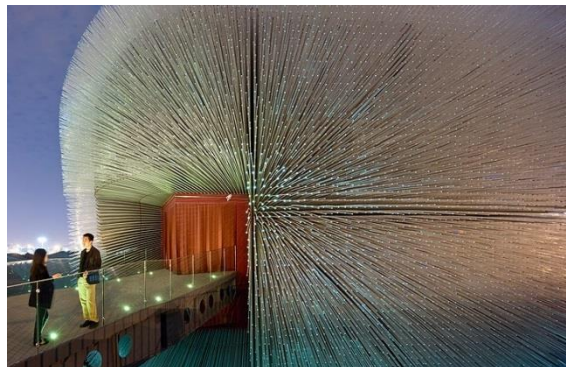


## Services

- Environmental Design
- Energy Analysis
- Lighting Design
- Masterplanning
- Benchmarking
- Carbon Management
- Façade Optimization



# High Performance Facades



# Case Studies

- Façade optimization using DIVA for Rhino and Grasshopper
- Daylight design for vegetation

## Façade Optimization – MSKCC/CUNY



# Urban Context Façade Optimization



## **Project Team:**

Architect: Ennead Architects

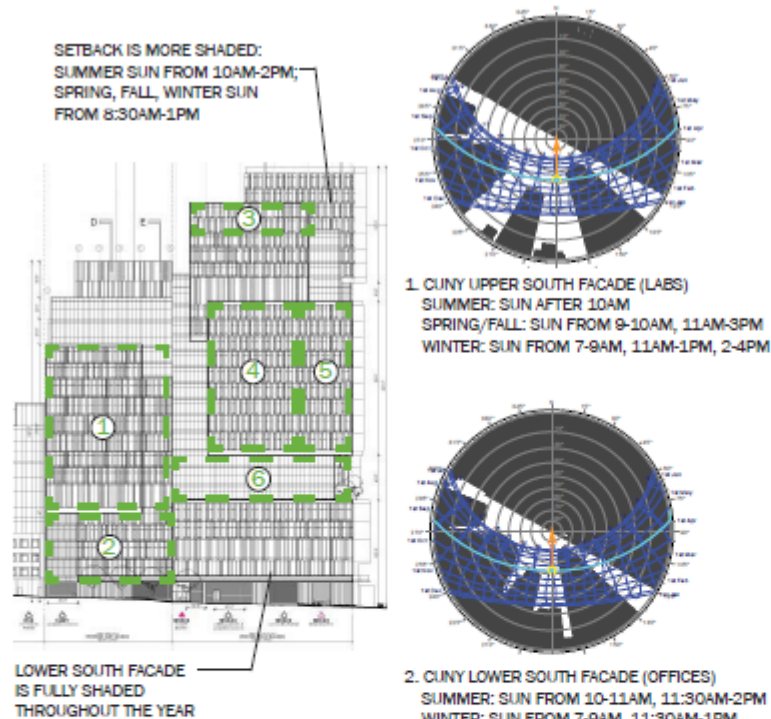
Envelope Consultant: Heintges

Environmental Consultant: Atelier Ten

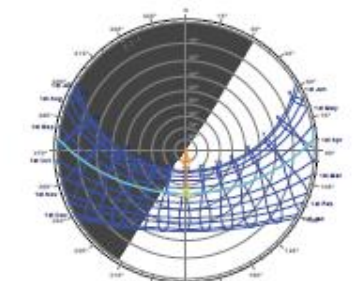
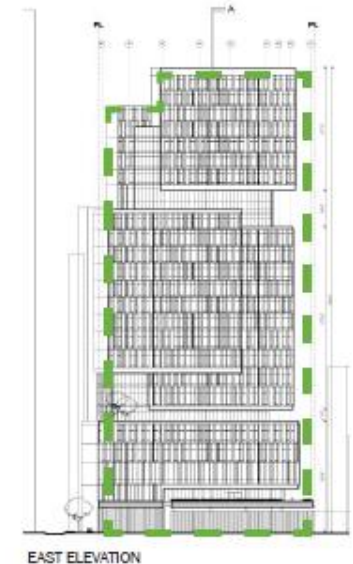
Mechanical Engineer: JB&B

# Overshadowing

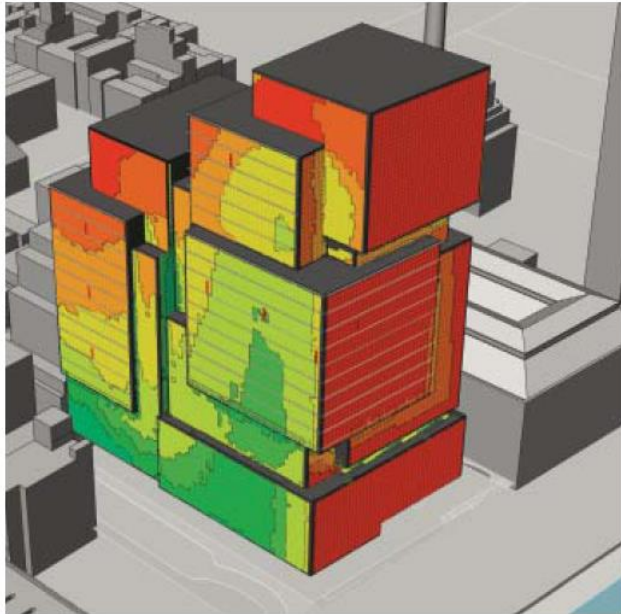
## South Facade



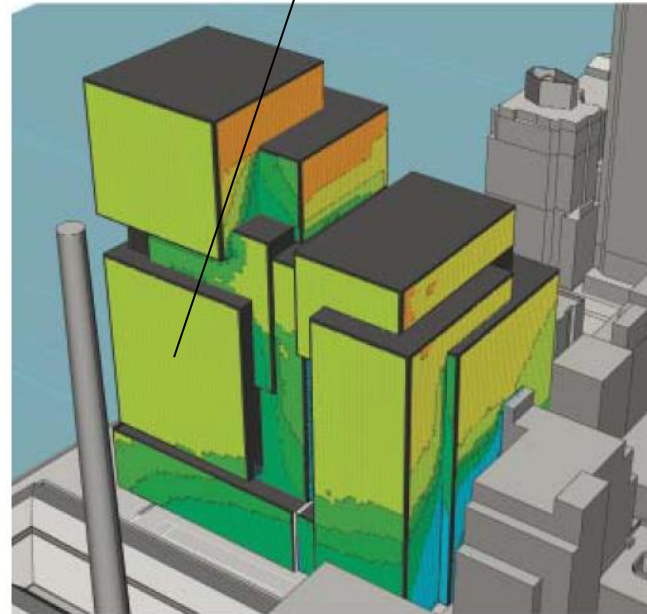
## East Facade



# Solar Insolation Bands (100 kWh/m<sup>2</sup> increments)



SOUTH AND EAST FACADE SOLAR RADIATION ZONES



NORTH AND WEST FACADE SOLAR RADIATION ZONES

North façade used as target  
solar radiation level

Annual Radiation  
(kWh/m<sup>2</sup>)

900-1000

800-900

700-800

600-700

500-600

400-500

300-400

200-300

100-200

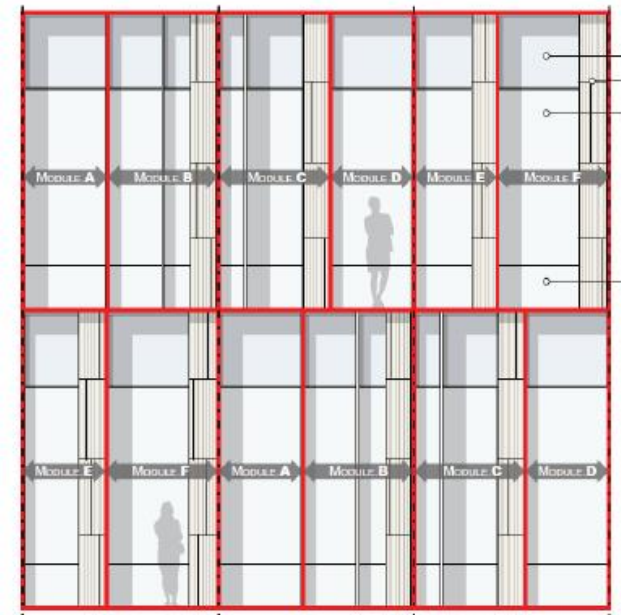
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# Curtain Wall System



RENDERING OF MODULES - SYSTEM 1A-V55



DEPLOYMENT OF VARIOUS PANEL WIDTHS ACROSS A MODULE - SYSTEM 1A-V55

Glass lite widths:

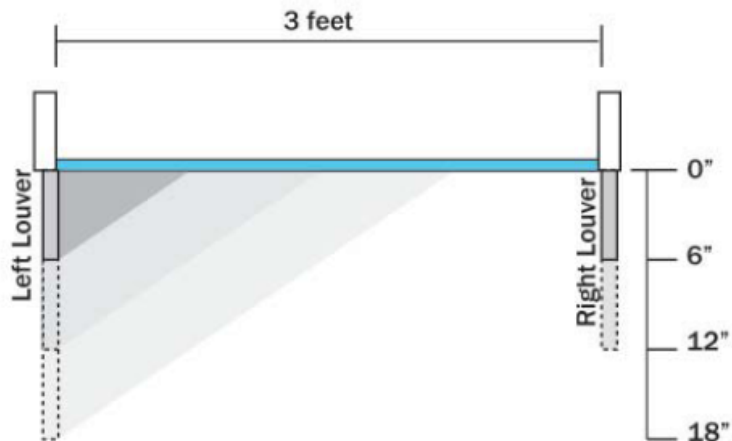
1'-6"

3'-0"

4'-6"



# External Shading Studies



GLAZING PANEL ANALYZED (PLAN VIEW)

600-700 kWh/m <sup>2</sup> <b>3</b>		Left Fin Depth			
		0 Inch	6 Inch	12 Inch	18 Inch
Right Fin Depth	0 Inch	636	607	592	574
	6 Inch	612	600	574	552
	12 Inch	621	588	571	549

700-800 kWh/m <sup>2</sup> <b>4</b>		Left Fin Depth			
		0 Inch	6 Inch	12 Inch	18 Inch
Right Fin Depth	0 Inch	726	651	606	554
	6 Inch	705	619	567	524
	12 Inch	665	595	552	503

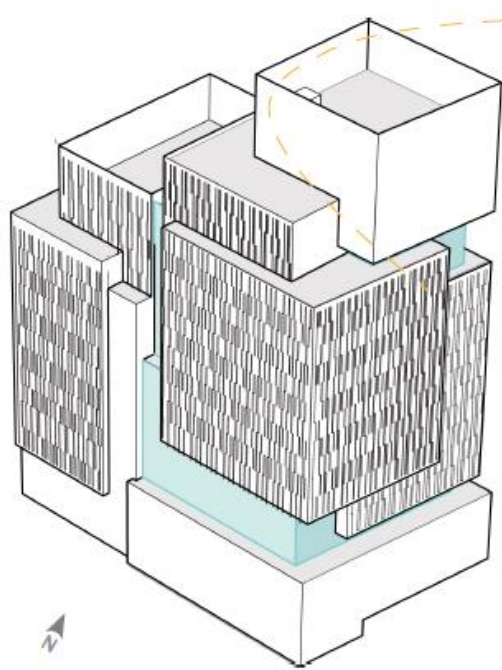
800-900 kWh/m <sup>2</sup> <b>1</b>		Left Fin Depth			
		0 Inch	6 Inch	12 Inch	18 Inch
Right Fin Depth	0 Inch	823	783	746	706
	6 Inch	812	771	724	689
	12 Inch	812	757	714	679

600-700 kWh/m <sup>2</sup> <b>5</b>		Left Fin Depth			
		0 Inch	6 Inch	12 Inch	18 Inch
Right Fin Depth	0 Inch	601	555	492	450
	6 Inch	570	525	459	417
	12 Inch	547	507	443	400

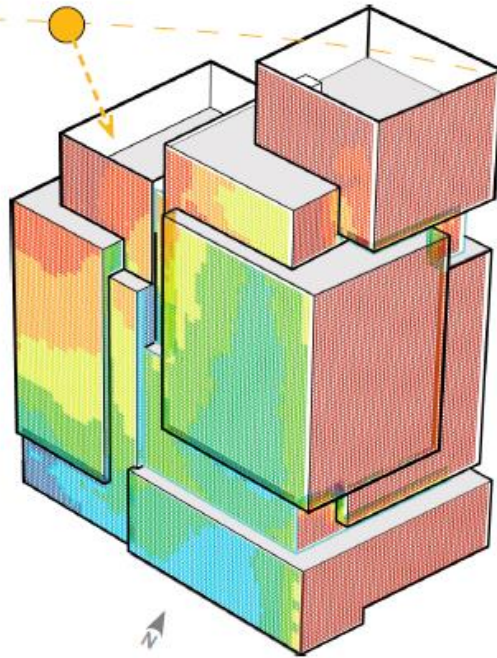


RECOMMENDED VERTICAL FIN DEPTH  
COMBINATIONS FOR LEFT AND RIGHT FINS

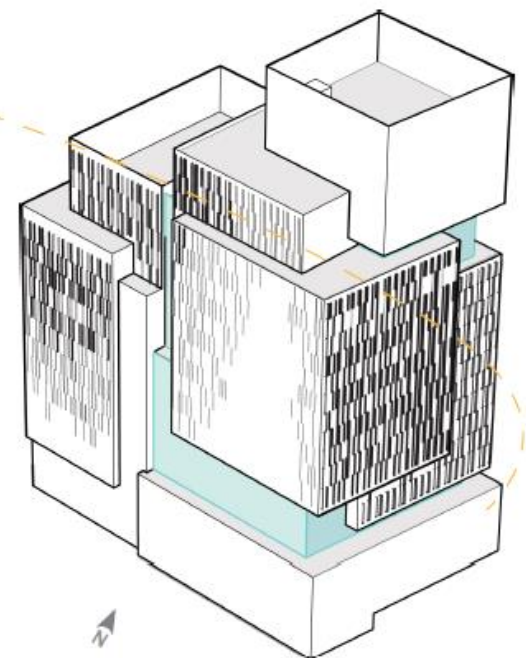
# Vertical Fin Application Diagram



Current Fin Design (12", 6" Fin Depth)

