



# **Loc Bihn Wellness Resort, Vietnam**

Concept Level Environmental Analysis



# Project Introduction

## Loc Bihn Wellness Resort - Vietnam

30 Ha of seaside resort near Da Nang, Vietnam, with Villas, Spas , Health clubs and conference facilities.

## Concept level Environmental Analysis

Assessing 3 design options and contribution towards net zero energy performance.

## Design Improvements

Energy efficiency measures in terms of passive design, façade performance and maintenance.



A minimalist graphic of a stylized tree. The trunk is a simple grey line. At the top, instead of leaves, there are several large, light-grey circles arranged in a cluster. Each circle has a smaller, darker-grey spiral shape inside it, resembling a stylized leaf or flower.

# Building Façade Analysis

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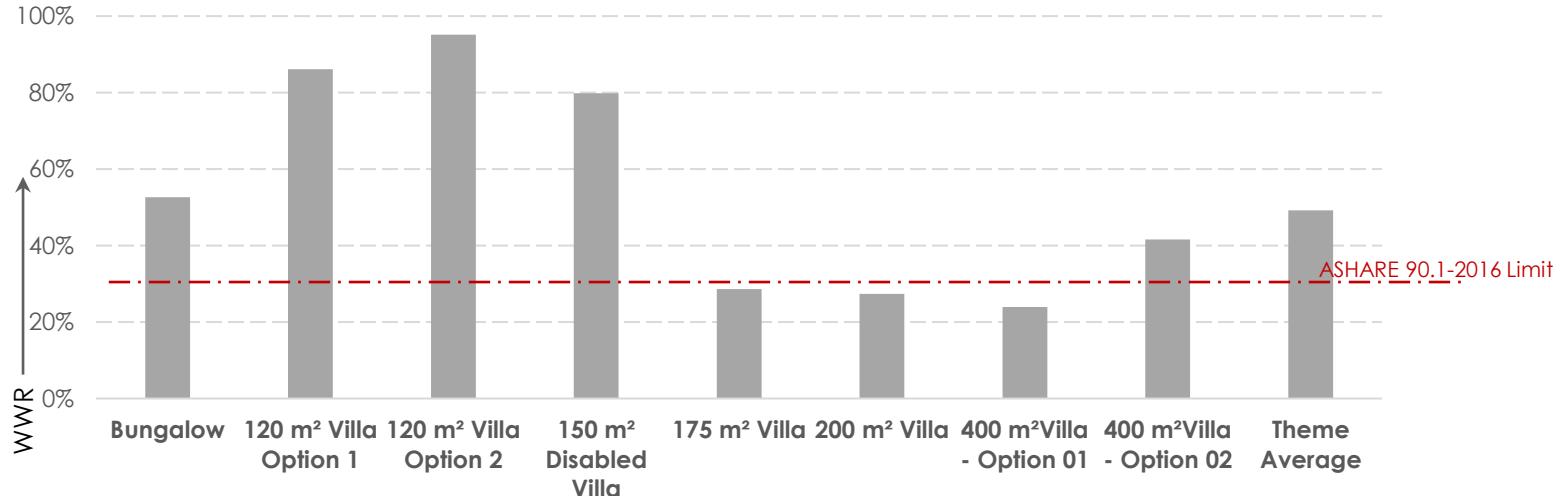


[

Window-Wall-Ratio

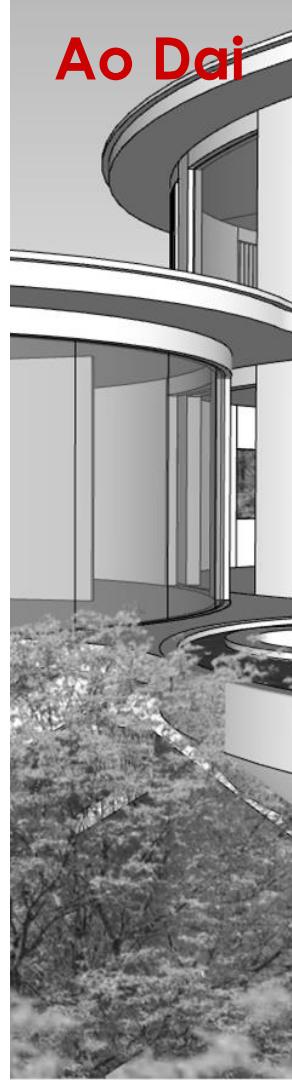
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## WWR: Units



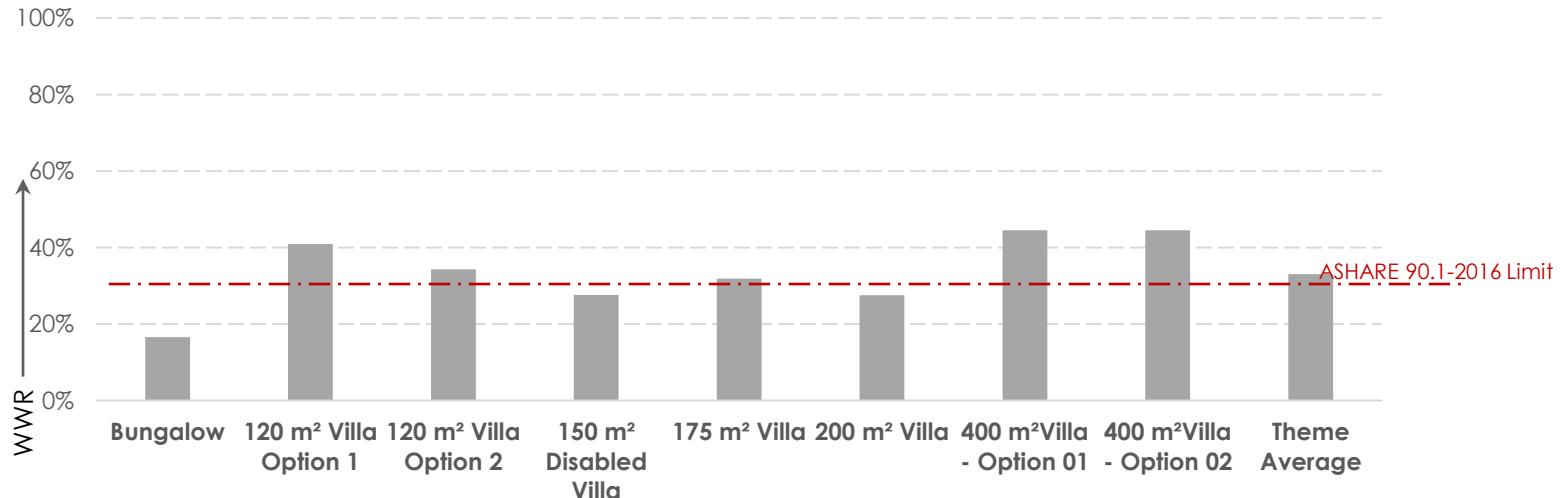
\*Maximum allowed WWR as per ASHRAE 90.1-2016 Limit

The average WWR including all the units places in the site is above the ASHRAE 90.1-2016 limit.



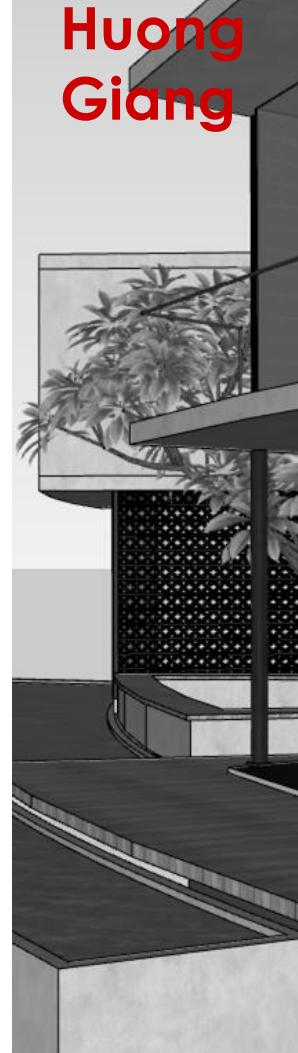


## WWR: Units



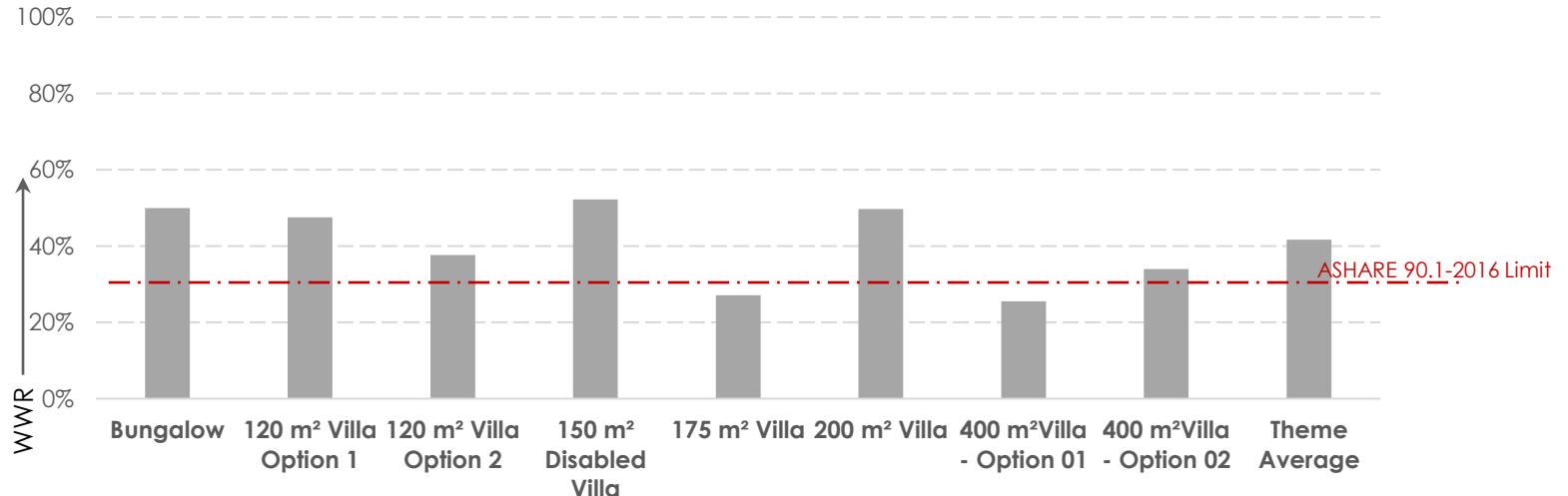
\*Maximum allowed WWR as per ASHRAE 90.1-2016 Limit

The average WWR including all the units places in the site is below the ASHRAE 90.1-2016 limit.



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## WWR: Units

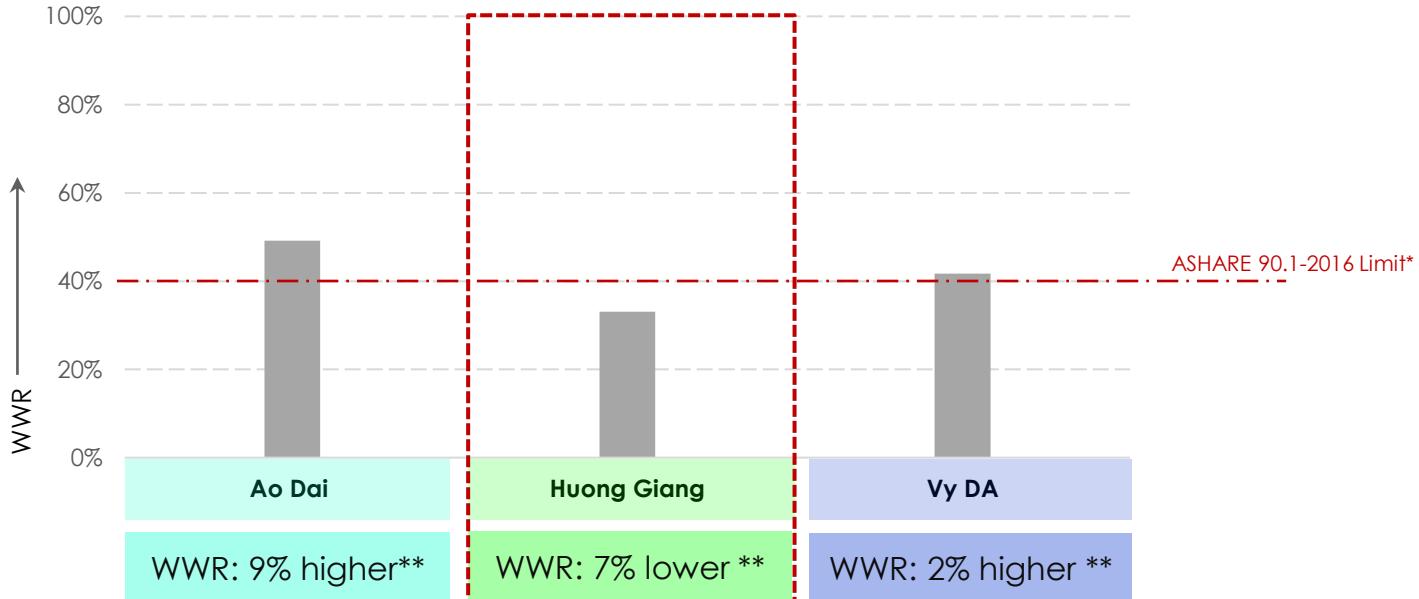


\*Maximum allowed WWR as per ASHRAE 90.1-2016 Limit

The average WWR including all the units places in the site is above the ASHRAE 90.1-2016 limit.



## WWR: Themes



Considering all the three themes, Huong Giang has the least WWR. The window sizes in the other two themes can be reduced marginally to bring down the WWR.



\*Maximum allowed WWR as per ASHRAE 90.1-2016 Limit

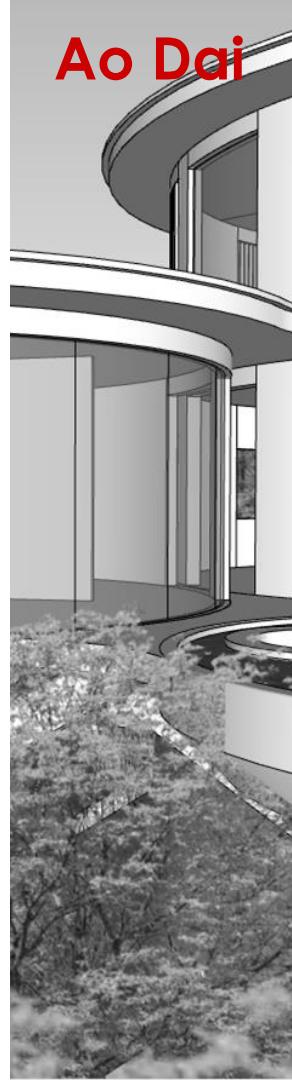
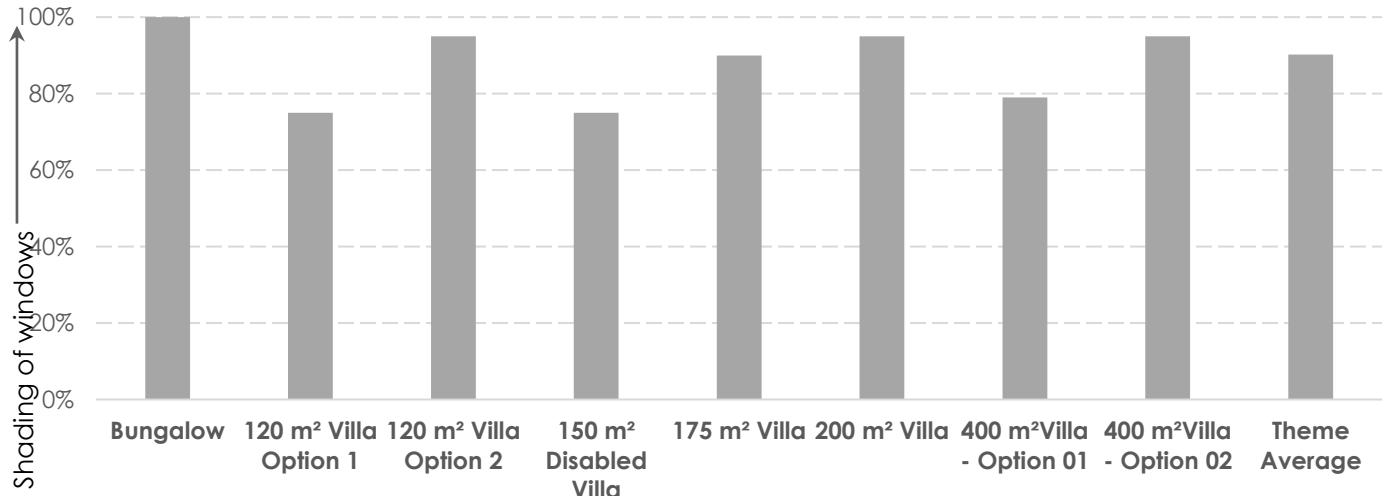
\*\* then the ASHRAE 90.1-2016 limit



[ Shading

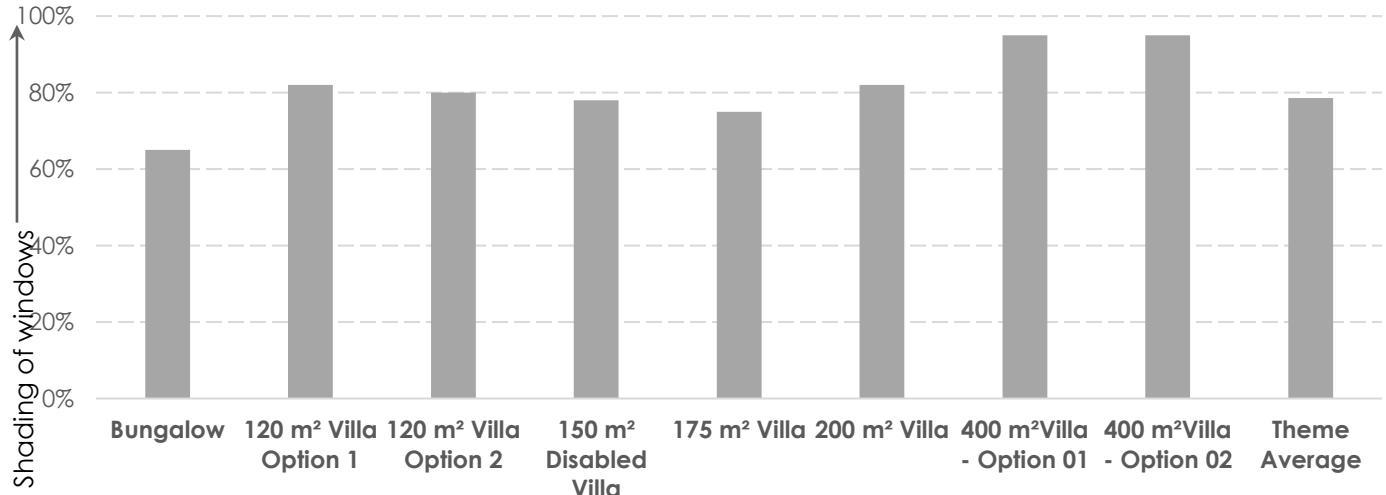
[

## Shading: Units



The 90% of the windows are shaded by design. Marginal alterations can be made in the design to increase shading.

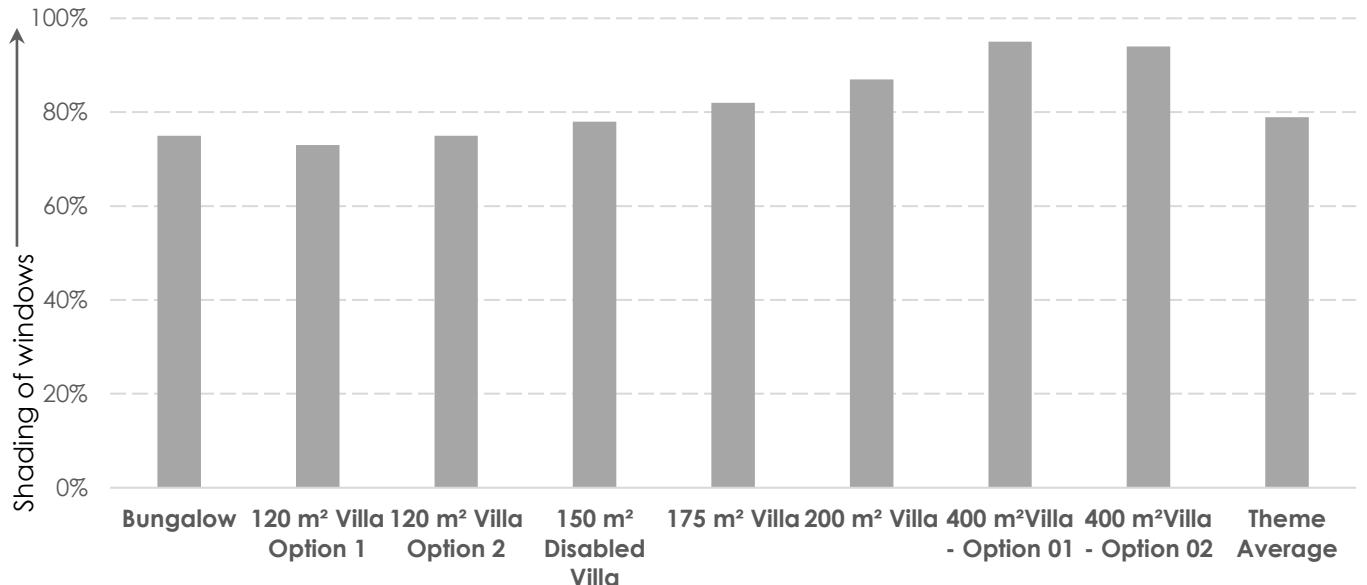
## Shading: Units



The 79% of the windows are shaded by design. Marginal changes can be made in the design to increase shading.



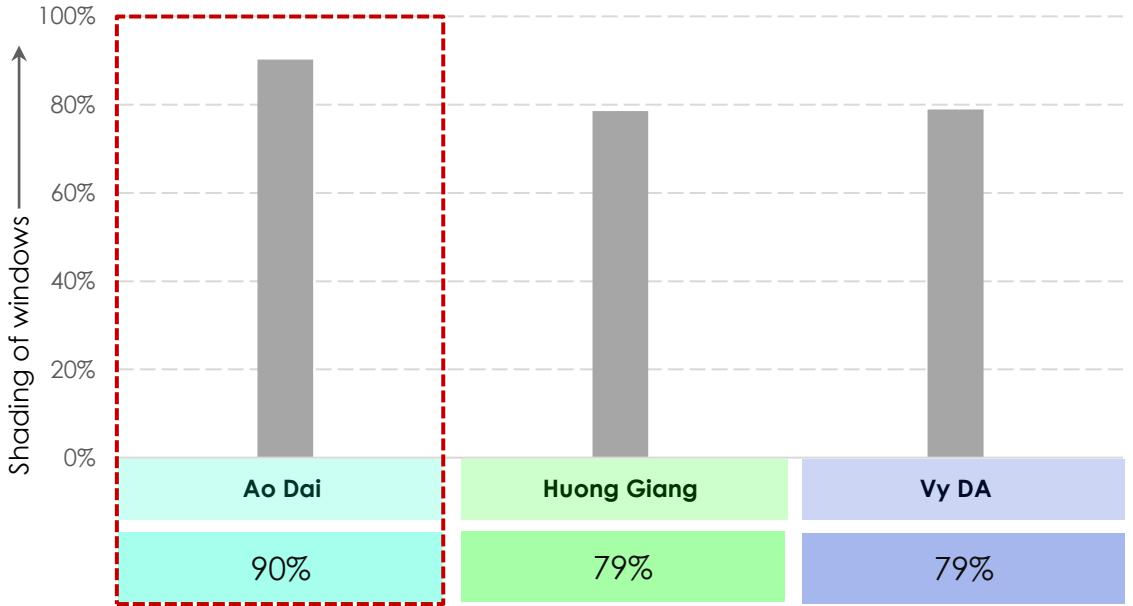
## Shading: Units



The 78% of the windows are shaded by design. Marginal changes can be made in the design to increase shading.



## Shading: Themes



Considering all the three themes, Ao Dai has 90% windows shaded as per the design. Marginal modifications are required in Huong Giang and Vy DA to increase the shaded areas of the windows.





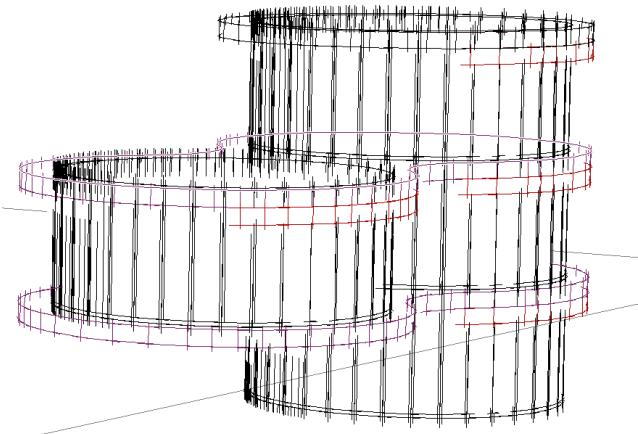
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Shading Suggestions

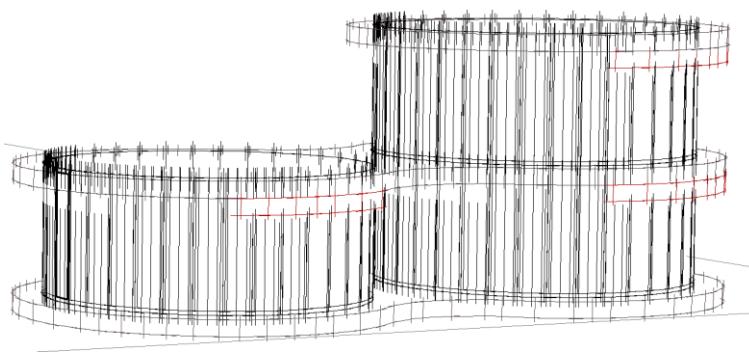
[

## Shading Suggestion

120 m<sup>2</sup> Villa & 150 m<sup>2</sup> Disabled villa



Increase the vertical shade(ring-like structures) by 0.5 m on the **North East, East and South East**



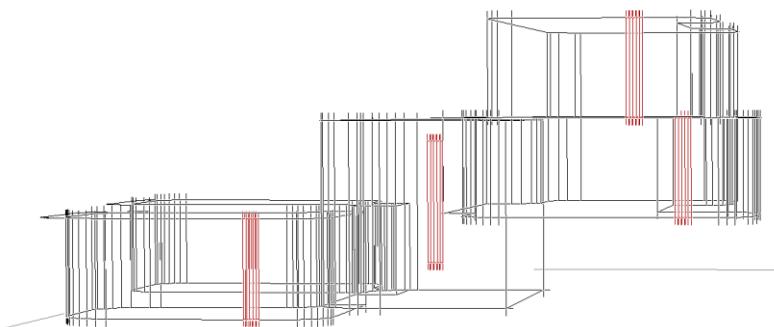
Increase the vertical shade(ring-like structures) by 0.5 m on the **North East and North West**