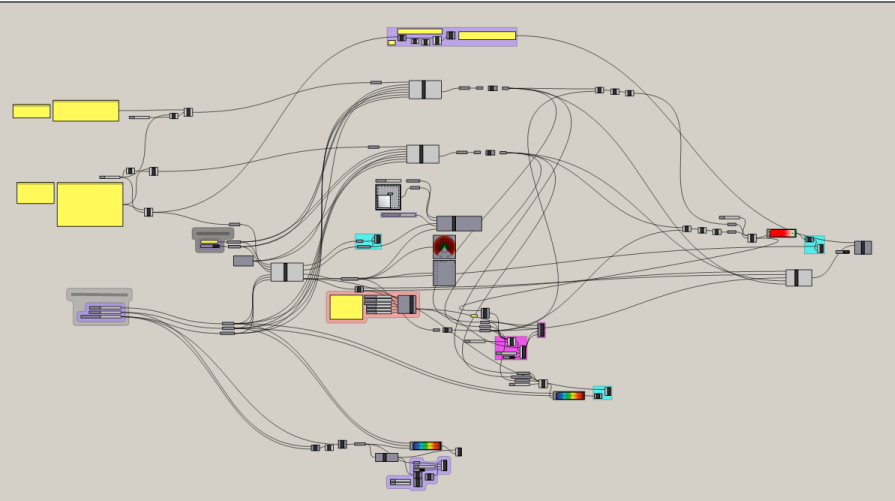


Annual Incident Solar Radiation Analysis



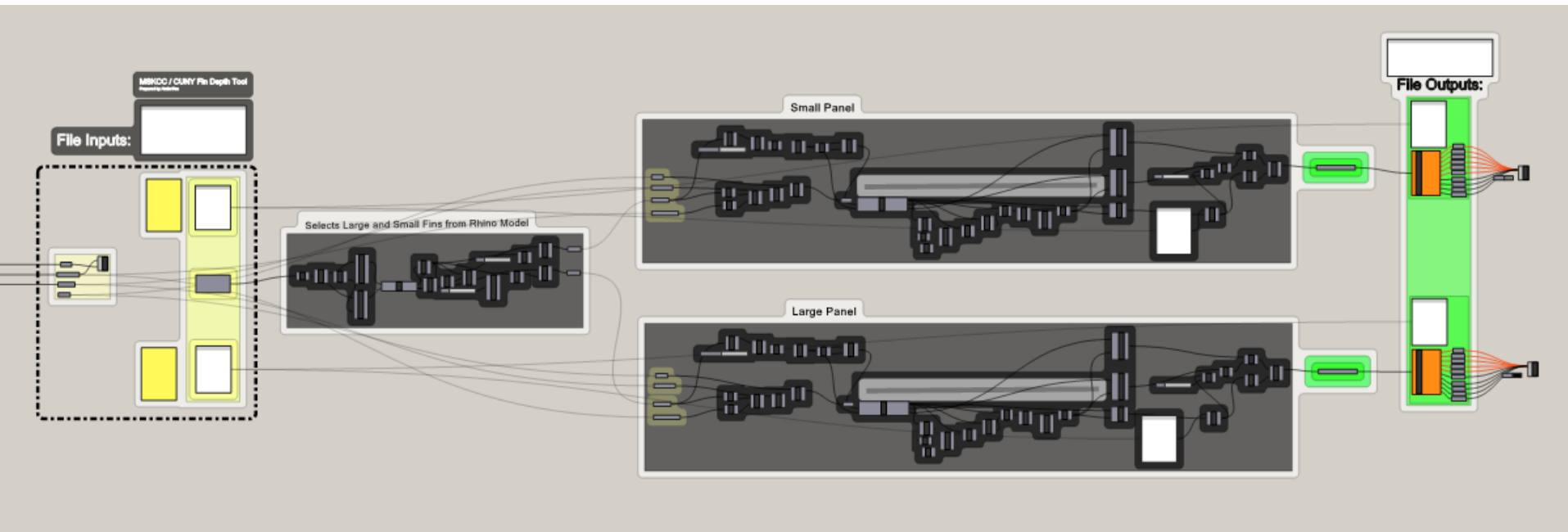
Proposed Fin Design (13.5", 10", 6", 4" Fin Depth)

# Grasshopper Process – Radiation Analysis



Key 1		Key 2		Key 3		Key 4		Key 5		Key 6		Key 7		Key 8		Key 9		Key 10		Key 11		Key 12		Key 13		Key 14		Key 15		Key 16		Key 17		Key 18		Key 19		Key 20		Key 21		Key 22		Key 23		Key 24		Key 25		Key 26		Key 27		Key 28		Key 29		Key 30		Key 31		Key 32		Key 33		Key 34		Key 35		Key 36		Key 37		Key 38		Key 39		Key 40		Key 41		Key 42		Key 43		Key 44		Key 45		Key 46		Key 47		Key 48		Key 49		Key 50		Key 51		Key 52		Key 53		Key 54		Key 55		Key 56		Key 57		Key 58		Key 59		Key 60		Key 61		Key 62		Key 63		Key 64		Key 65		Key 66		Key 67		Key 68		Key 69		Key 70		Key 71		Key 72		Key 73		Key 74		Key 75		Key 76		Key 77		Key 78		Key 79		Key 80		Key 81		Key 82		Key 83		Key 84		Key 85		Key 86		Key 87		Key 88		Key 89		Key 90		Key 91		Key 92		Key 93		Key 94		Key 95		Key 96		Key 97		Key 98		Key 99		Key 100		Key 101		Key 102		Key 103		Key 104		Key 105		Key 106		Key 107		Key 108		Key 109		Key 110		Key 111		Key 112		Key 113		Key 114		Key 115		Key 116		Key 117		Key 118		Key 119		Key 120		Key 121		Key 122		Key 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900		Key 901		Key 902		Key 903		Key 904		Key 905		Key 906		Key 907		Key 908		Key 909		Key 910		Key 911		Key 912		Key 913		Key 914		Key 915		Key 916		Key 917		Key 918		Key 919		Key 920		Key 921		Key 922		Key 923		Key 924		Key 925		Key 926		Key 927		Key 928		Key 929		Key 930		Key 931		Key 932		Key 933		Key 934		Key 935		Key 936		Key 937		Key 938		Key 939		Key 940		Key 941		Key 942		Key 943		Key 944		Key 945		Key 946		Key 947		Key 948		Key 949		Key 950		Key 951		Key 952		Key 953		Key 954		Key 955		Key 956		Key 957		Key 958		Key 959		Key 960		Key 9	
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# Grasshopper Process – Fin deployment



## Input

- Radiation data
- Fins
- Fin chart

## Output location

Grouping of  
existing fins

## Output processing

Grouping of fins  
based on solar  
radiation analysis

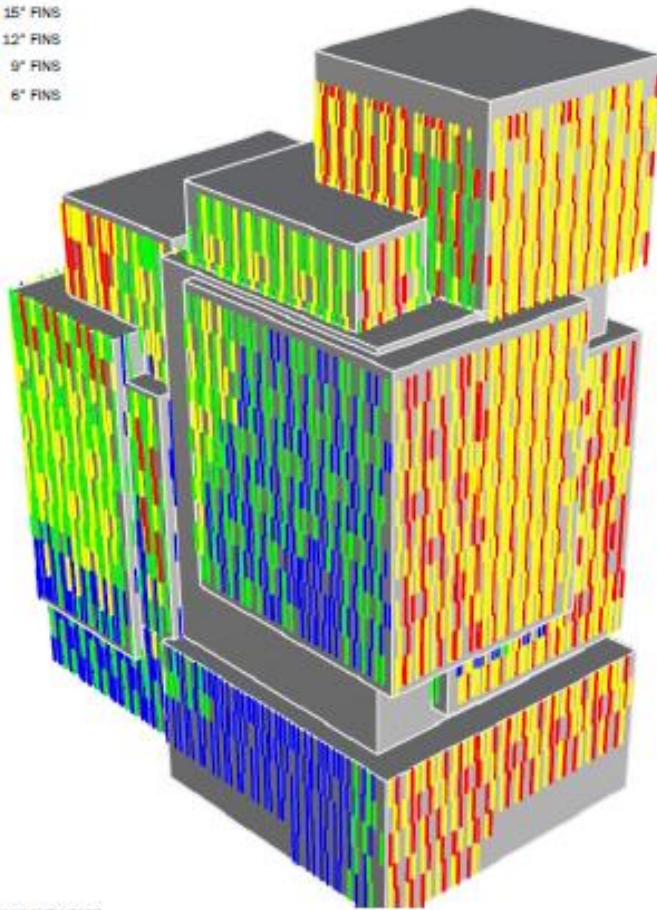
## Output

Fins in different  
layers according  
to radiation bands

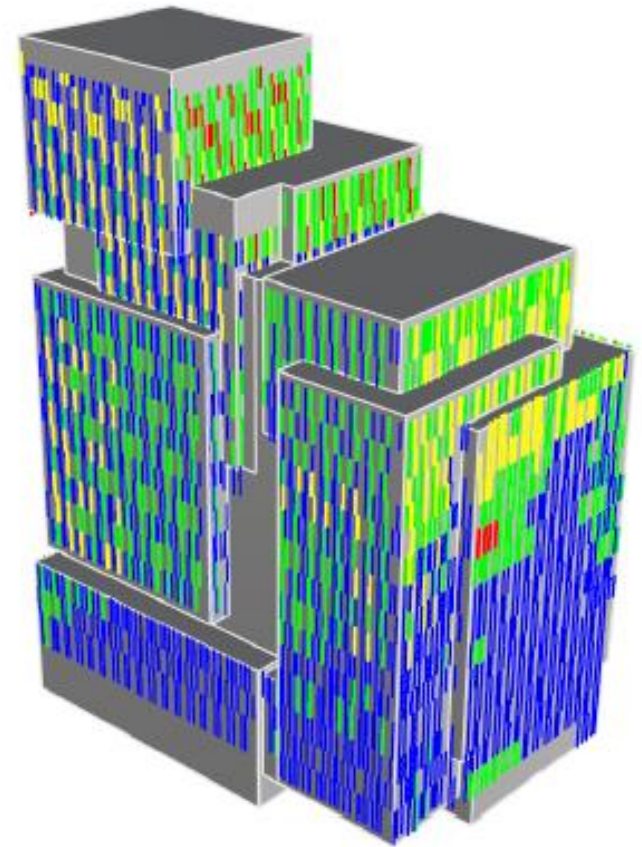


# Baseline – Recommendation Comparison

Analysis with recommended fin depth



VIEW FROM SOUTH EAST

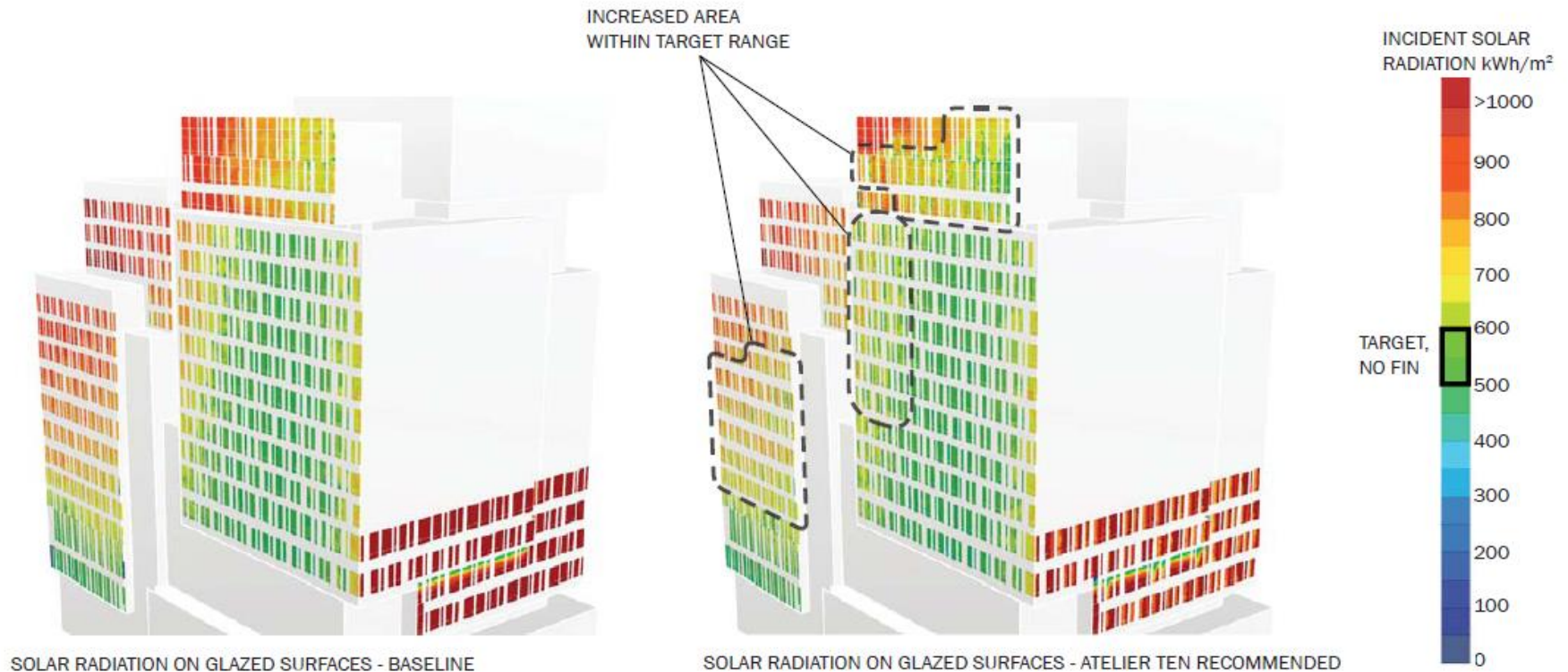


VIEW FROM NORTH

Incident Solar Radiation received by panel	Adjacent Glass Width		
	< 2'-0"	2'-0" - 4'-0"	> 4'-0"
> 900	12"	15"	15"
750 - 899	9"	12"	15"
600 - 749	9"	12"	15"
450 - 599	6"	9"	12"
< 450	6"	6"	9"