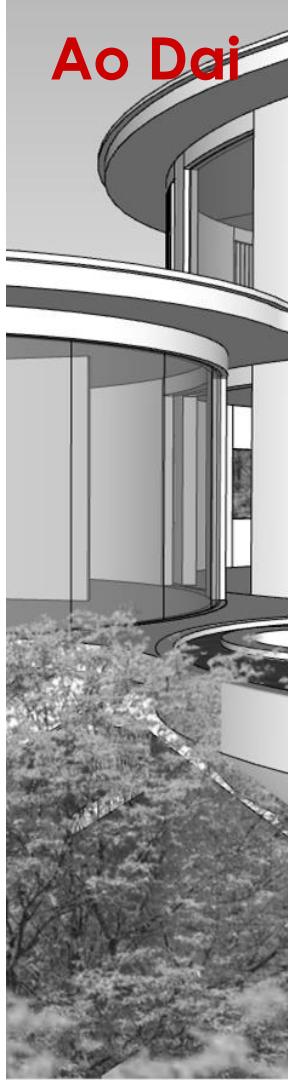
[

## Shading Suggestion

400 m<sup>2</sup> Villas

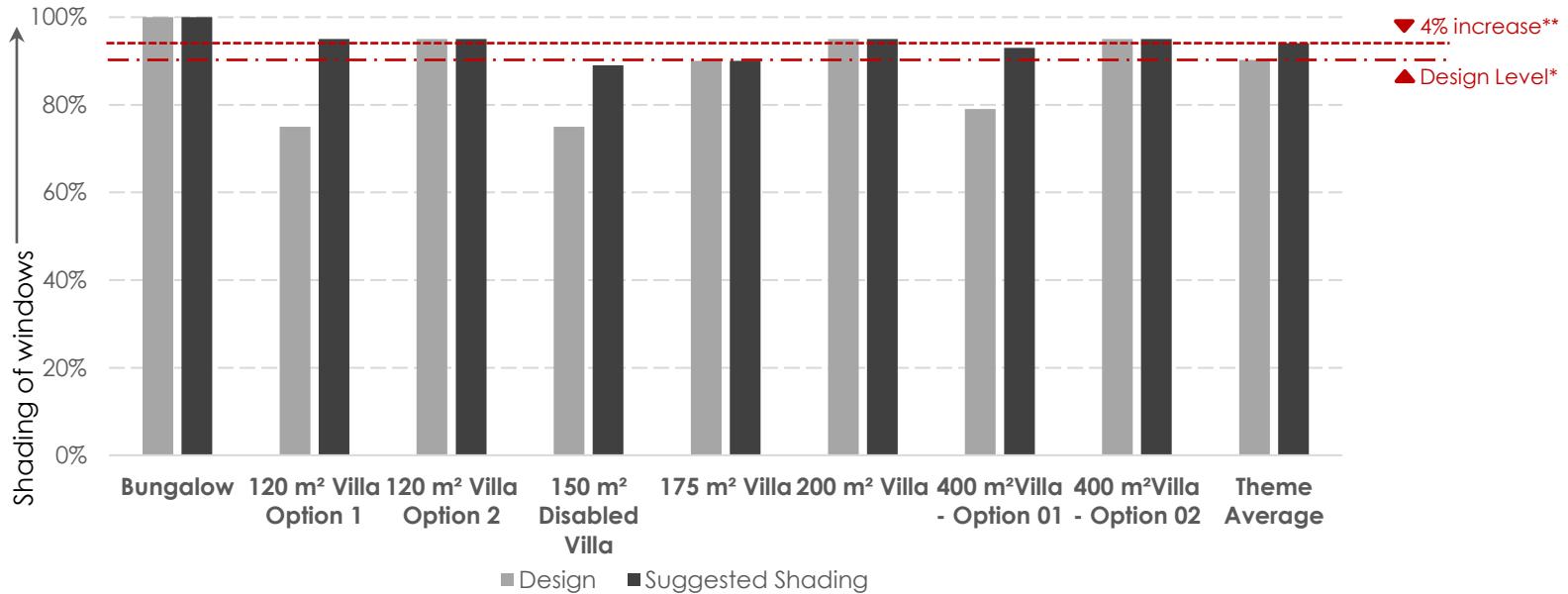


Add vertical fins/louvers to all the slit windows on all levels

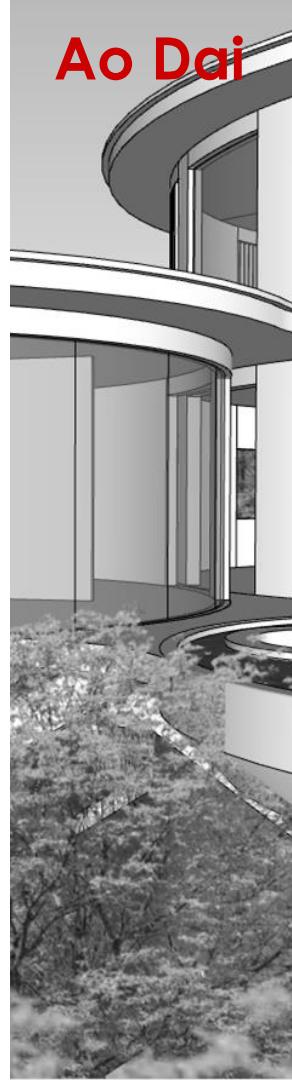


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## Shading: Units



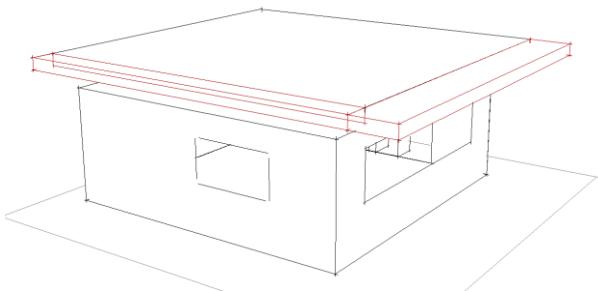
On addition of extra shading devices, 94% shading can be obtained



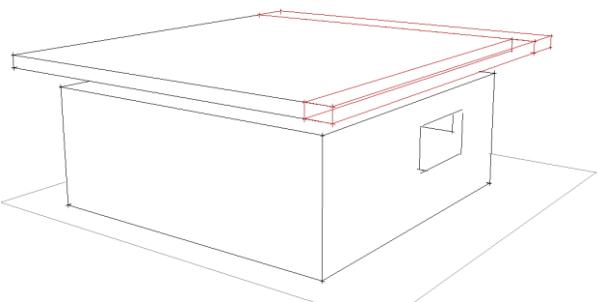
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## Shading Suggestion

Bungalow



Increase the overhang depth by 0.9 m on the **West**



Increase the overhang depth by 0.5 m on the **South**

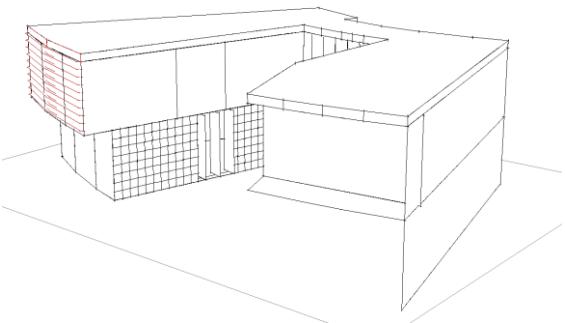


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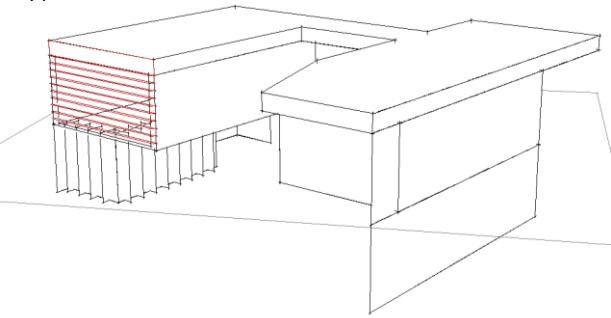
## Shading Suggestion

120 m<sup>2</sup> Villas

Type 01



Type 02



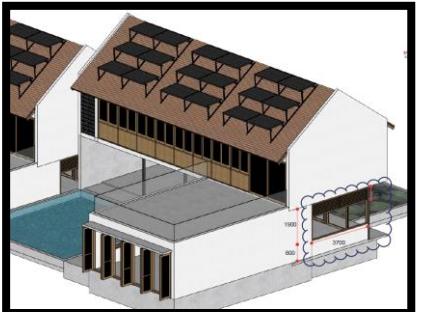
Add 10 louvers of 100 mm depth at a distance of 240 mm each



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## Shading Suggestion

150 m<sup>2</sup> Disable Villa

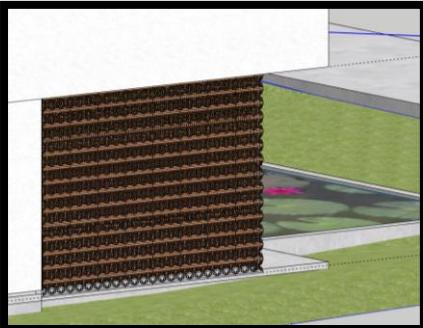


Three options of shading devices are feasible for this window as highlighted below.

Note that the window cannot be shaded completely as it faces the North-West direction.



Option 01 – vertical louvers of 200 mm depth at 74 mm distance centre to centre



Option 03 –  
Lattice/trellis



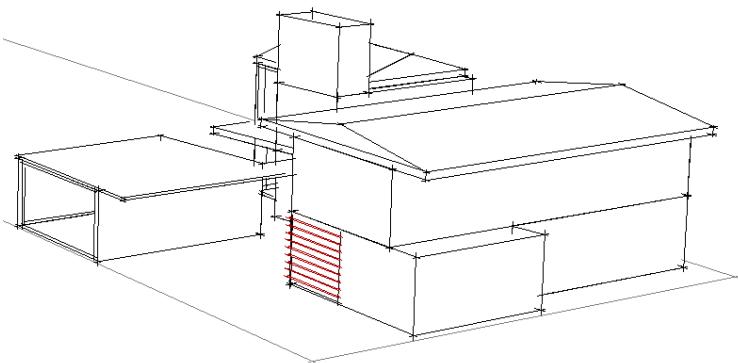
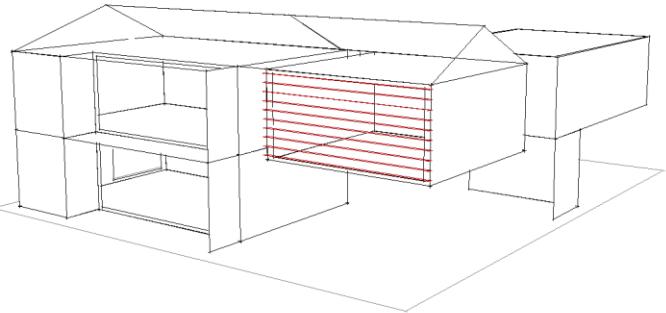
Option 02 –  
louvered  
shutters



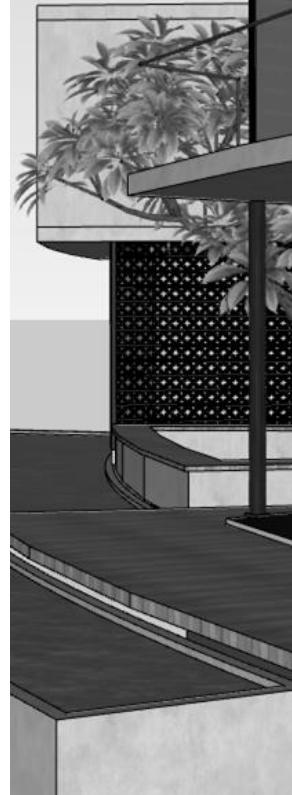
[

## Shading Suggestion

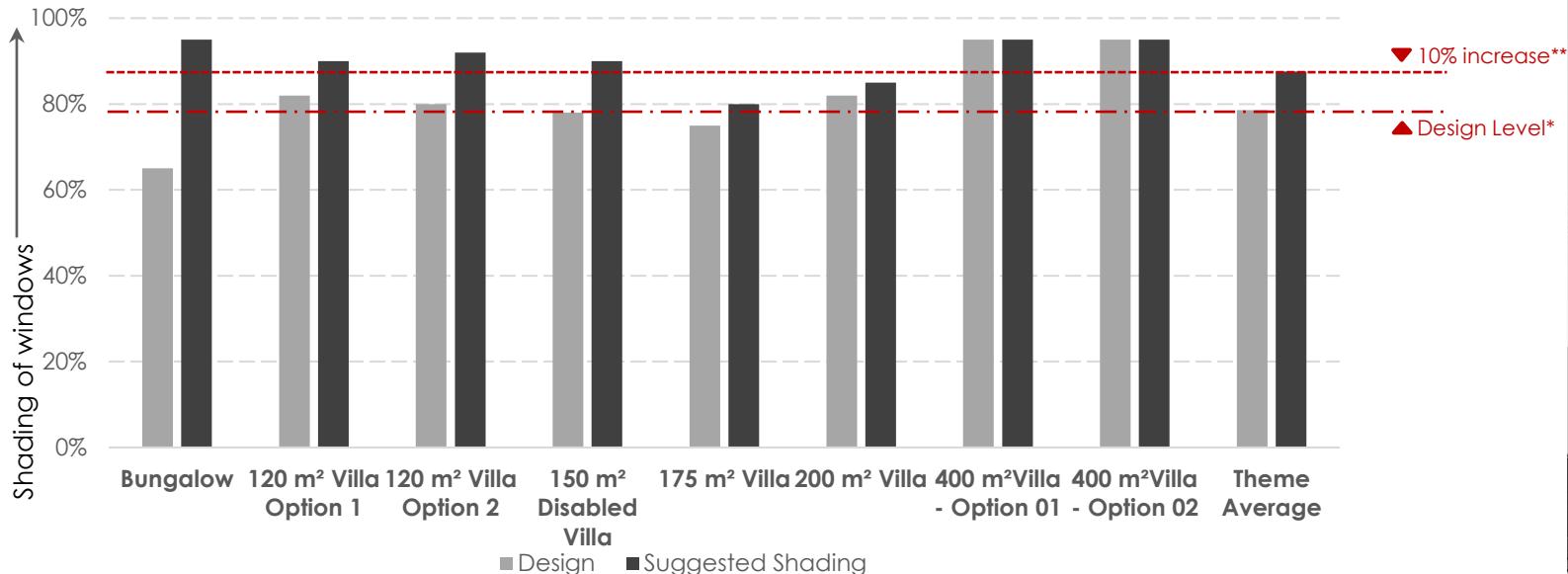
175 m<sup>2</sup> Villa & 200 m<sup>2</sup> Villa



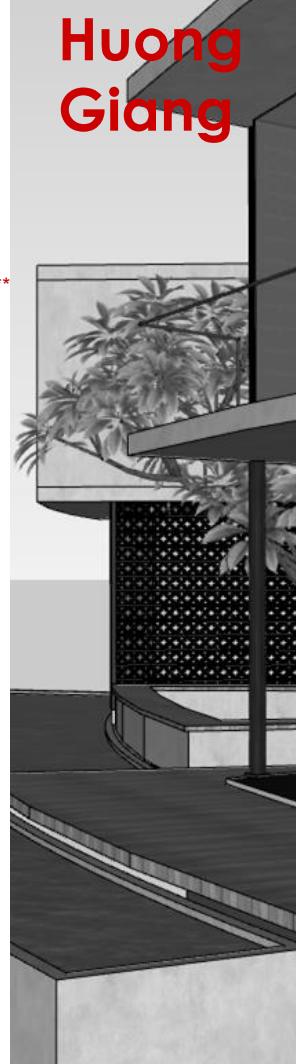
Add 10 louvers of 100 mm depth at a distance of 240 mm each



## Shading: Units



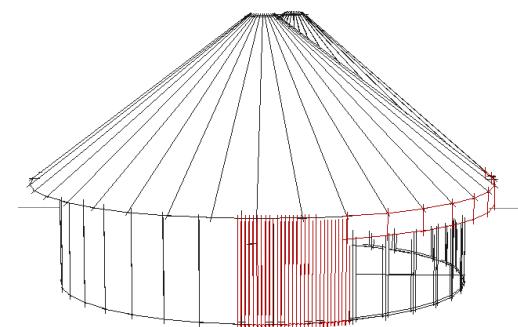
On addition of extra shading devices, 88% shading can be obtained.



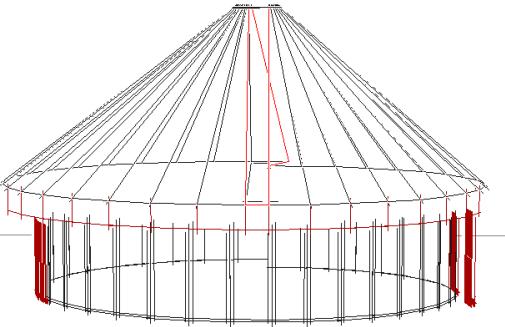
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## Shading Suggestion

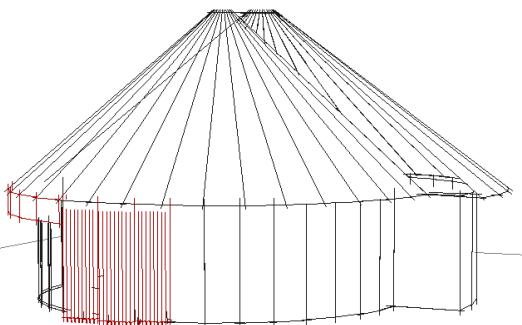
Bungalow



Add vertical louvers/fins to all windows facing **East**



Add vertical shade of 0.5 m on the roof periphery on **North East, North** and **North West**



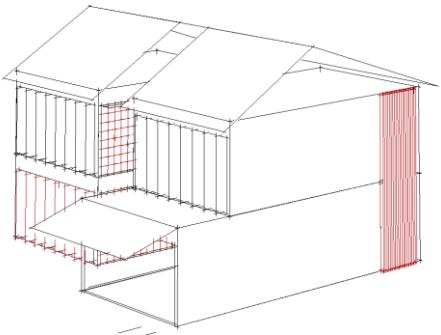
Add vertical louvers/fins to all windows facing **West**



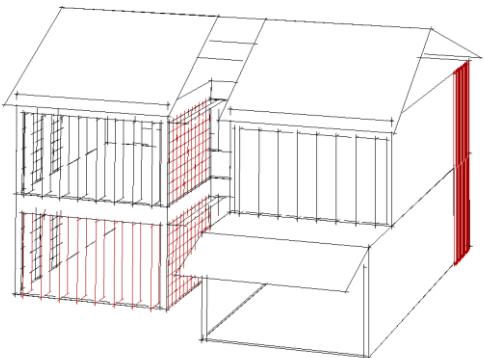
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## Shading Suggestion

120 m<sup>2</sup> Villa- Option 1 & 2



Add fins/louvers to windows near the staircase



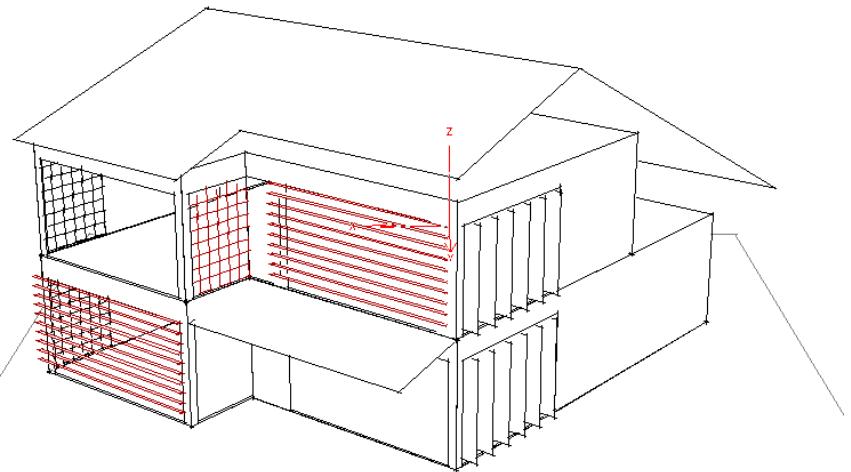
Add shutters to the picture window on the ground floor and lattices to the courtyard windows on both floors



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## Shading Suggestion

150 m<sup>2</sup> Disable Villa



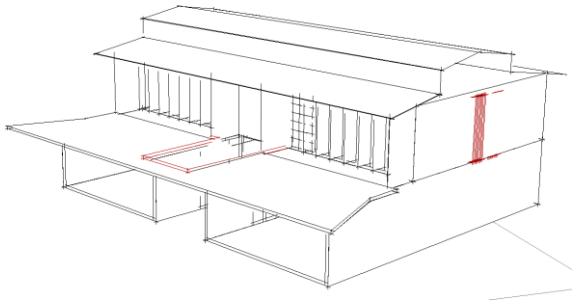
- Add 10 louvers of 100 mm depth at a distance of 240 mm each to both the picture windows on ground and first floor
  - Add Lattice to the side window on the first floor



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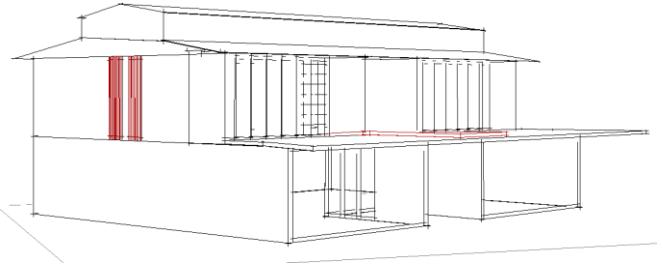
## Shading Suggestion

175 m<sup>2</sup> Villa



Shade the courtyard /entrance porch on the ground floor

Add fins/louvers to the slit windows in the bedroom



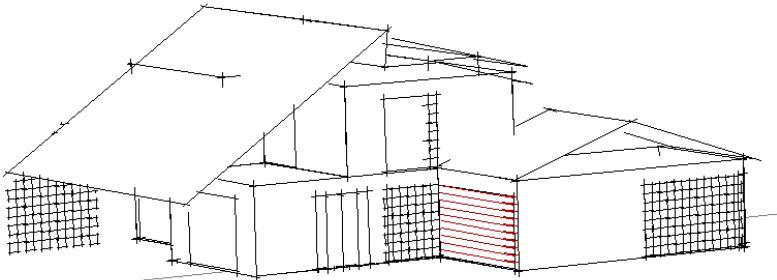
Add fins/louvers to the slit windows in the bedroom



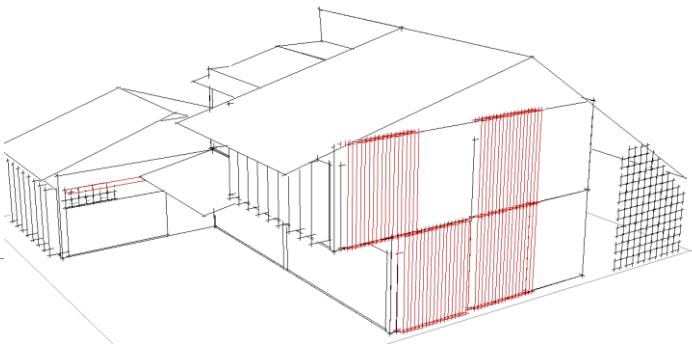
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## Shading Suggestion

200 m<sup>2</sup> Villa



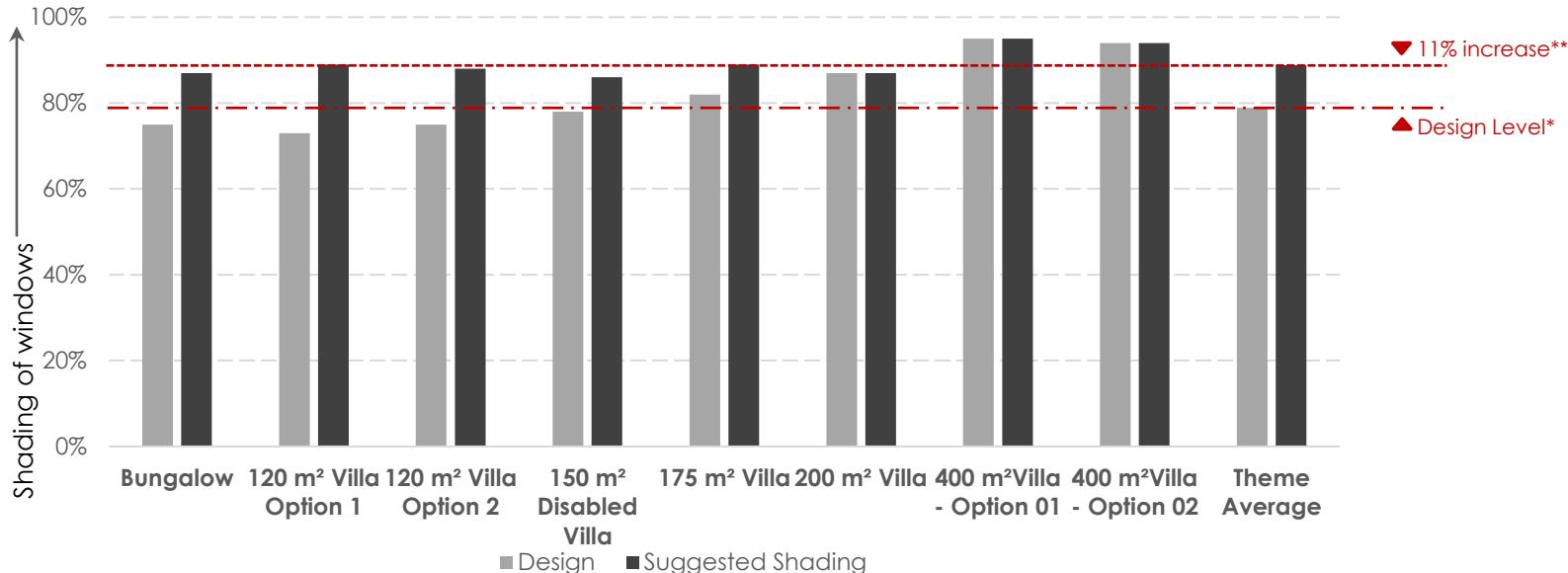
Add 10 louvers of 100 mm depth at a distance of 240 mm each to the picture window in the bedroom on ground floor



Add an overhang of 0.5 m to the ground floor bedroom window facing the courtyard  
Add fins/louvers to all the picture windows.



## Shading: Units

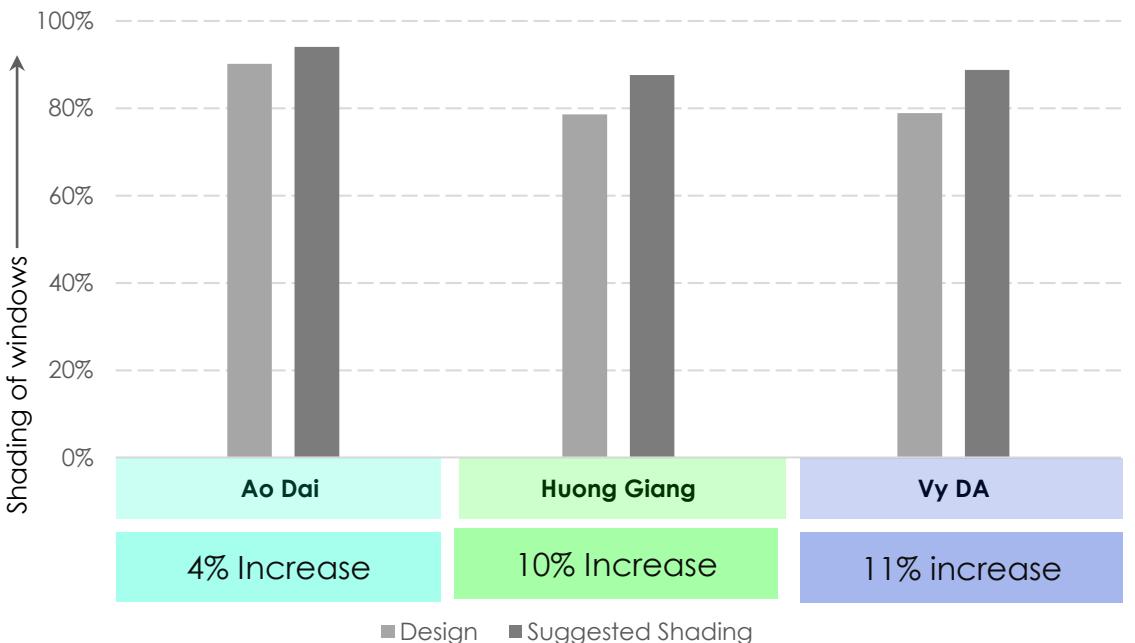


On addition of extra shading devices, 89% shading can be obtained.





## [ Shading: Themes



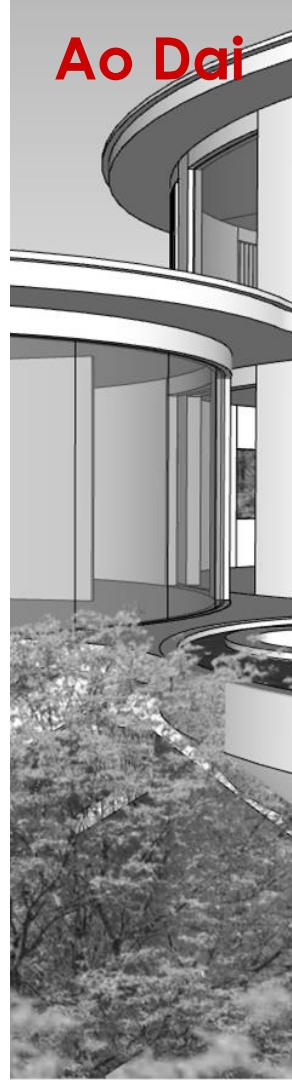
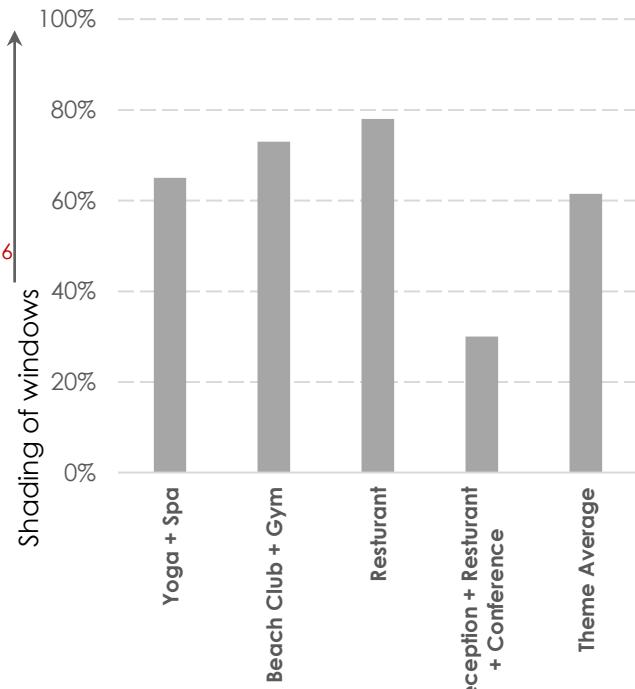
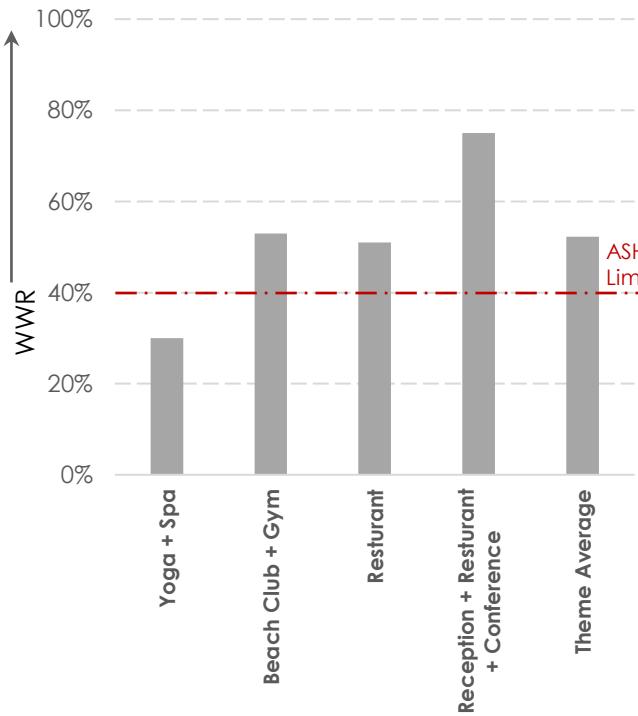