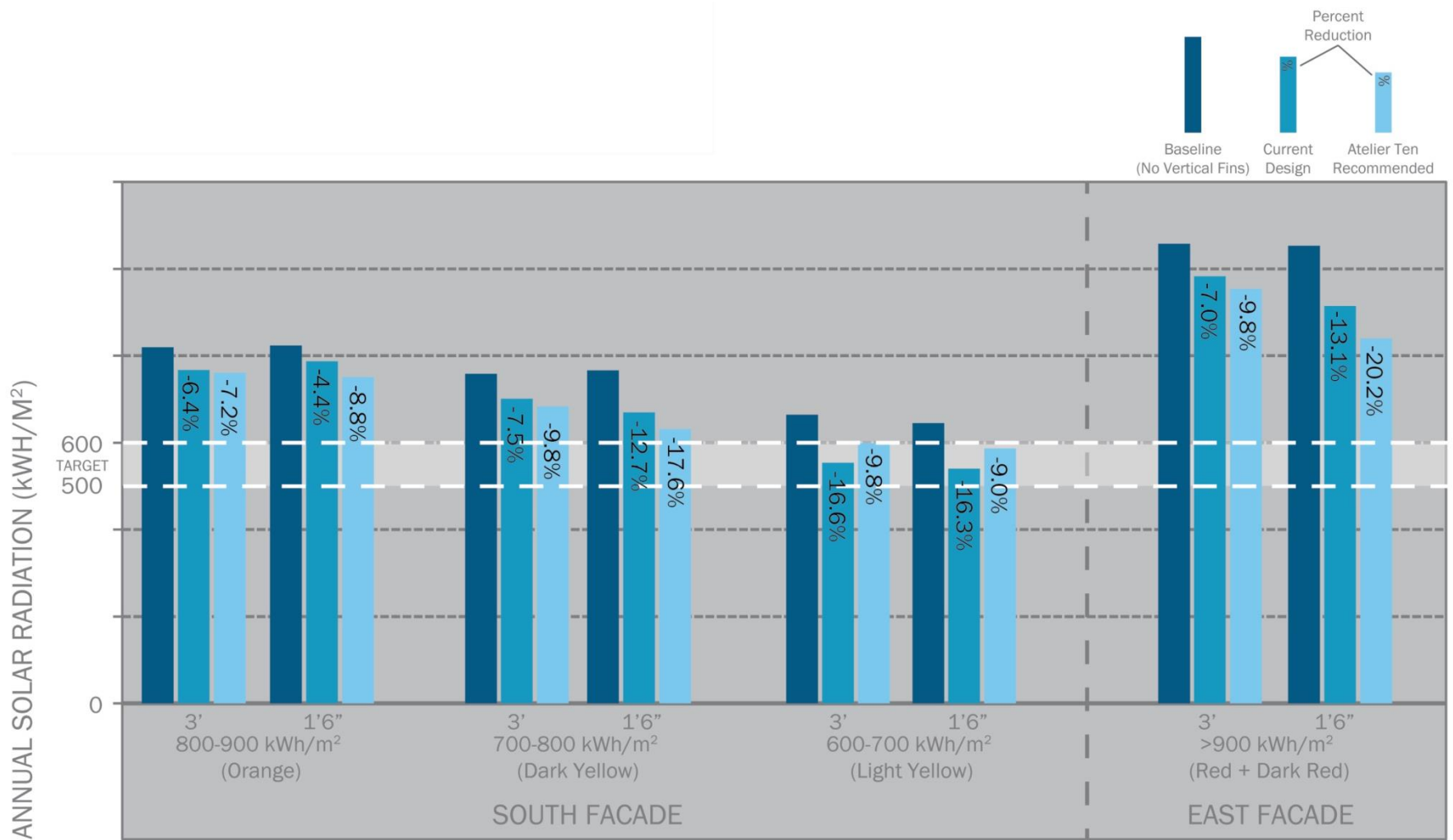
# Baseline – Recommendation Comparison

Analysis with recommended fin depth



# Fin Optimization Summary

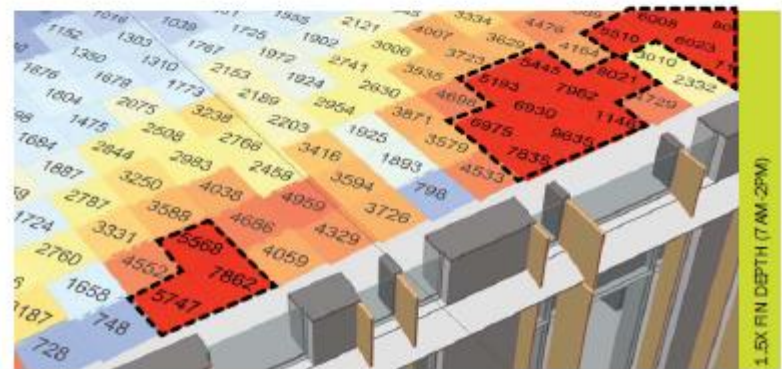
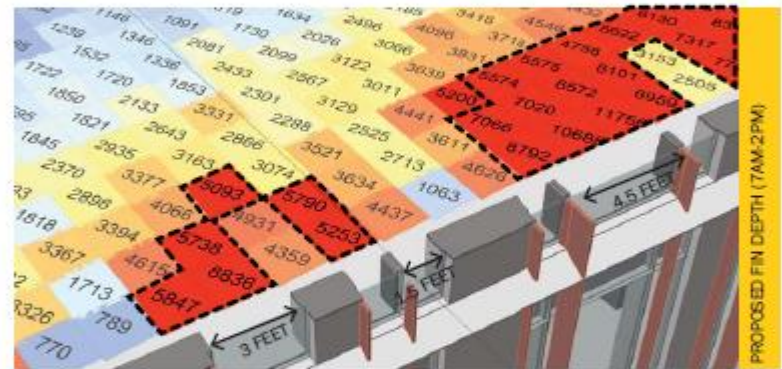
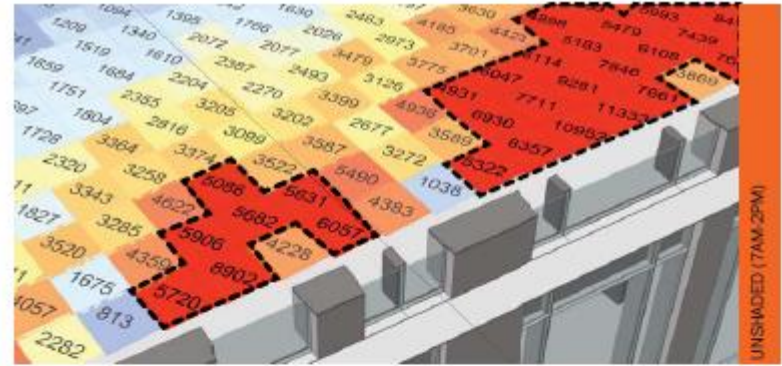
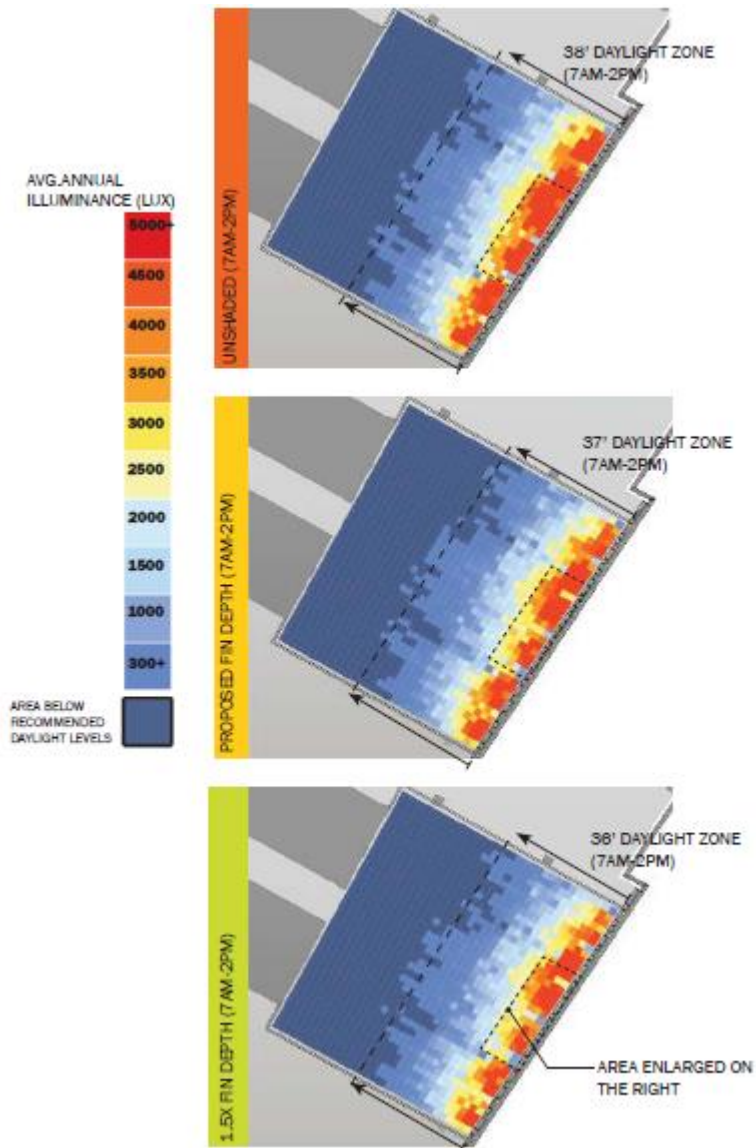
## Vertical Fin Options Tested



GLASS PANEL WIDTH PER BASELINE SOLAR RADIATION RANGES

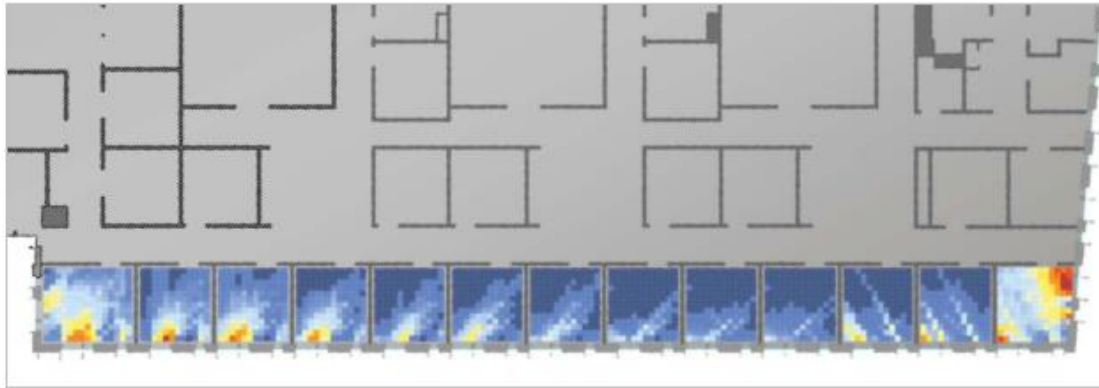


# Daylight Analysis & Fin Depth East Facade

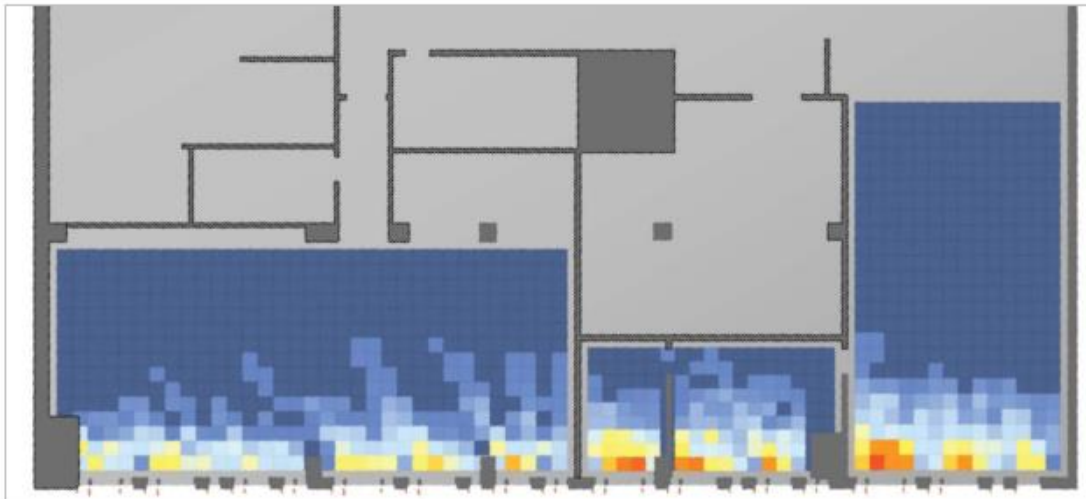
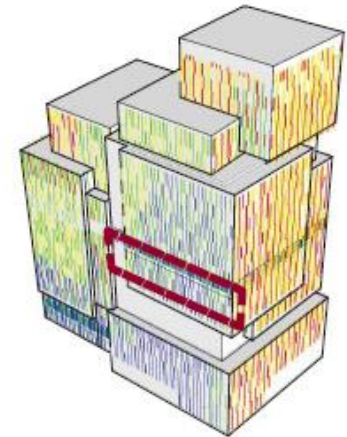
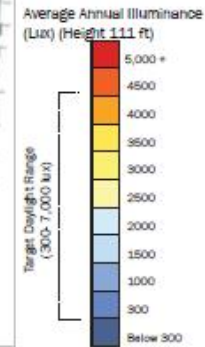




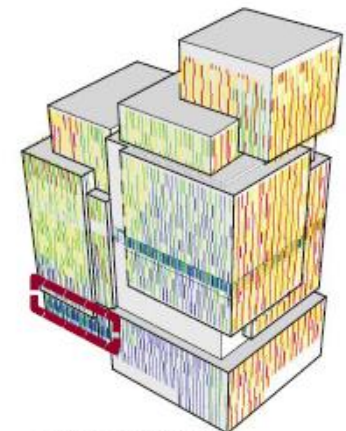
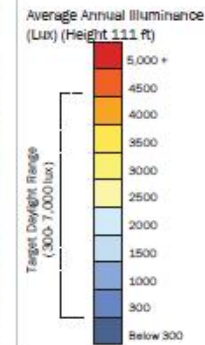
# Daylight Analysis & Fin Depth South Facade