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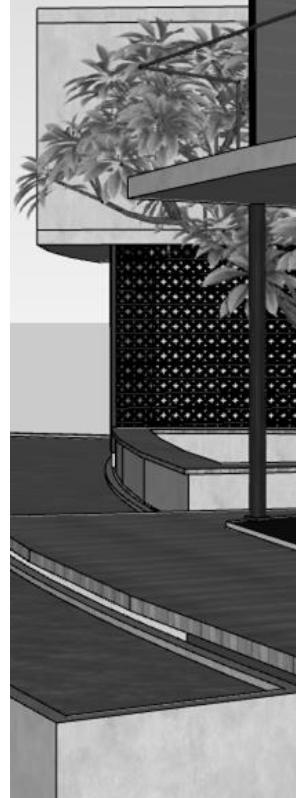
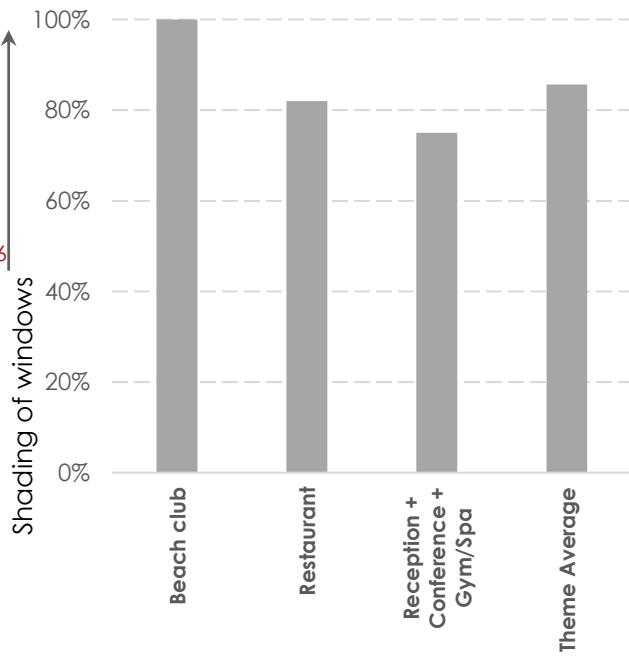
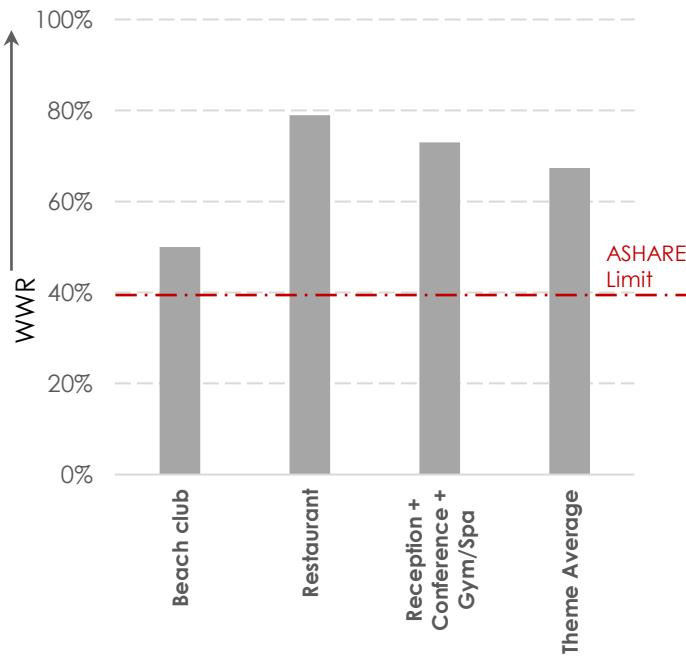
# Public Spaces

Preliminary Analysis

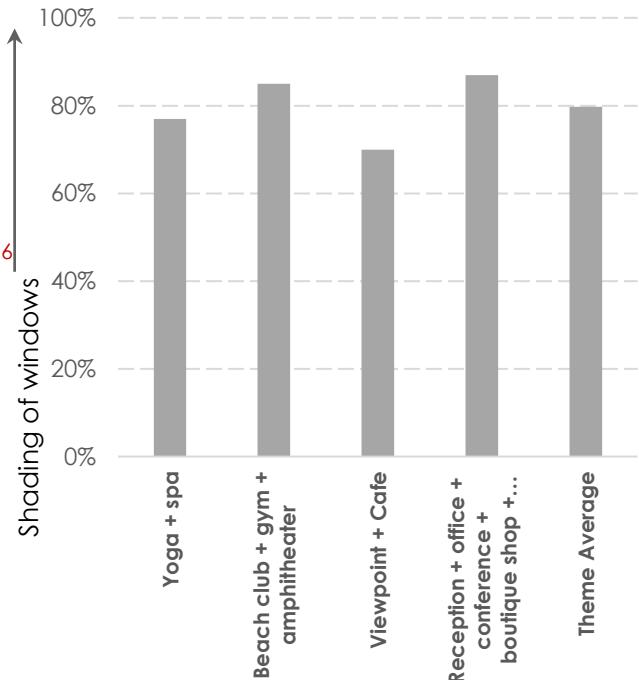
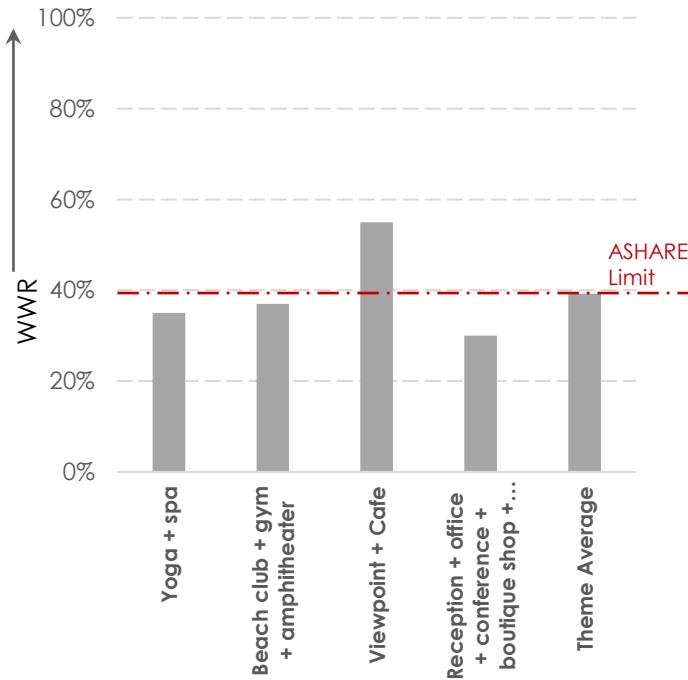
## Public Areas



## Public Areas



## Public Areas

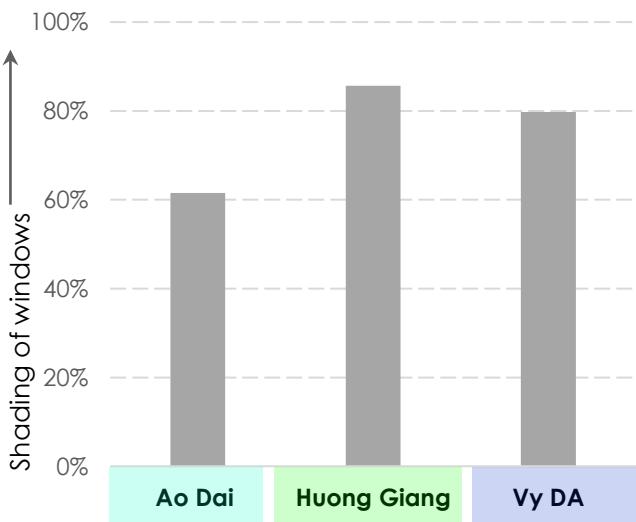


Ao Dai

## Shading: Themes



Considering all the three themes, public buildings in the theme Vy DA have the least WWR, 1% below the ASHRAE 90.1-2016 limits.



Additional shading needs to be provided in all the three themes.





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Daylight Analysis

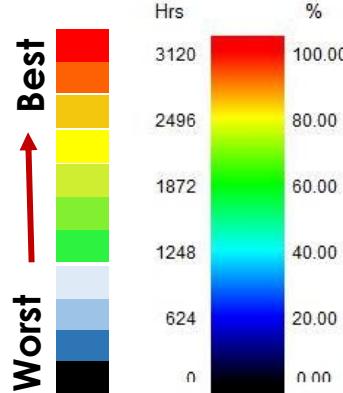
# Day Lighting Evaluation Methodology

Metrics are used for evaluating Day Light

- Useful Day light Illuminance (UDI)

## ***Useful Day light Illuminance (UDI): 100 to 2000 lux***

- UDI is the annual occurrence of illuminance distribution across the working Plane that is within a range of 100 to 2000 lux considered “**useful**” by occupants
- High UDI % suggest that the entire floor area of the space under evaluation has Adequate day light throughout the year.

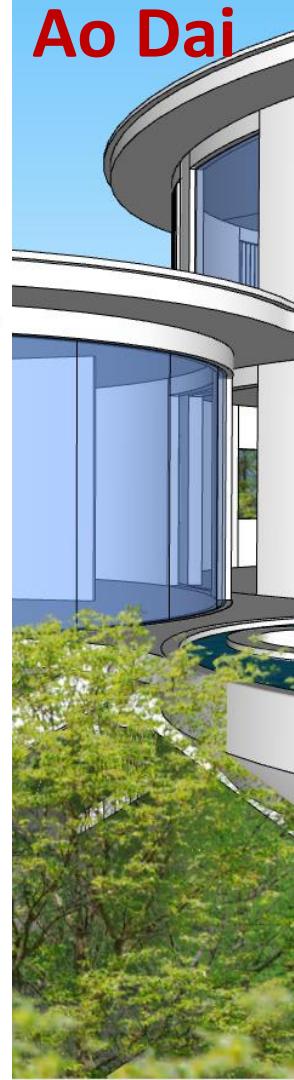
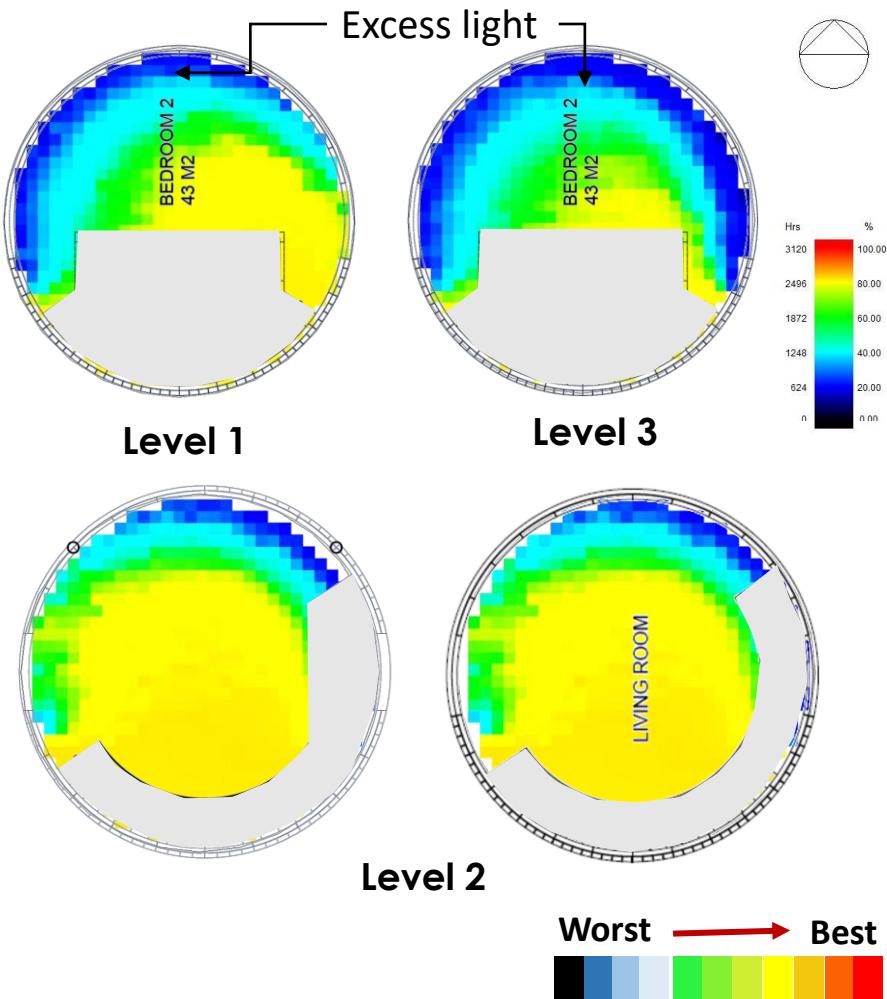


# Villa 120 – Type 1 : Useful Daylight Luminance Analysis (100 to 2000 Lux)

Ao Dai



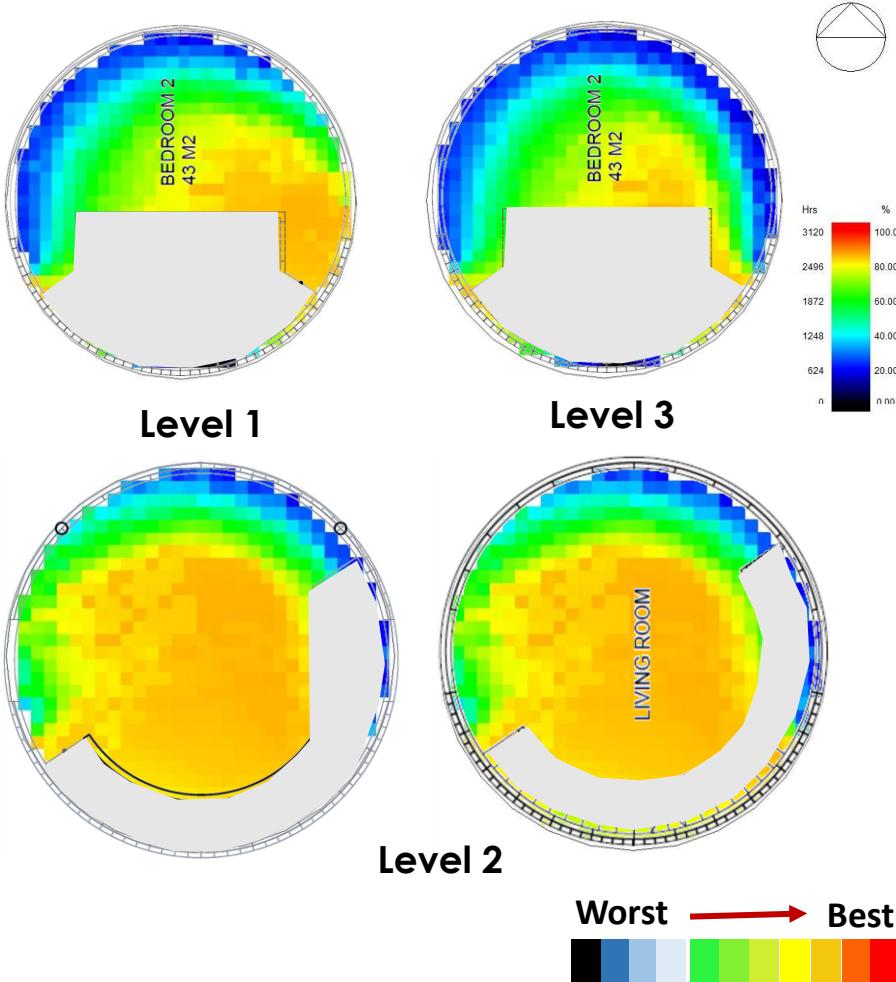
- Useful daylight is observed for **90 %** time over approximately **100 % of the occupiable floor area** at all levels.



# Recommendation

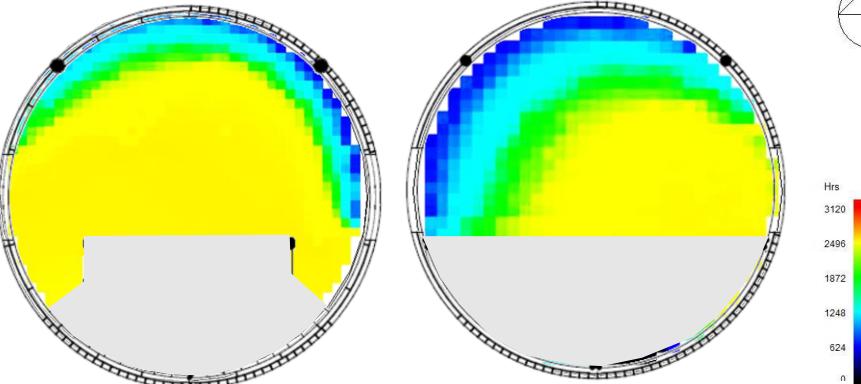
Ao Dai

- Useful daylight is observed for **95 %** time over approximately **100 % of the occupiable floor area** at all levels with addition of **0.5 m shading devices** on **North, South East and East facades** and reducing percentage of window to wall ratio to 40%

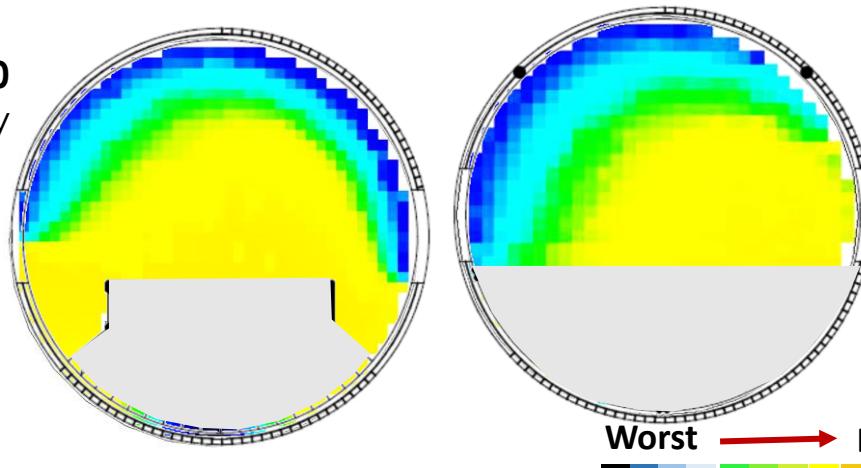


# Villa 120 – Type 2: Useful Daylight Luminance Analysis (100 to 2000 Lux)

Ao Dai



Level 1



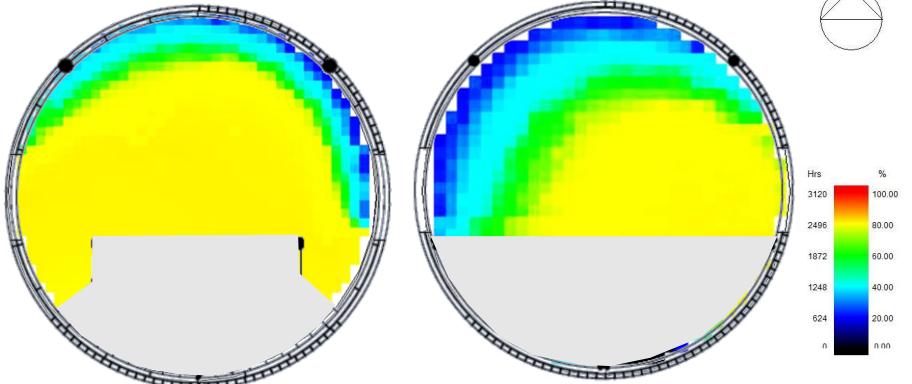
Level 2

- Useful daylight is observed **for 20 to 90 %** time over approximately **100 % of the occupiable floor area** at all levels.

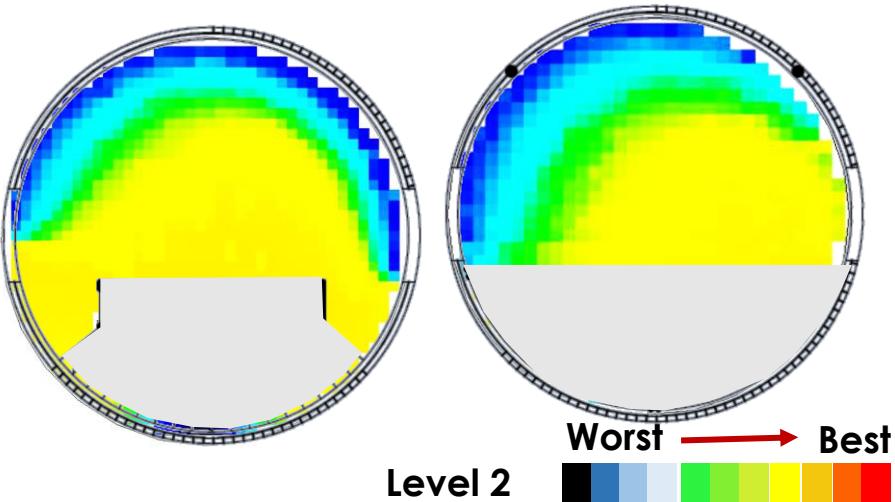


# Disable Villa : Useful Daylight Luminance Analysis (100 to 2000 Lux)

AoDai



Level 1



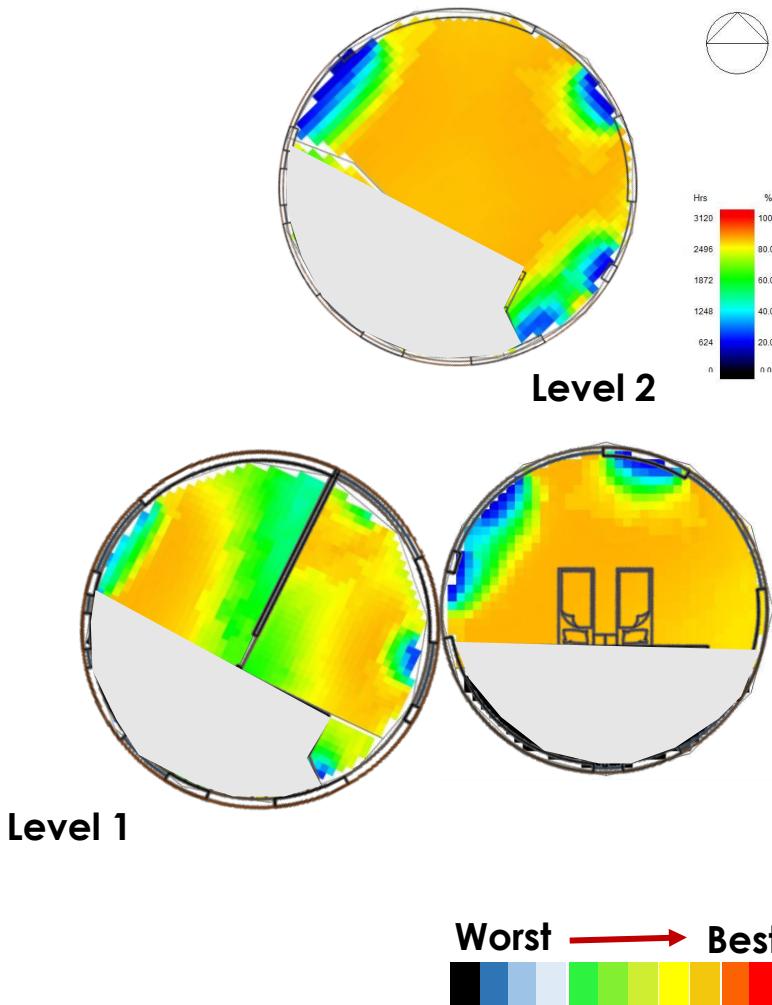
Level 2

# Villa 175 sq. m : Useful Daylight Luminance Analysis (100 to 2000 Lux)

AoDai

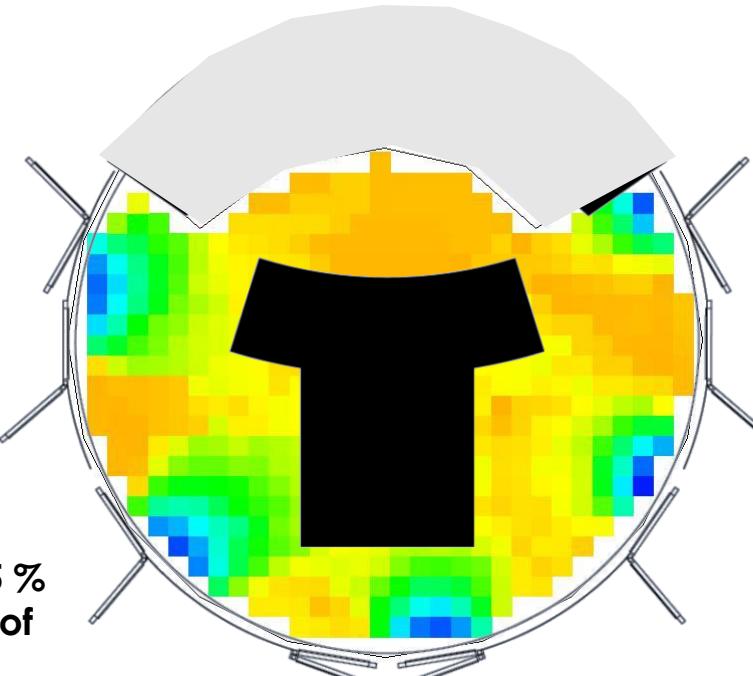


- Useful daylight is observed for **90 %** time over approximately **100 % of the occupiable floor area** at level 1 and **90 %** at level 2.



# Bungalow: Useful Daylight Luminance Analysis (100 to 2000 Lux)

AoDai



Level 1

Worst → Best

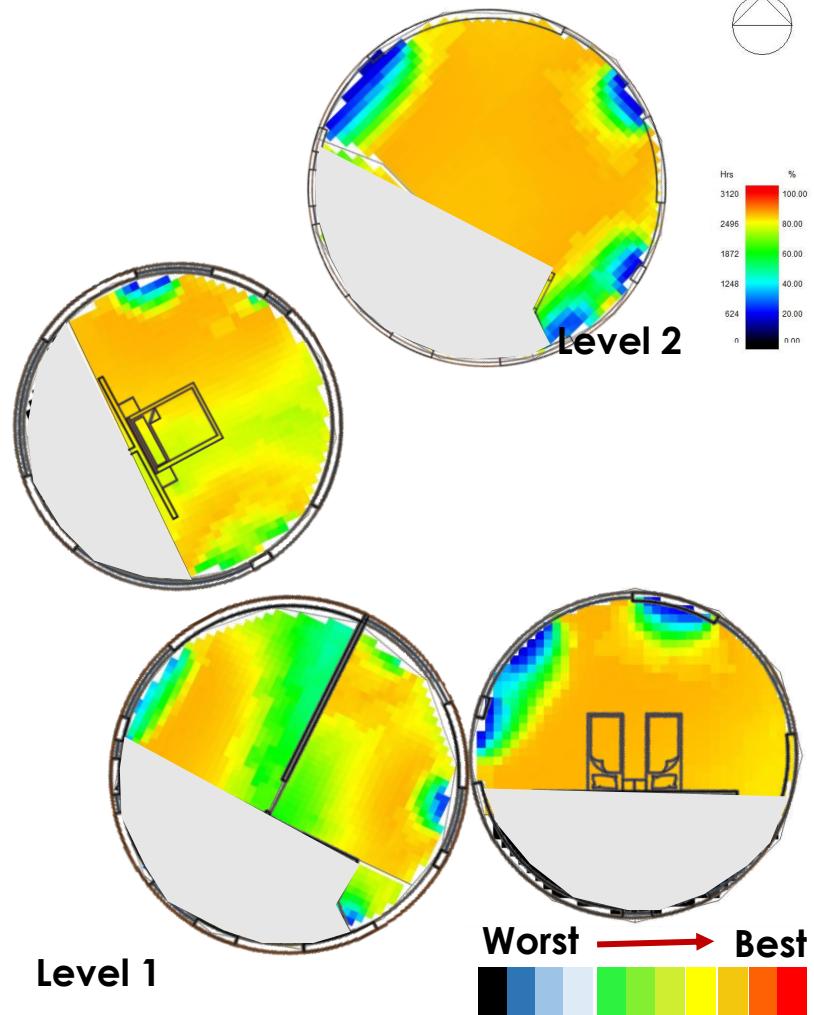
A horizontal color bar used as a legend. It shows a gradient from black on the left to red on the right, with intermediate colors in shades of blue, cyan, green, and yellow. Below the bar, the word 'Worst' is on the left and 'Best' is on the right, with a red arrow pointing from 'Worst' towards 'Best'.