MSKCC- 12TH FLOOR SOUTH, WITH FINS



CUNY- 3RD FLOOR SOUTH, WITH FINS



CUNY, FLOOR 3, SOUTH FACADE

# Façade Optimization - Designing for Vegetation





# Marina Bay - 2006



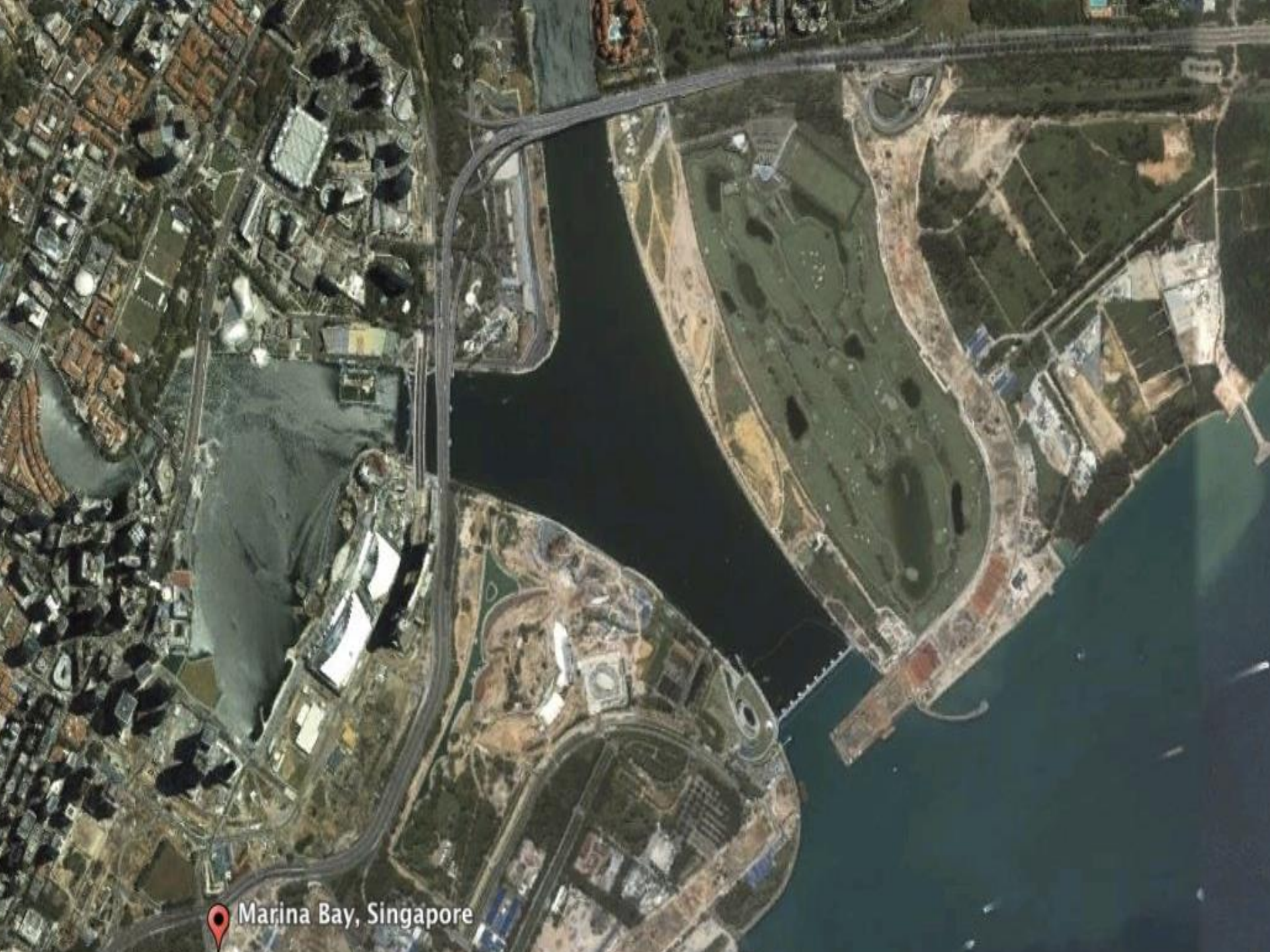


# The Esplanade Theatres on the Bay

Michael Wilford + DP Architects





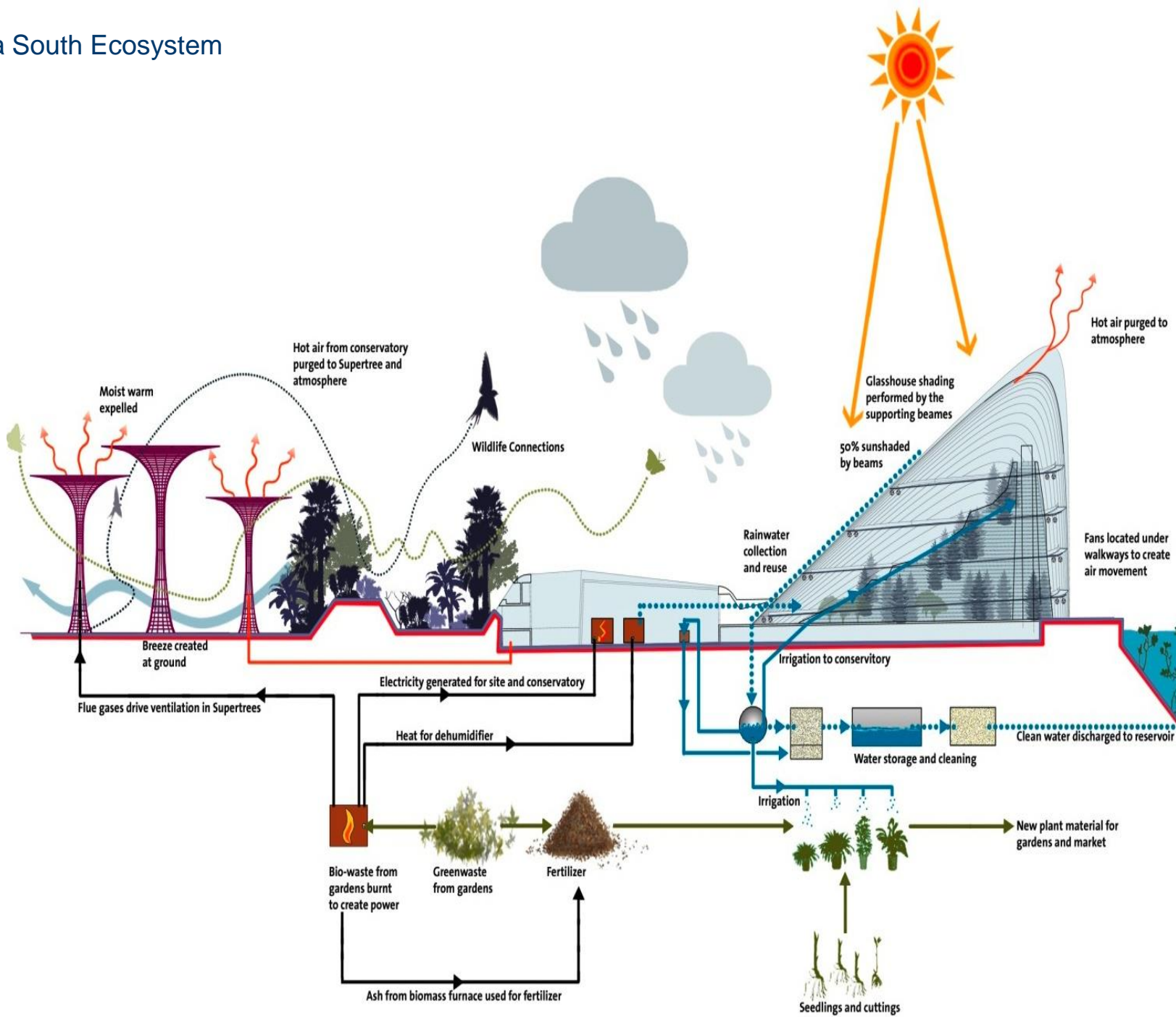


Marina Bay, Singapore



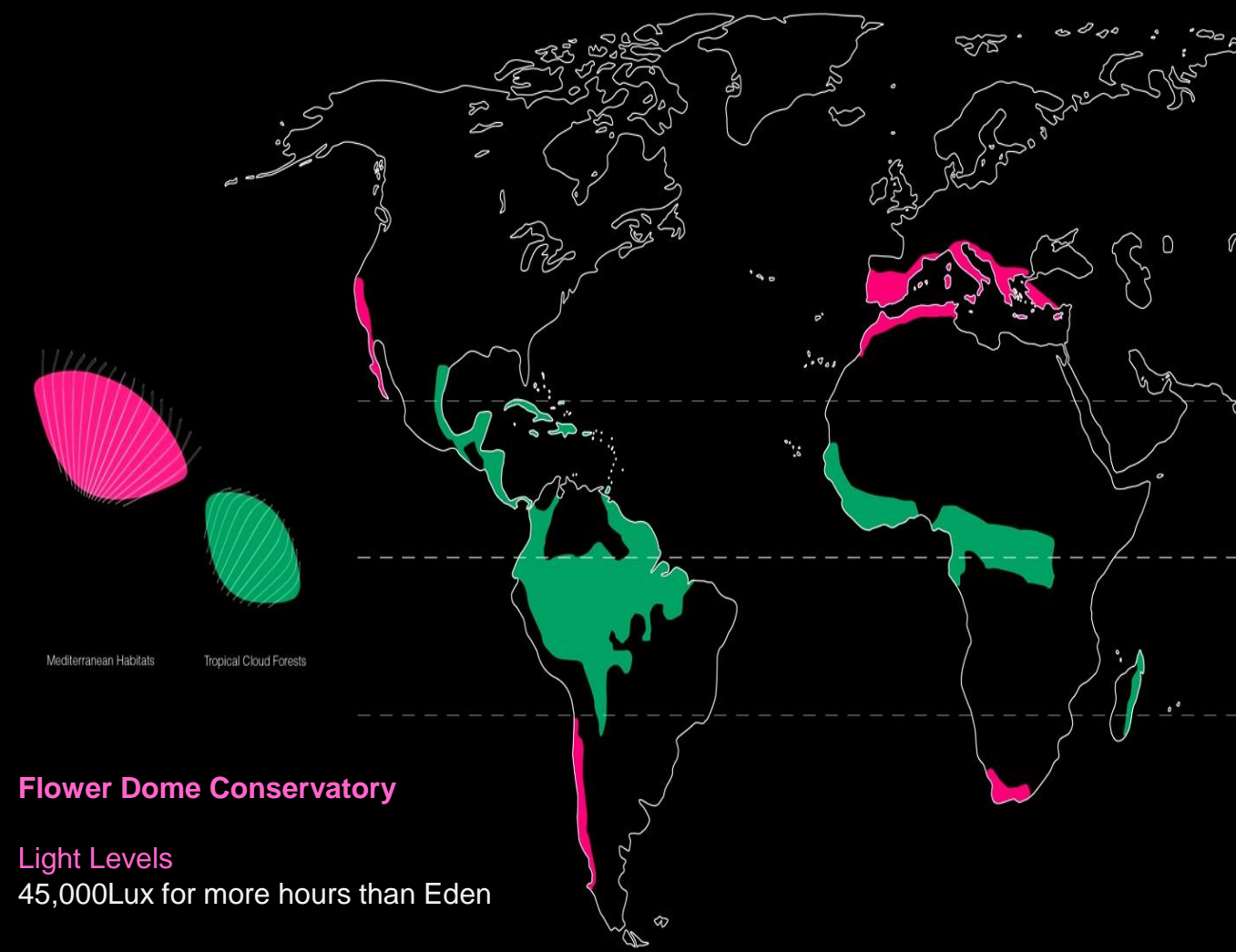


# Marina South Ecosystem





Design Criteria – Temperature, Humidity + Light



Mediterranean Habitats      Tropical Cloud Forests

Flower Dome Conservatory

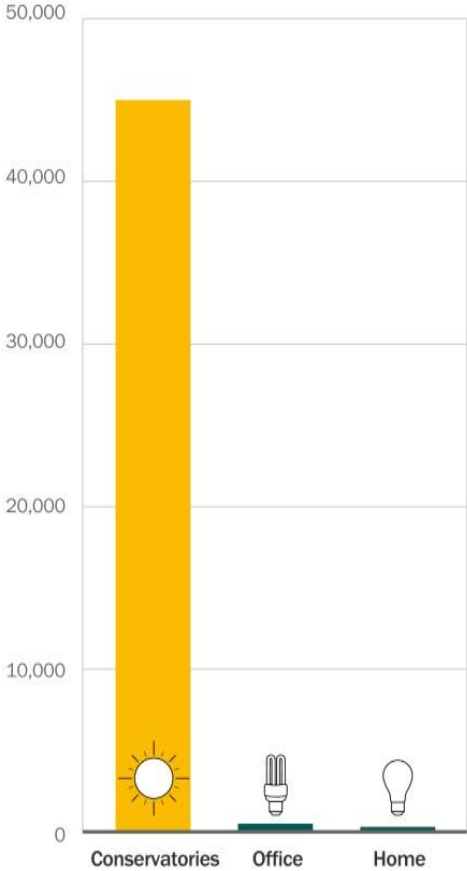
Light Levels  
45,000Lux for more hours than Eden

Air Temperature  
Daytime condition: 25°C @ 65% RH max  
Night-time condition: 17°C @ 65% RH or more  
Ignition condition : 13°C @ 70% RH or more

Lux levels

Comparing spaces

Internal Illuminance Level (Lux)



Singapore  
1° 22' N, 103° 45' E

# Cool Dry Biome

## Design Criteria



### Daylight Levels

45,000Lux for more hours per annum than Eden

### Air Temperatures

Daytime Condition – 25oC\*\* @ 60% RH

Night-time Condition – 17oC @ 80% RH

Ignition Condition – 13oC @ 80% RH





## Cool Dry Biome





# Cool Moist Biome

## Design Criteria



### Daylight Levels

45,000Lux For More Hours Than Eden

### Air Temperatures

Daytime Condition – 25oC @ 80% RH +

Night-time Condition – 17oC @ 80% RH +

Ignition Condition – 16oC @ 80% RH +

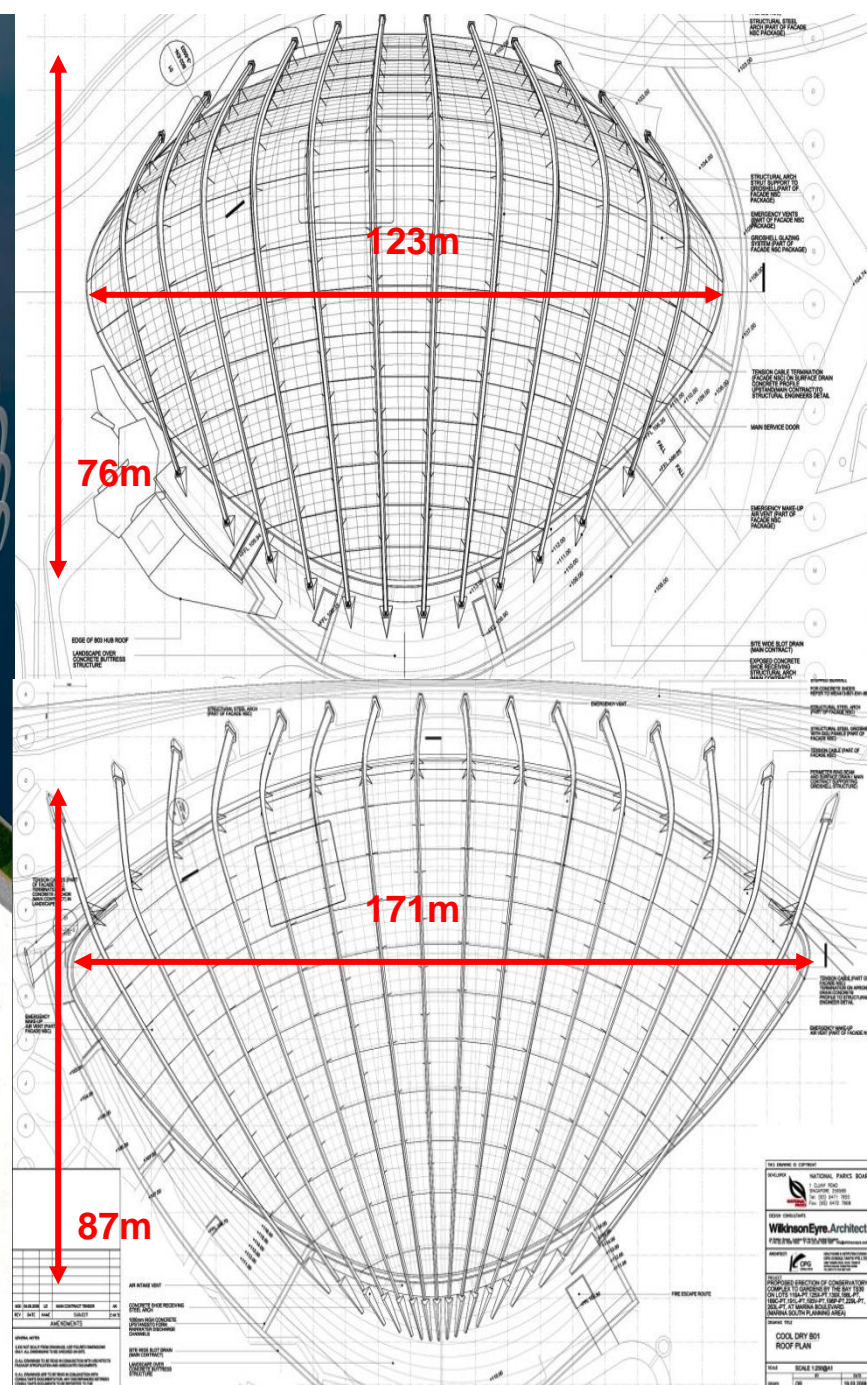




## Cool Moist Biome







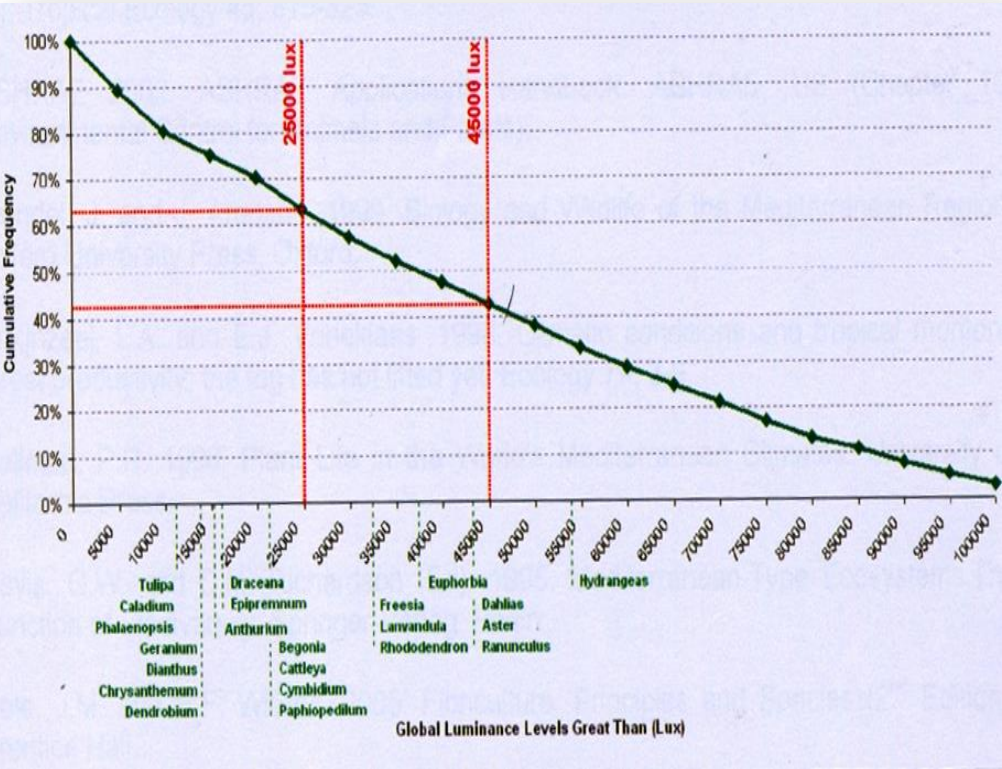


# The Biomes at Eden

Grimshaw 2000



# Annual Global Luminance Levels for Plants

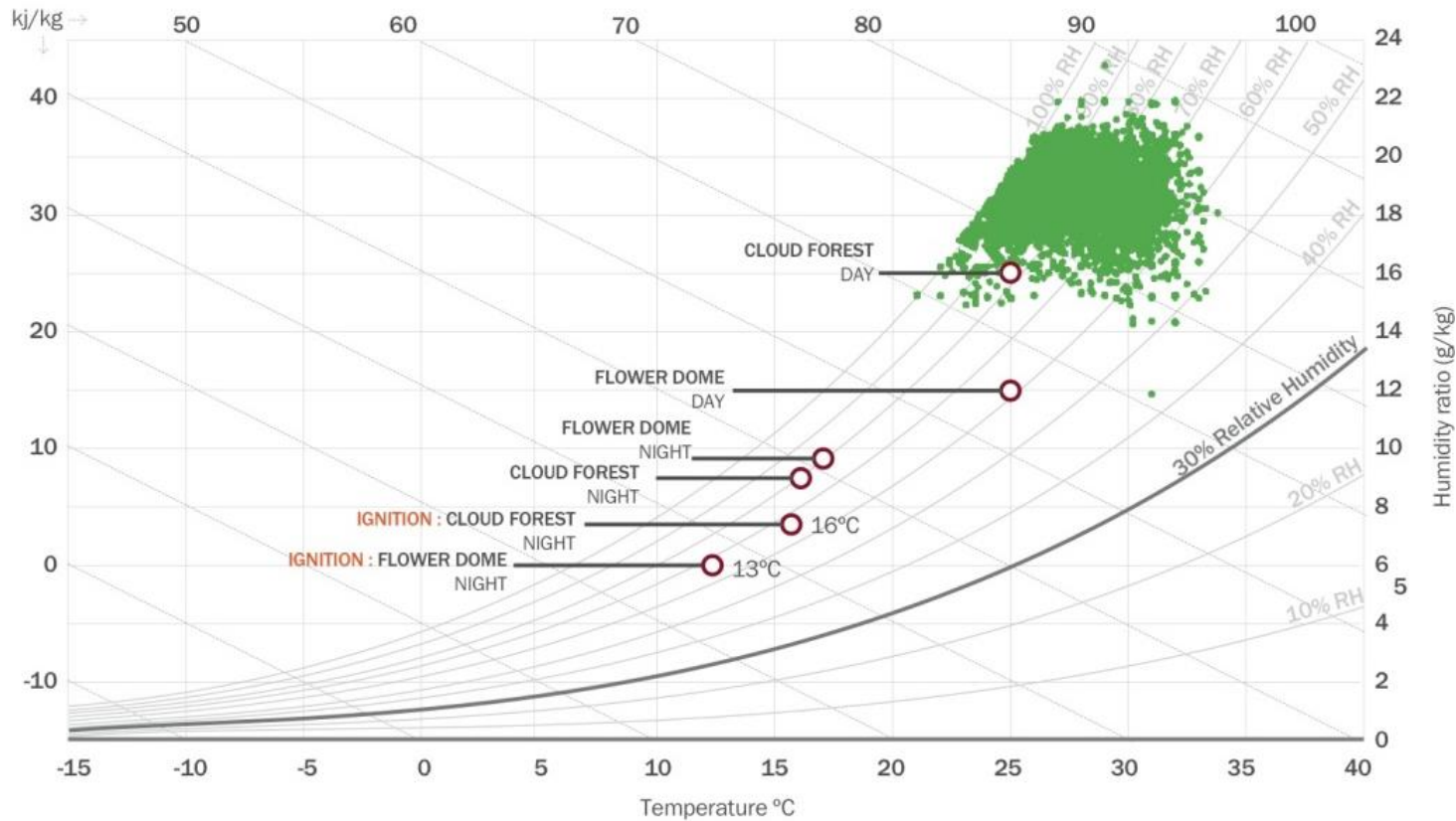




# Greenhouse Conditions

## Psychrometric Chart

Location : Singapore IWECC



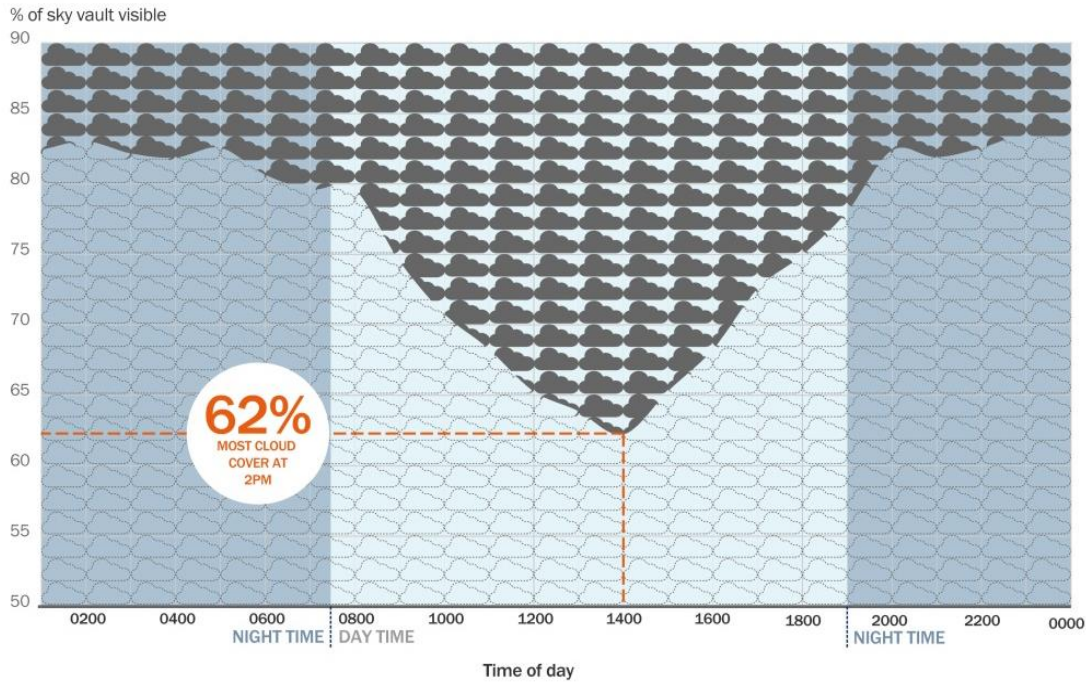
## Daylight Levels

45,000Lux for more hours per annum than Eden Project

# Climate Analysis

## Cloud Cover

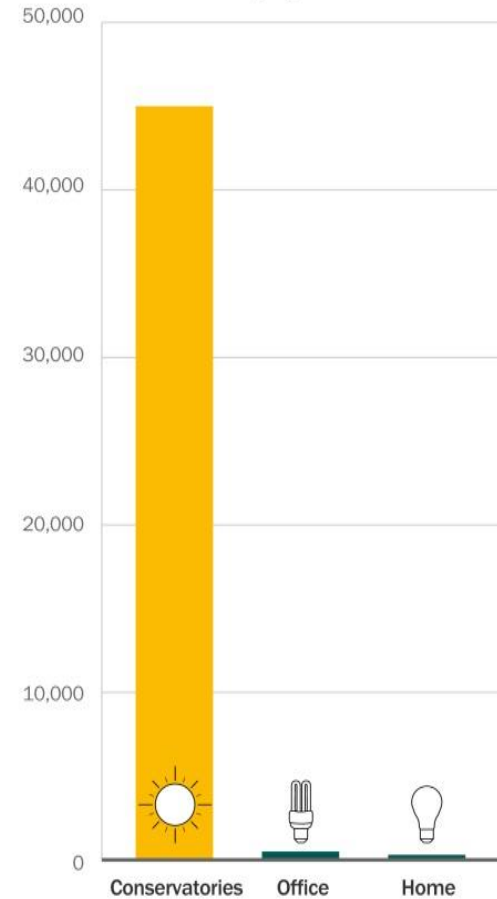
Represented as annual percentage of sky vault visible at time



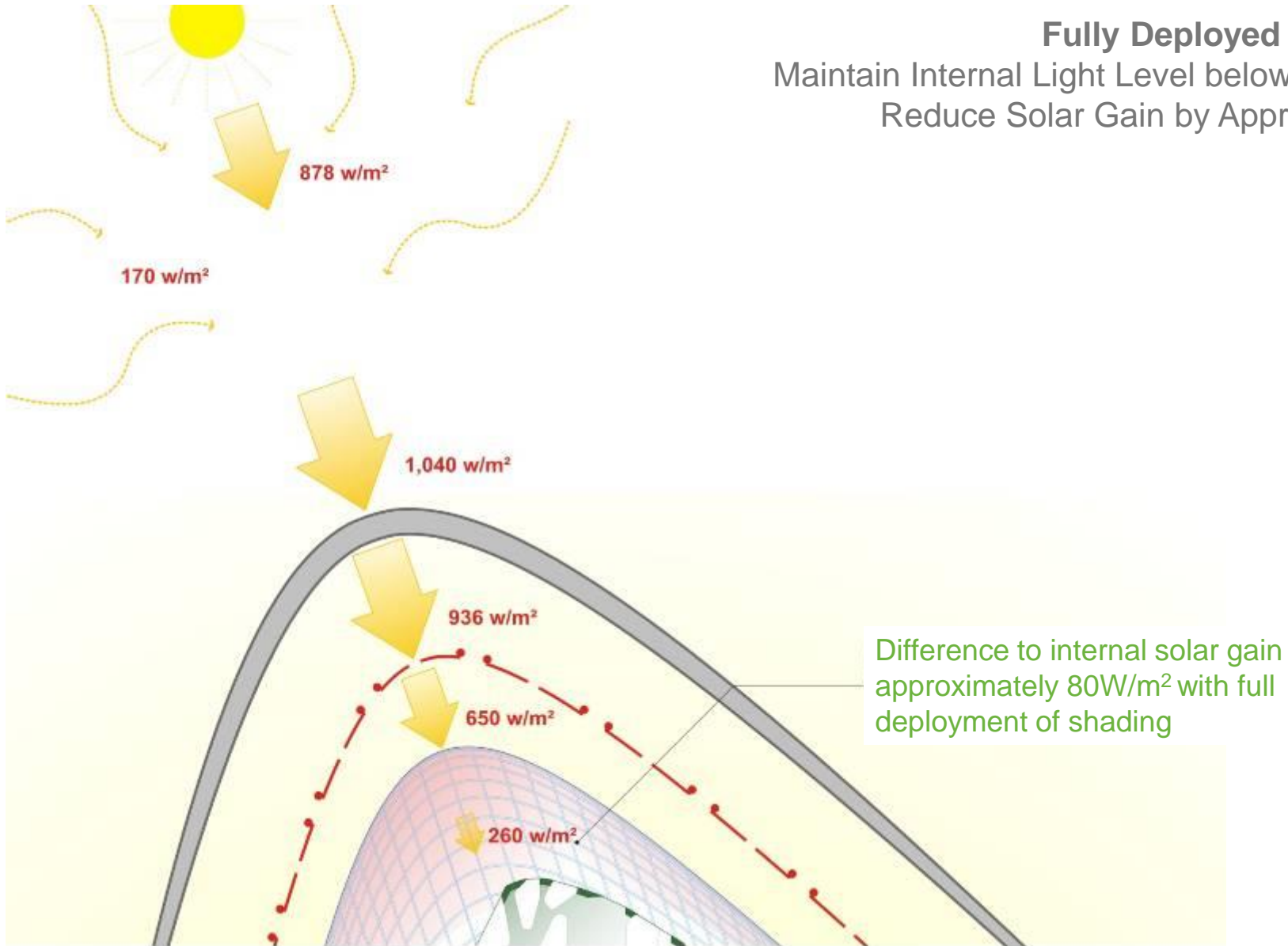
## Lux levels

Comparing spaces

Internal Illuminance Level (Lux)



# Solar Control



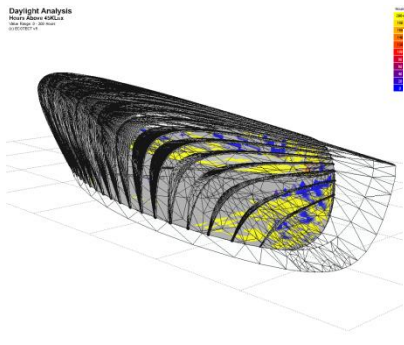
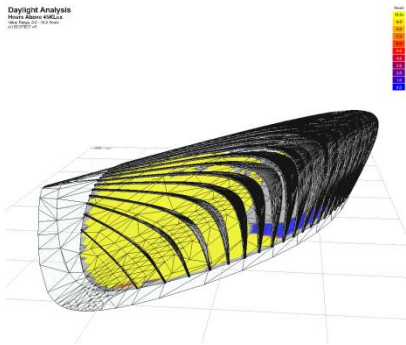
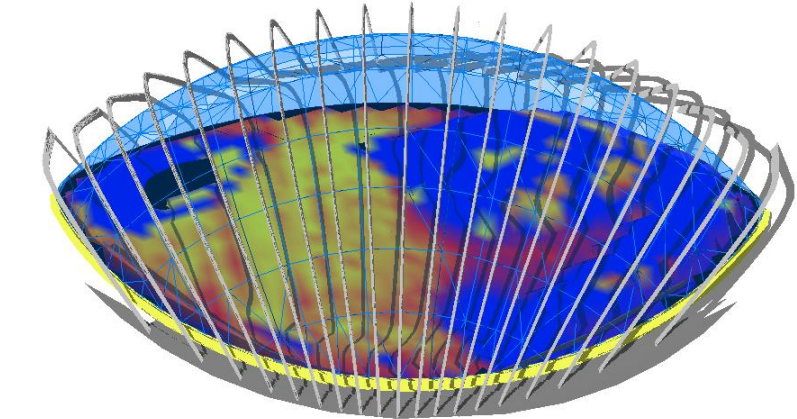
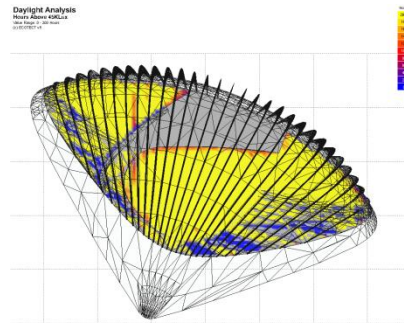
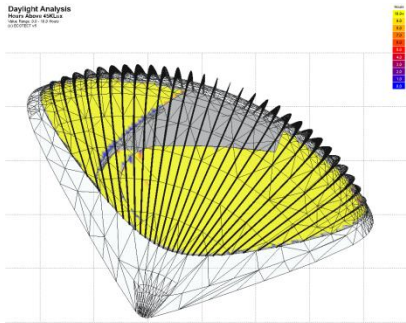
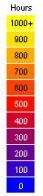
## Fully Deployed Shades

Maintain Internal Light Level below 45kLux

Reduce Solar Gain by Approx 90%.