# Villa 200 sq. m : Useful Daylight Luminance Analysis (100 to 2000 Lux)

AoDai

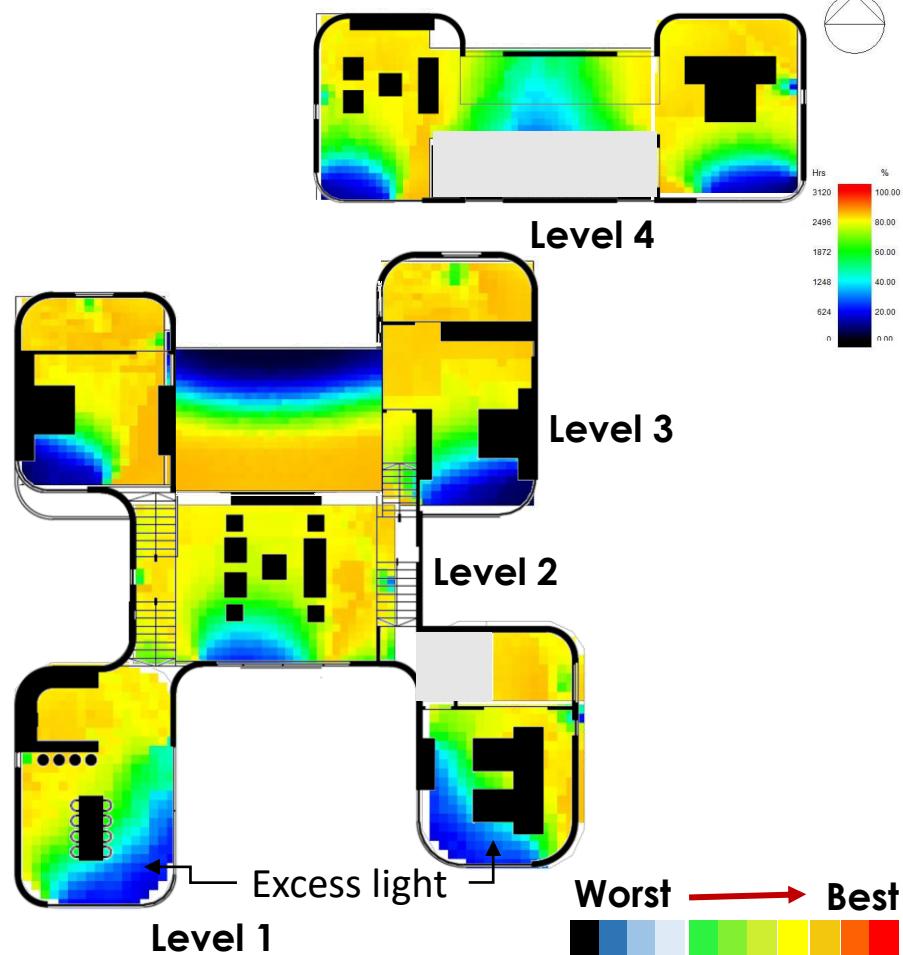


- Useful daylight is observed for **90%** time over approximately **100 % of the occupiable floor area** at level 1 and 2.



# Villa 400 sq. m -1 : Useful Daylight Luminance Analysis (100 to 2000 Lux)

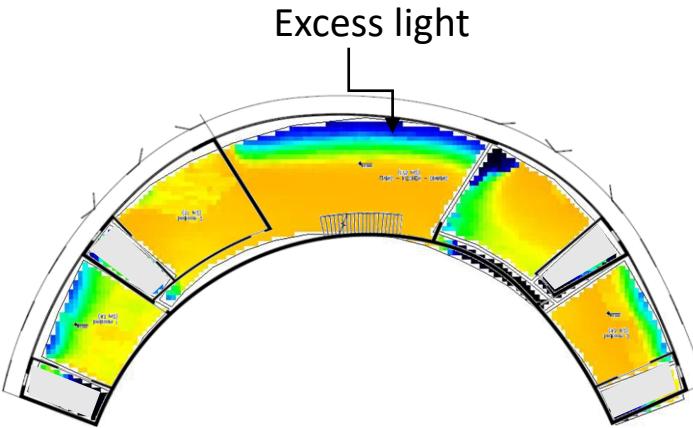
AoDai



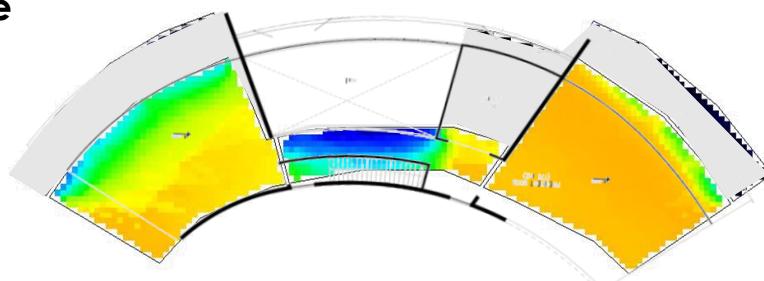
- Useful daylight is observed for **20 to 95 %** time over approximately **100 % of the occupiable floor area.**

# Villa 400 sq. m - 2 : Useful Daylight Luminance Analysis (100 to 2000 Lux)

AoDai



Level 1

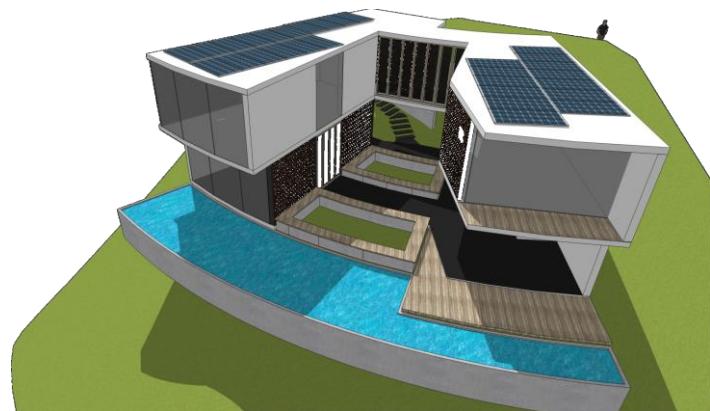


Level 2

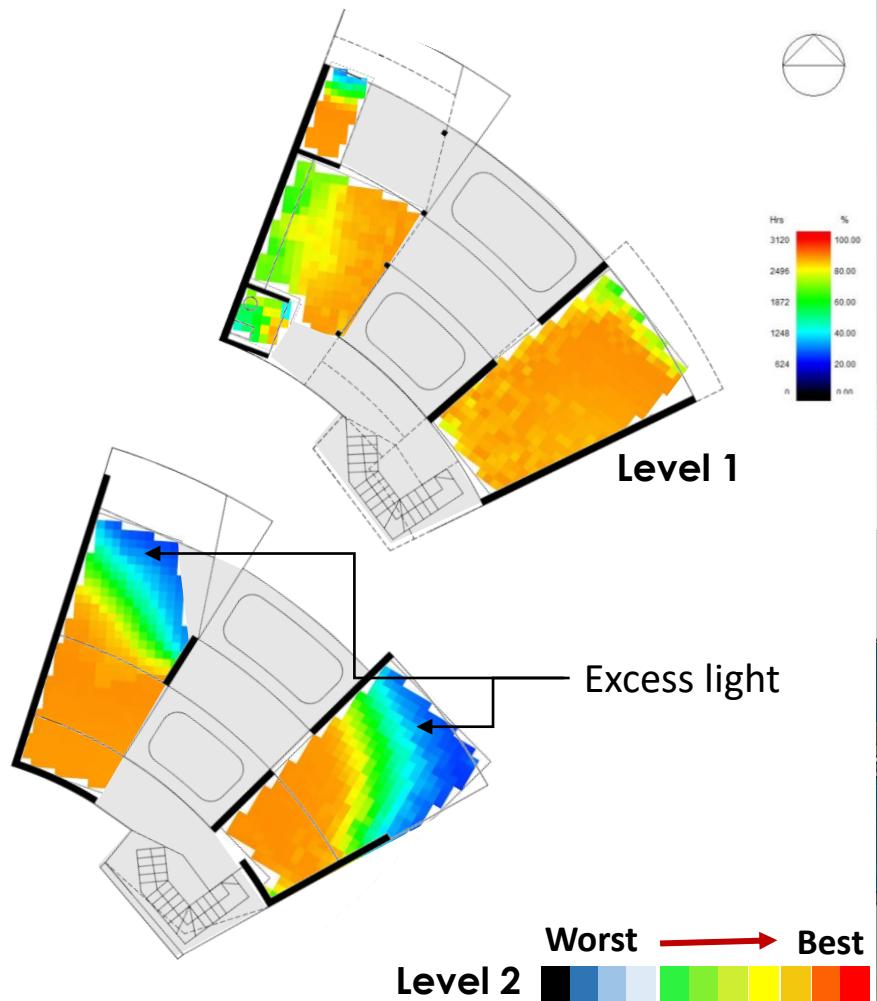
Worst → Best

# Villa 120 – Type 1 : Useful Daylight Luminance Analysis (100 to 2000 Lux)

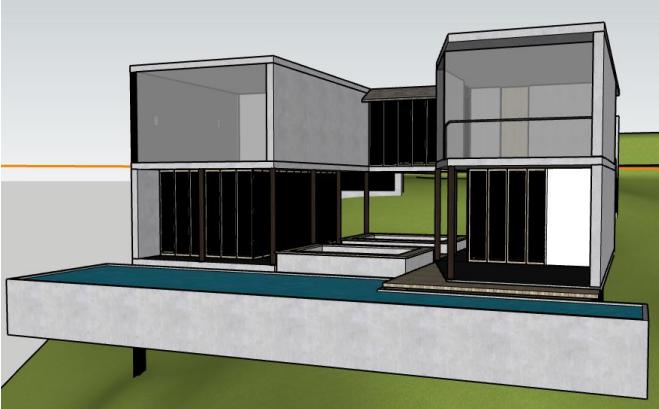
Huong  
Giang



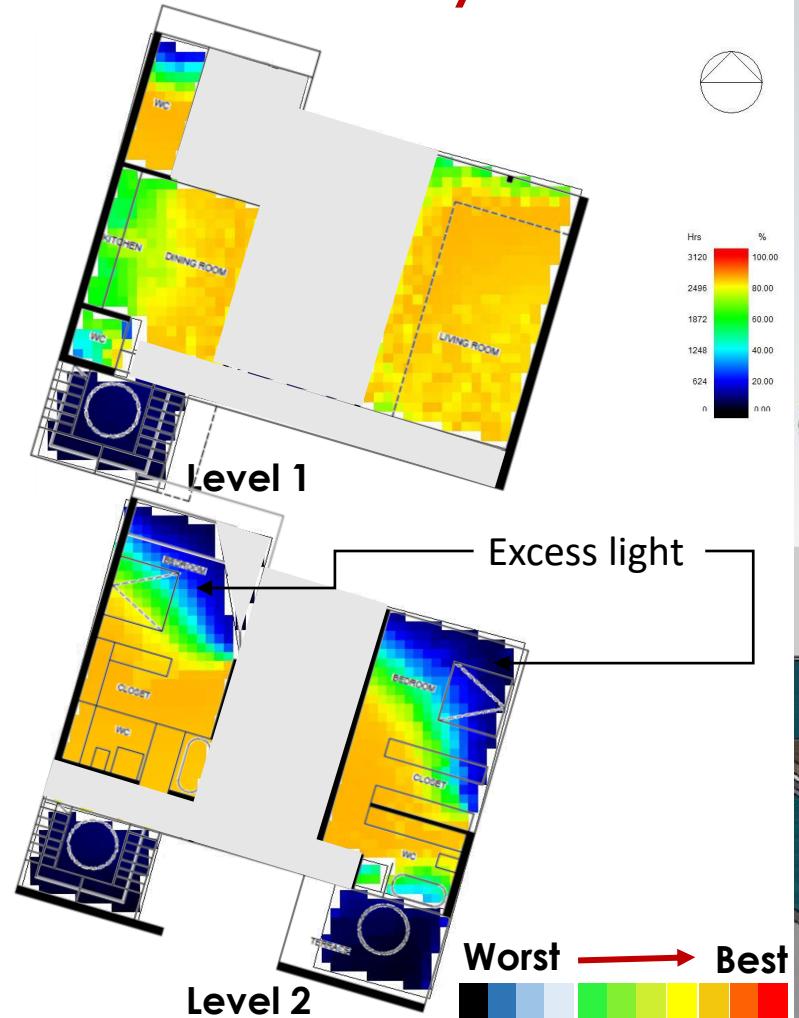
- Useful daylight is observed for **20 to 90 %** time over approximately **100 % of the occupiable floor area** at all levels.



# Villa 120 – Type 2: Useful Daylight Luminance Analysis (100 to 2000 Lux)



- Useful daylight is observed for **20 to 95 %** time over approximately **100 % of the occupiable floor area** at all levels.



Huong  
Giang

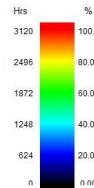
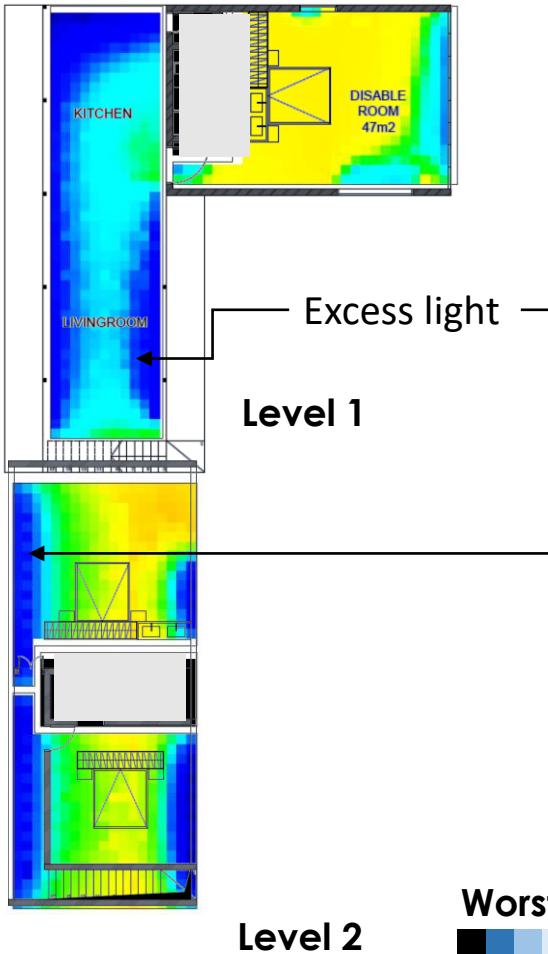


# Disable Villa : Useful Daylight Luminance Analysis (100 to 2000 Lux)

Huong  
Giang

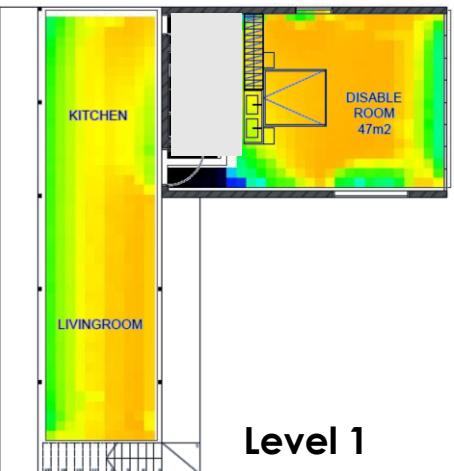


- Useful daylight is observed for **20 to 95 %** time over approximately **100 % of the occupiable floor area** at all levels.