# Solar Control

Analysis Grid  
Hours Above 45Klux  
Value Range: 0.0 - 1000.0 Hours  
(c) ECOTECT v5



FIN

TRUSS

GRID SHELL



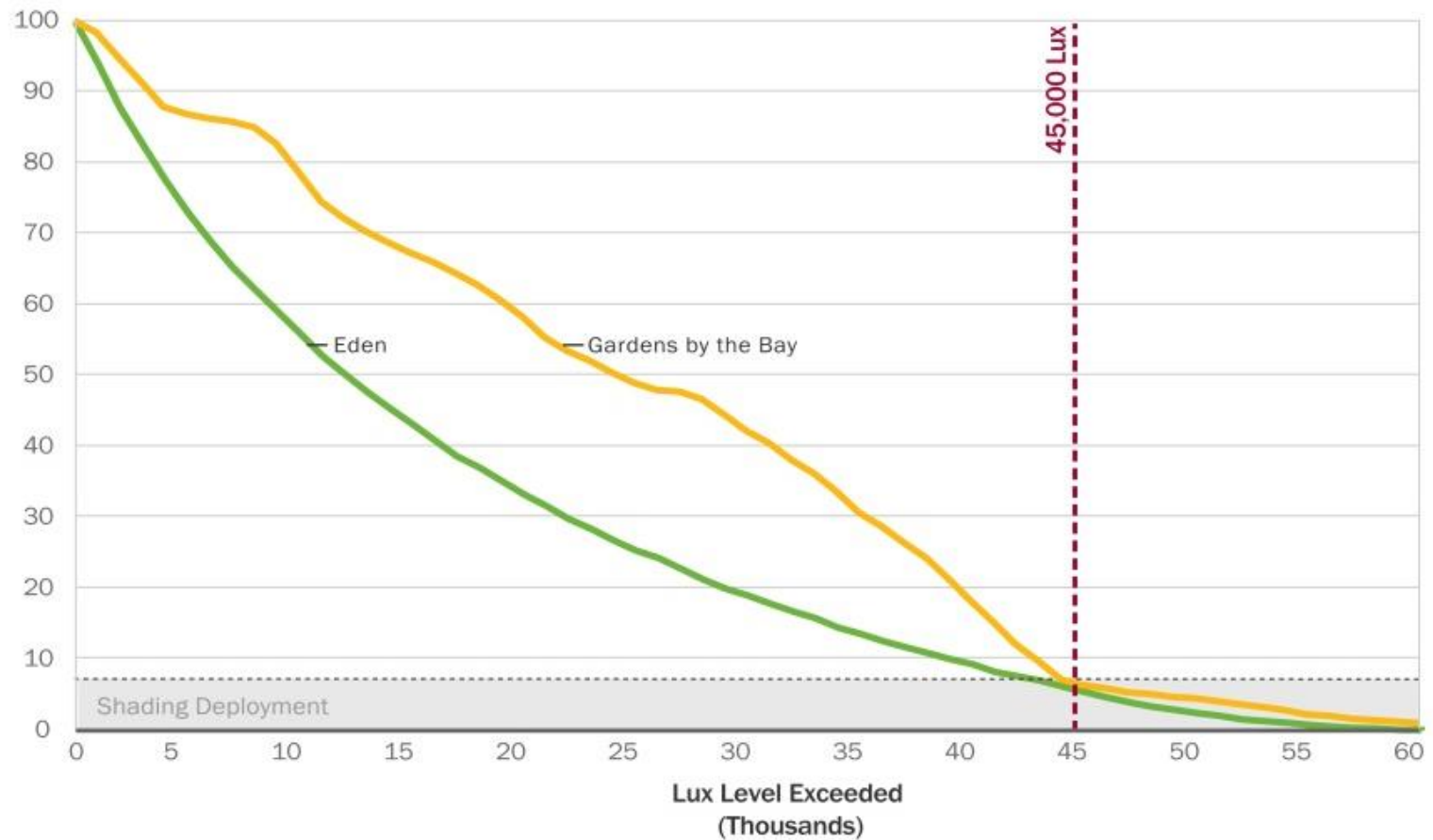
# Modeling Shading

## Modelling Shading Impacts

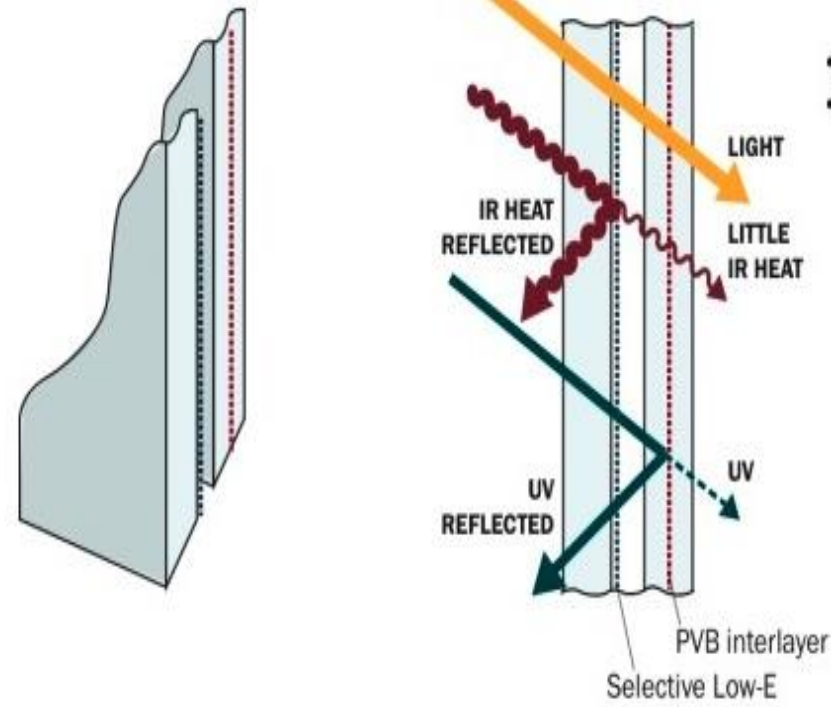
Projected Illumination Levels and frequency for 65% VLT glass

Annual Hours Above Lux Level

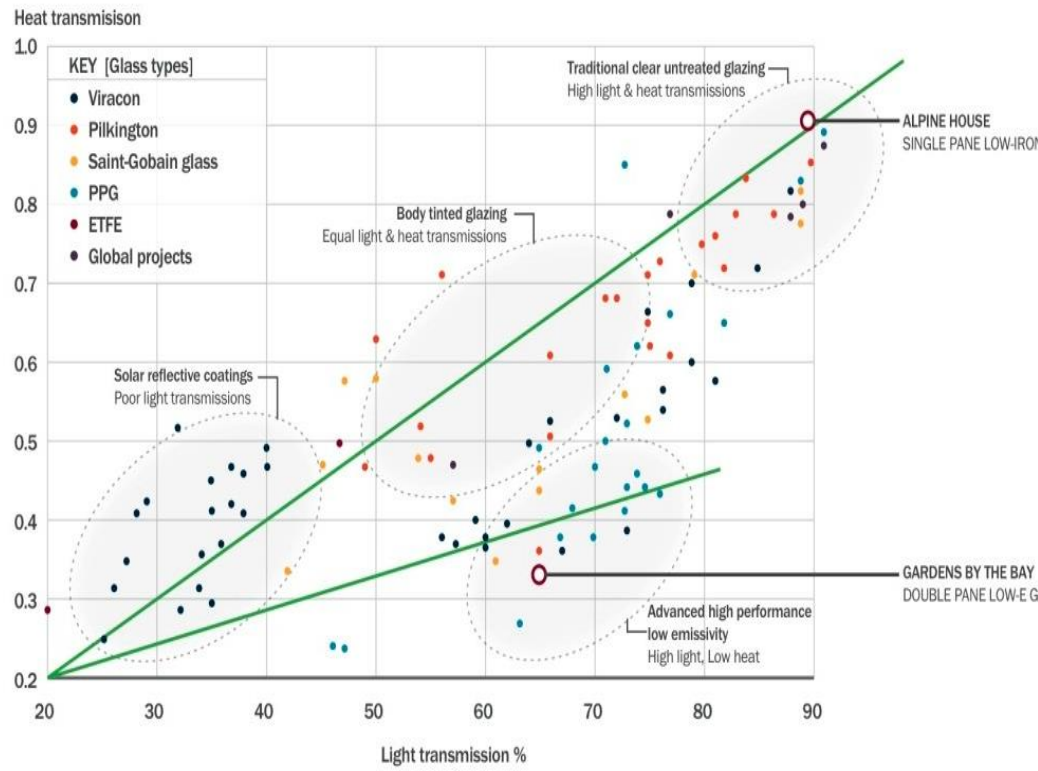
%

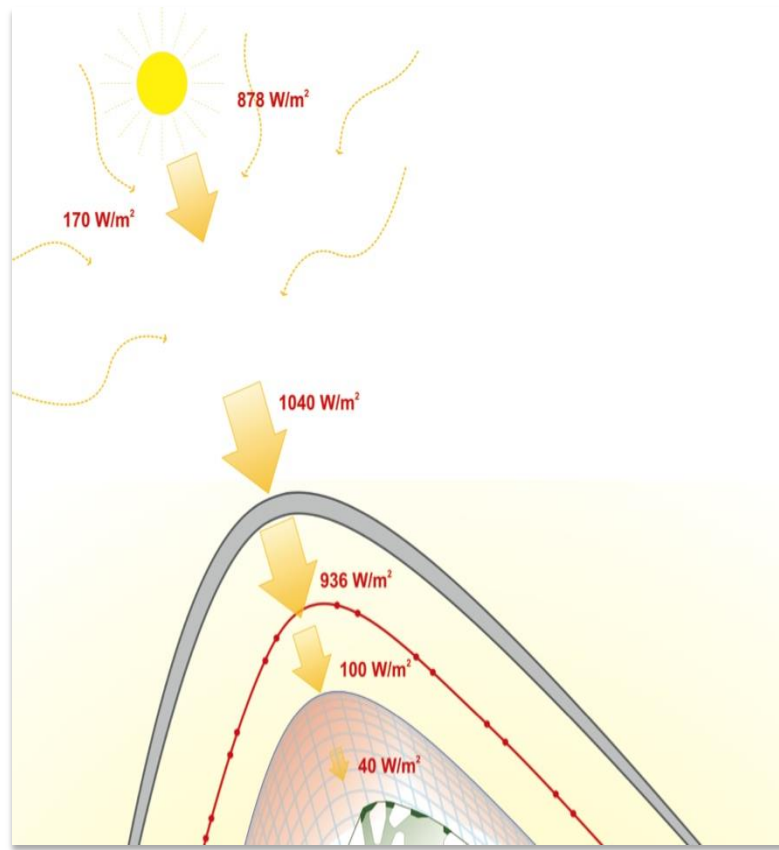
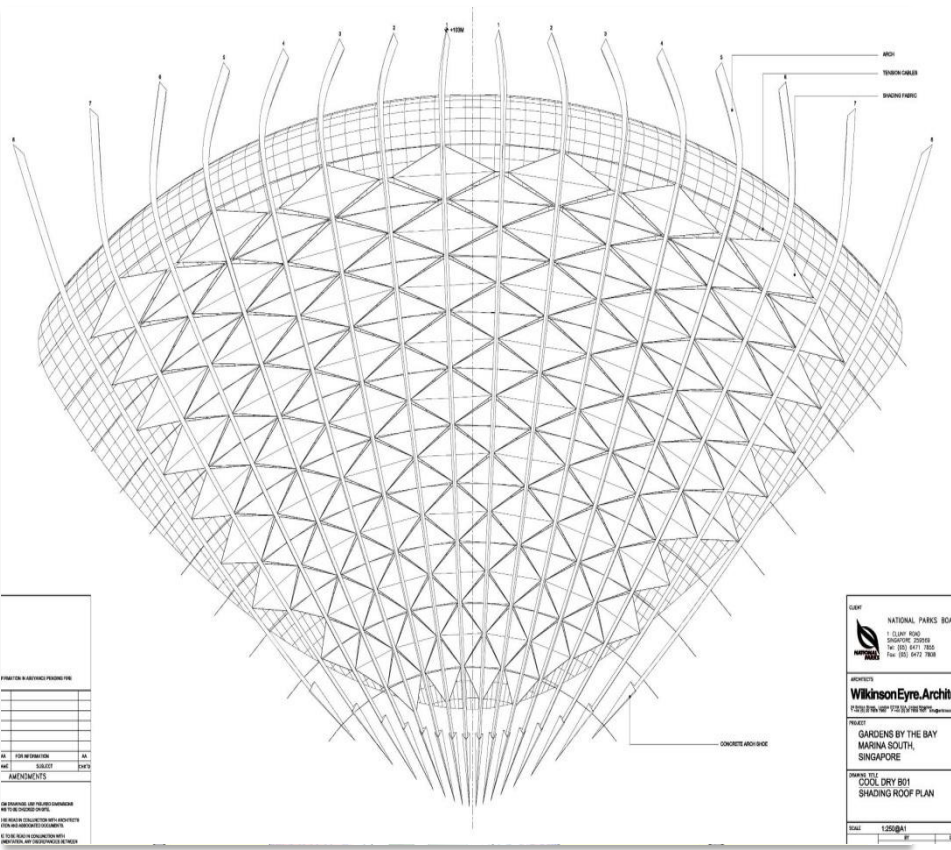


SELECTIVE GLAZING LAMINATE



Properties of high performance glass





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SINGAPORE 259502  
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PROJECT  
GARDENS BY THE BAY  
MARINA SOUTH,  
SINGAPORE

PROJECT TITLE  
COOL DRY B01  
SHADING ROOF PLAN

DATE  
12SEP04



## External Shading





## External Shading







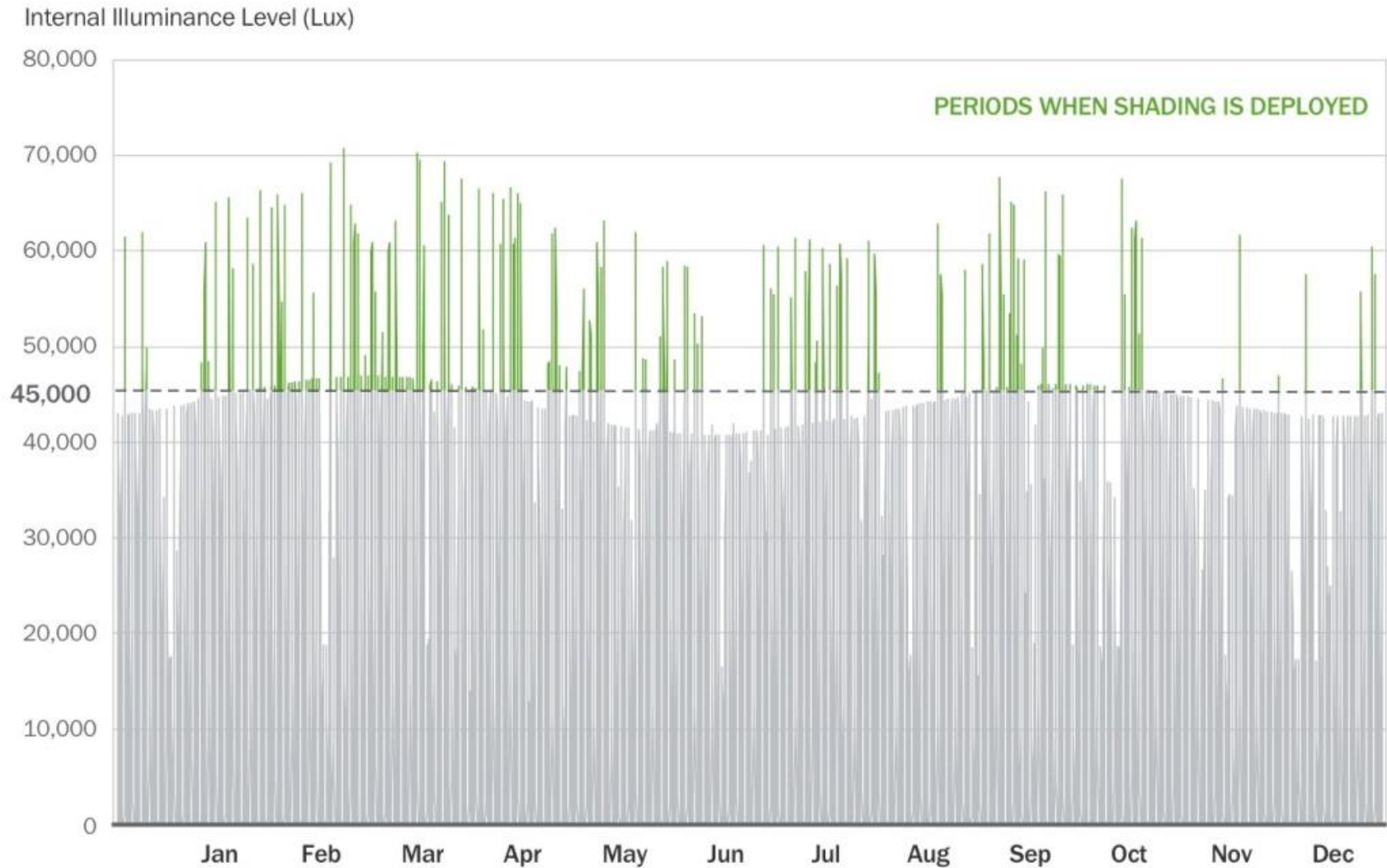






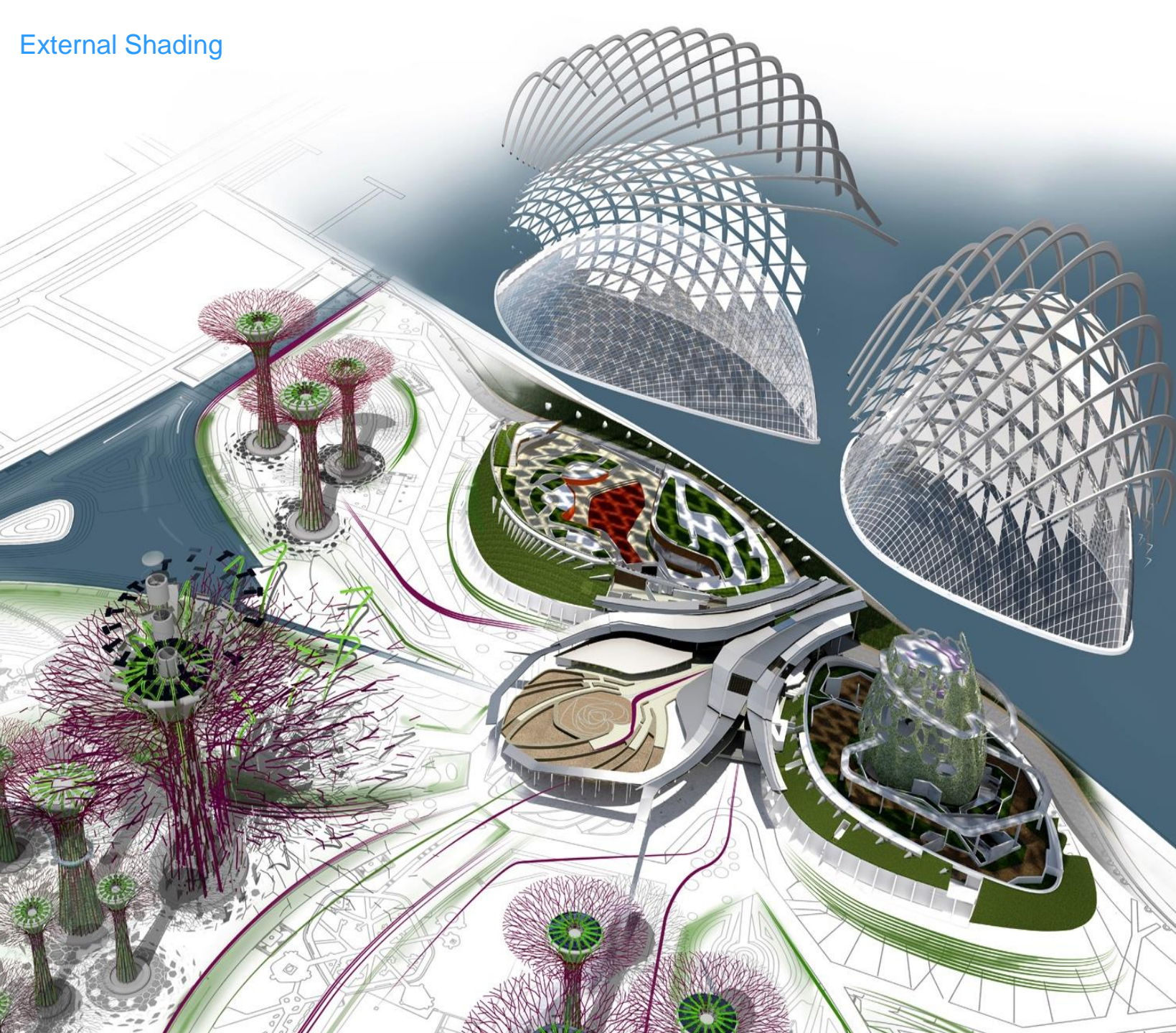


# Solar Control



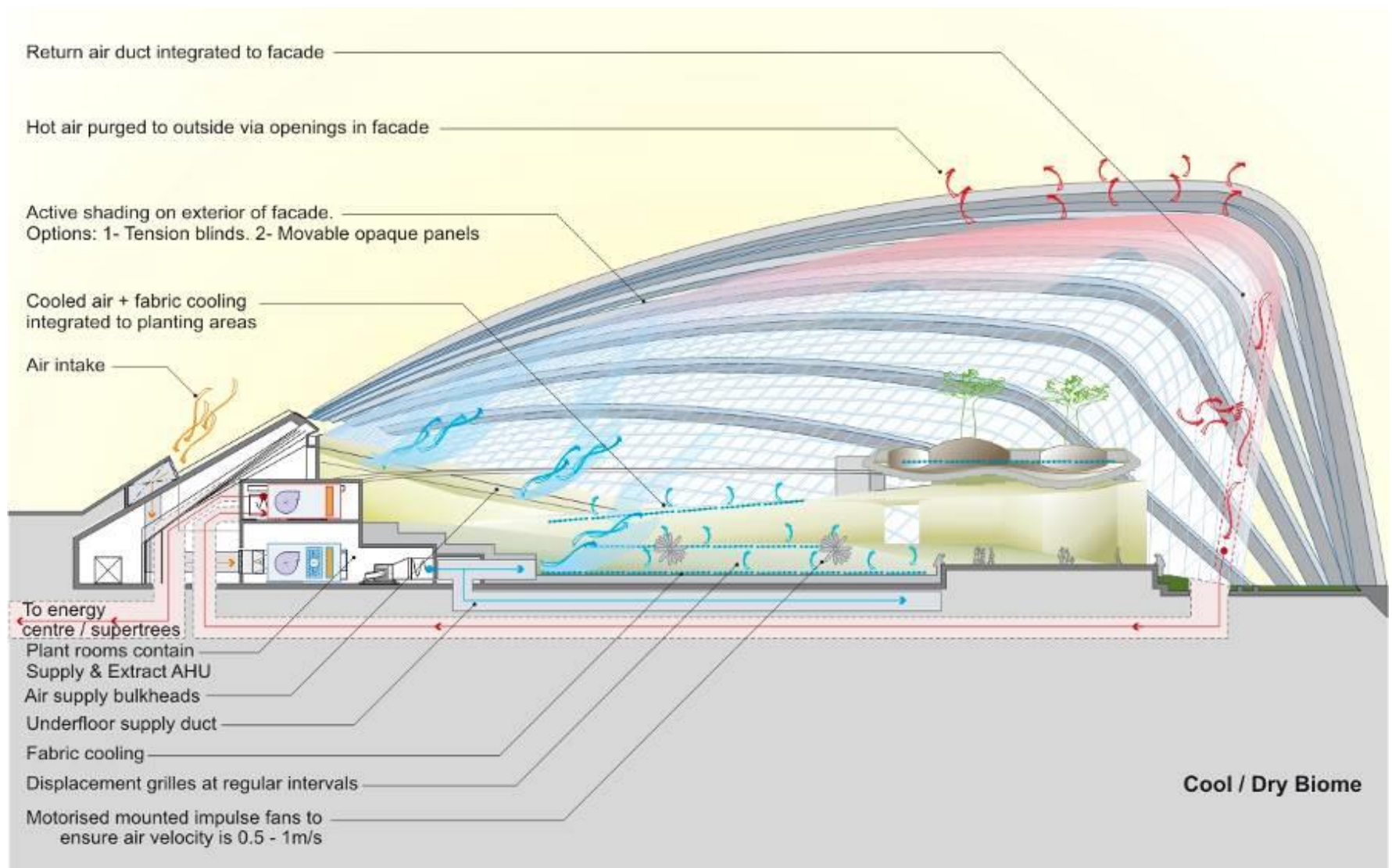


External Shading



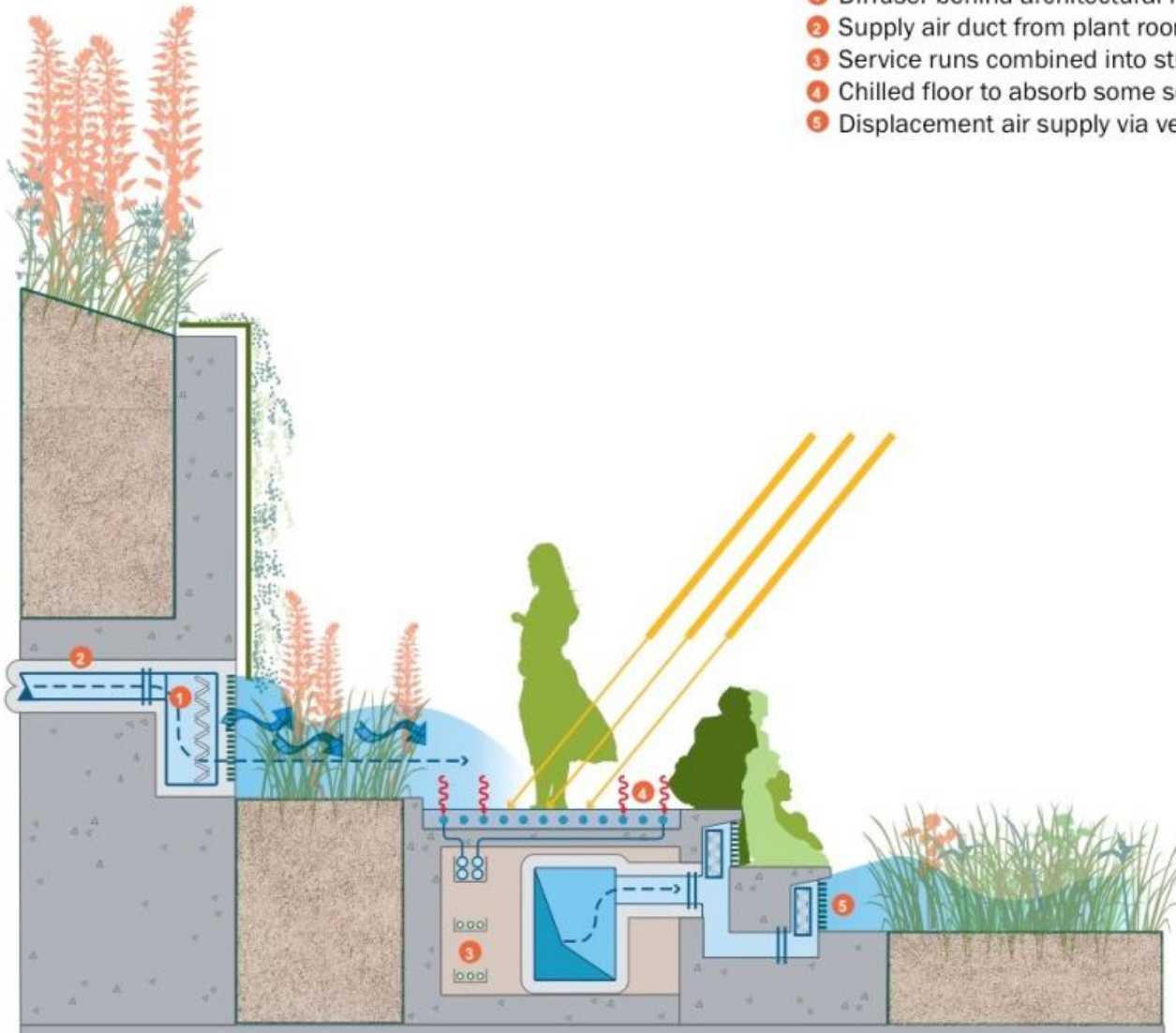


# Environmental Concept



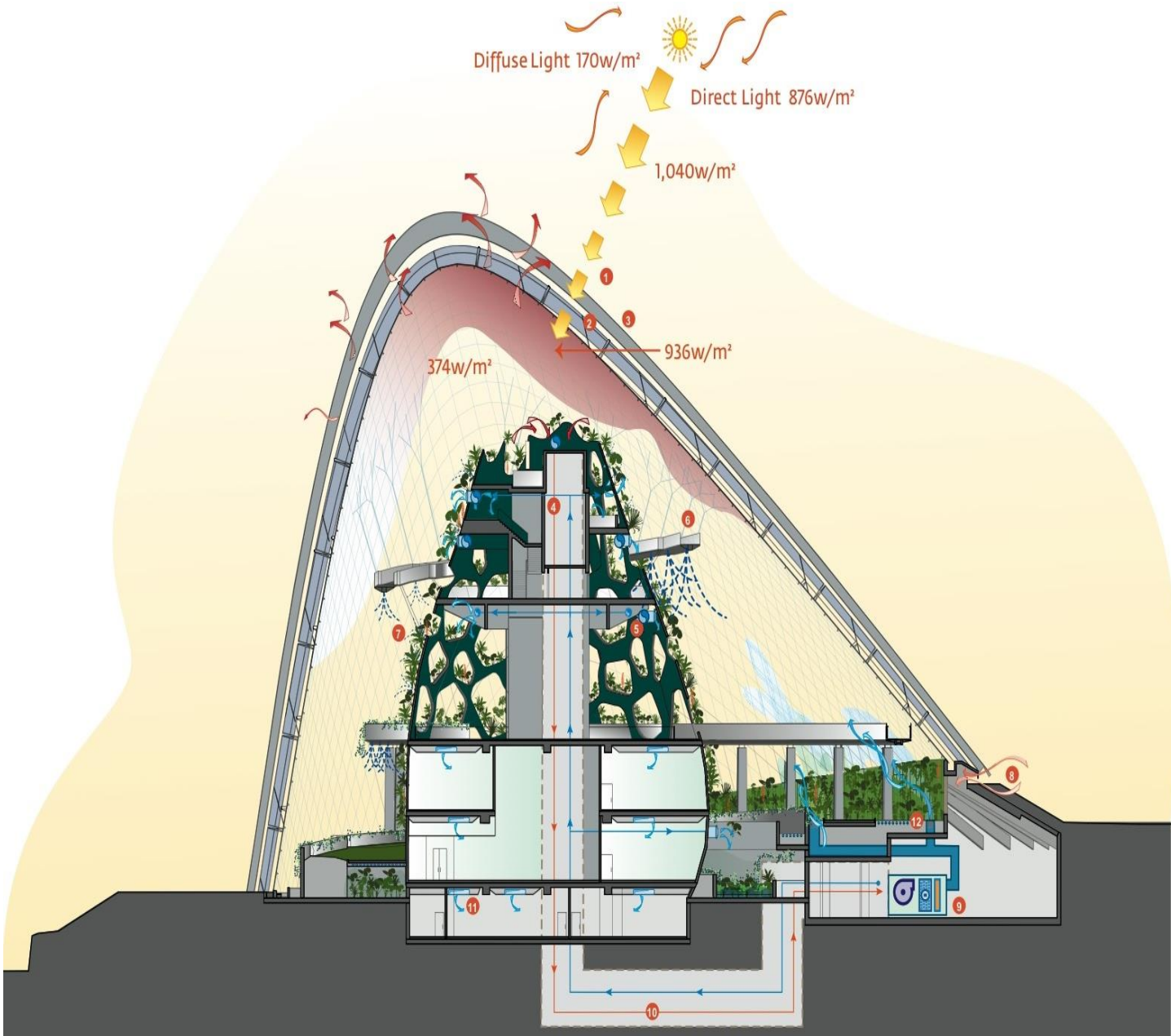
# Conditioning Strategy

- 1 Diffuser behind architectural finish
- 2 Supply air duct from plant rooms
- 3 Service runs combined into structure
- 4 Chilled floor to absorb some solar gain
- 5 Displacement air supply via vertical surface





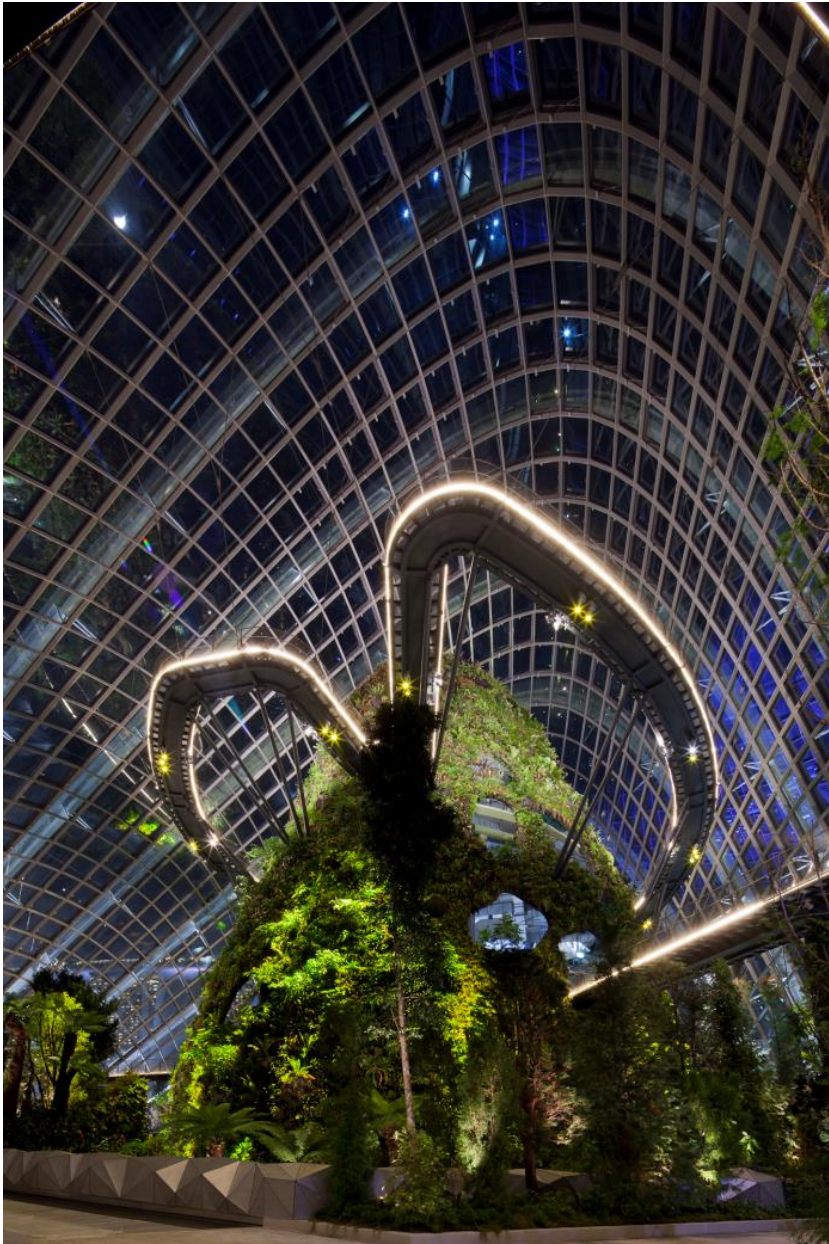
# The Cloud Forest



- 1 Hot air Purged to outside via openings in facade. Space is always positively pressurised
- 2 Active shading on exterior of facade. Self-furling shades
- 3 Air volume equivalent to fresh air rate purged through facade at high level
- 4 Return air duct integrated to mountain
- 5 Air distribution via ring ducts at each level to set diffusers pointing inwards and pointing outwards
- 6 No conditioning to walkways. Misters are on underside of walkway. Internal misters can be used to assist shade on very bright days
- 7 Misting nozzles distributed throughout surface of space
- 8 Air intake
- 9 Ground air handling plant room. Supply and extract AHU's dehumidification unit
- 10 Tunnel beneath building connecting air handling plant room to core of mountain
- 11 Block box internal spaces conditioned with fancoil
- 12 Air distribution and fabric cooling integrated to planter and walkway areas







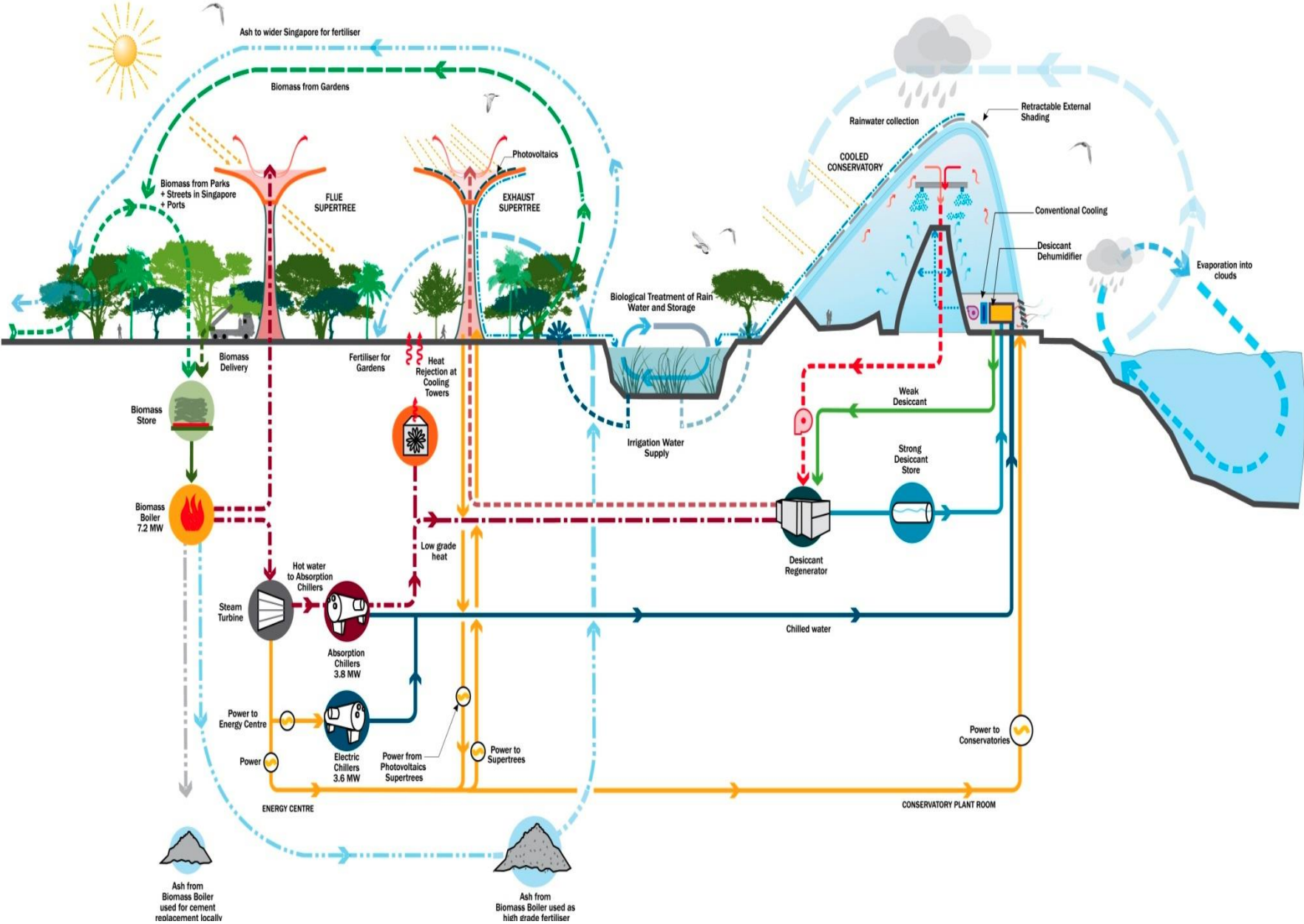


# Gardens by the Bay, Singapore

Grant Associates and Wilkinson Eyre Architects

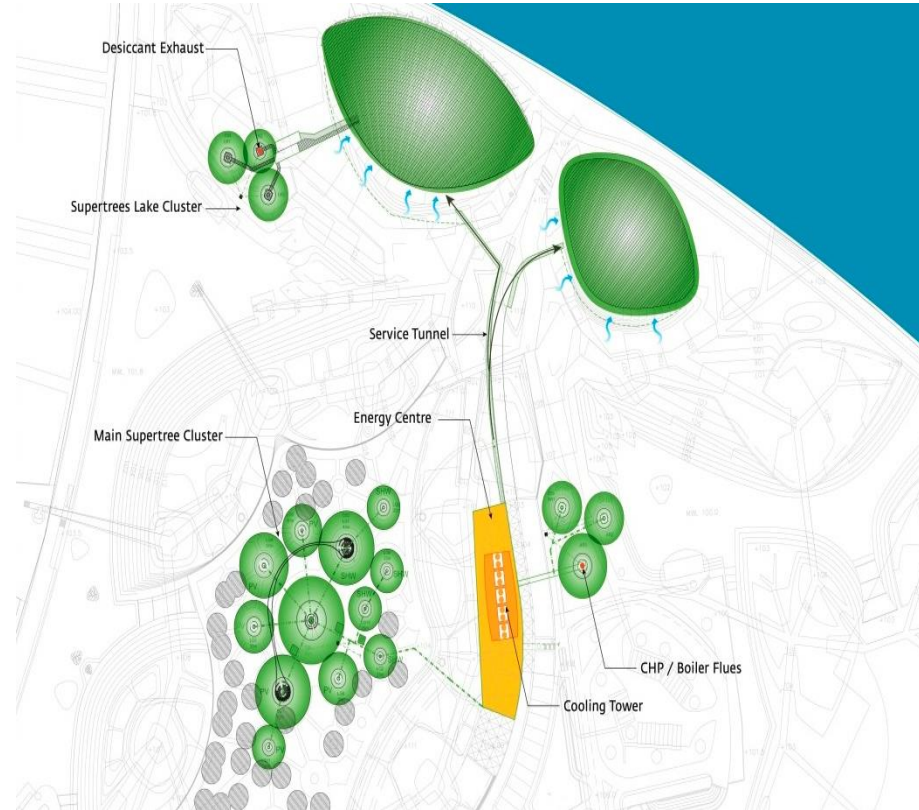


# Marina South Eco-System











# The Energy Centre



## Gardens By The Bay Annual Carbon Evaluation

Annual Carbon Consumption Or Offset  
[kg CO<sub>2</sub> / Year]







A group of four people are seated in a room that looks like a library or a study. They are engaged in a discussion. The room has tall bookshelves filled with books and binders in the background. The people are sitting on modern, light-colored chairs. The lighting is soft and even.

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