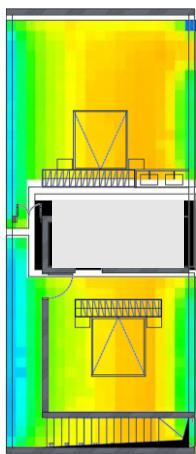


# Recommendation

- Useful daylight is observed for **60 to 95 %** time over approximately **100 % of the occupiable floor area** at all levels by reducing **window to wall ratio to 40 %**



Level 1



Level 2

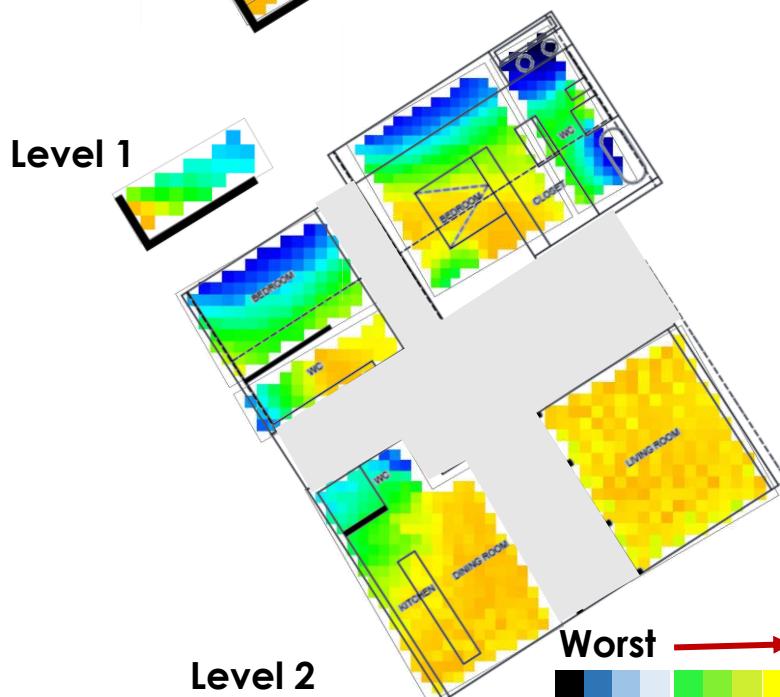
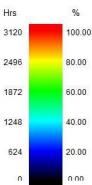
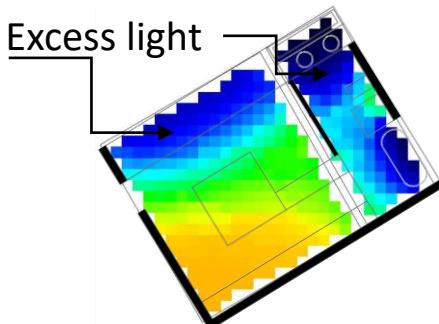
Worst → Best



Huong  
Giang

# Villa 175 sq. m : Useful Daylight Luminance Analysis (100 to 2000 Lux)

Huong  
Giang



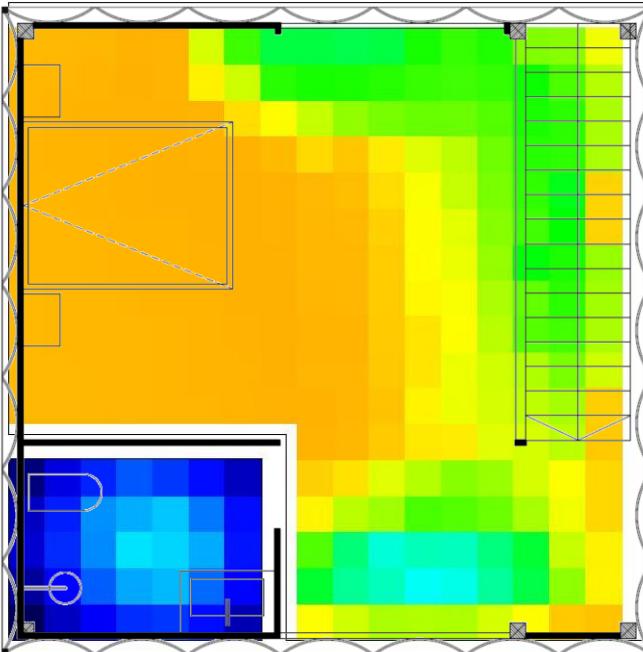
- Useful daylight is observed for **20 to 95 %** time over approximately **100 % of the occupiable floor area** at level 1 and 2.

# Bungalow: Useful Daylight Luminance Analysis (100 to 2000 Lux)

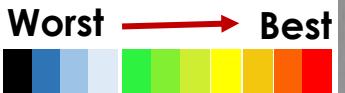
Huong  
Giang



- Useful daylight is observed for **60 to 90%** time over approximately **100 % of the occupiable floor area.**

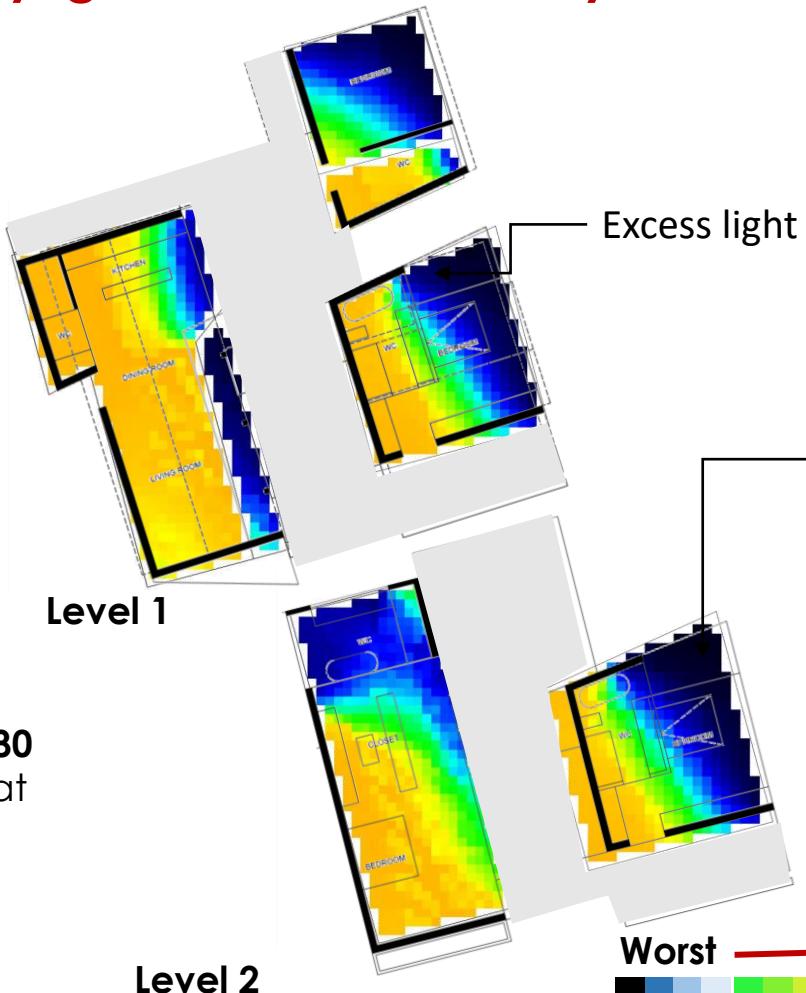


Worst → Best



# Villa 200 sq. m : Useful Daylight Luminance Analysis (100 to 2000 Lux)

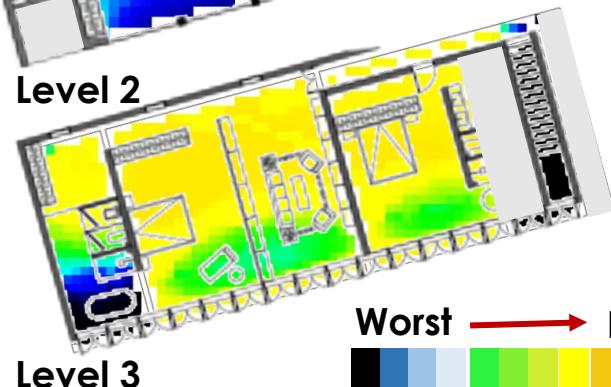
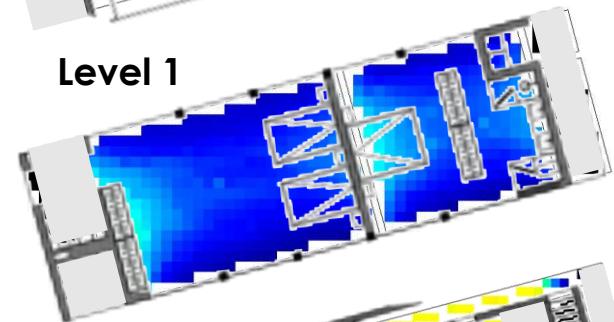
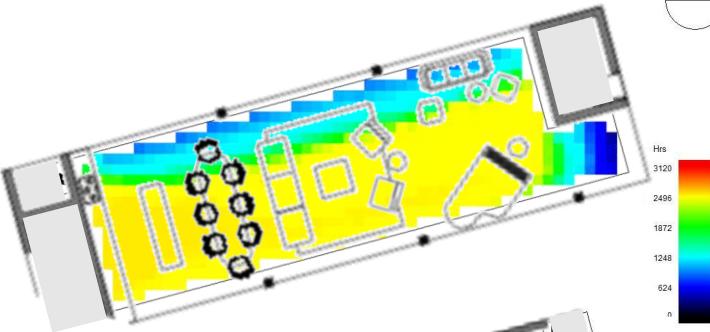
Huong  
Giang



- Useful daylight is observed for **20 to 95%** time over approximately **80 % of the occupiable floor area** at level 1 and 2.

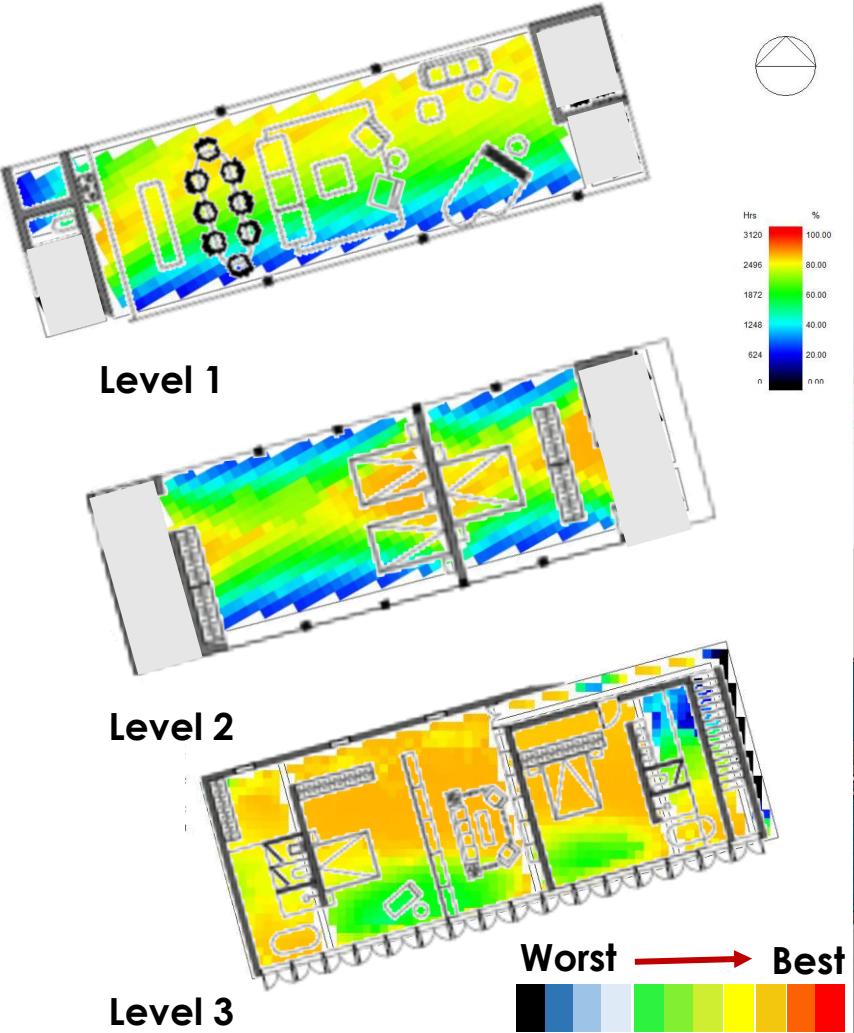
# Villa 400 sq.m – Type 1: Useful Daylight Luminance Analysis (100 to 2000 Lux)

Huong  
Giang



# Recommendation

- Useful daylight is observed for **40 to 95%** time over approximately **100 %** of the occupiable floor area at all levels by reduction of window to wall ratio to 40%.

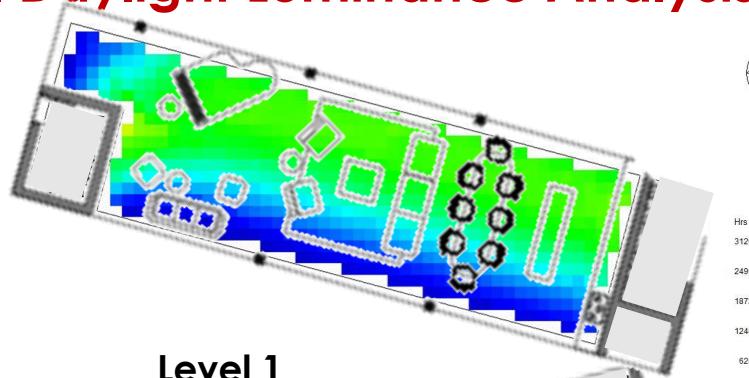


Huong  
Giang

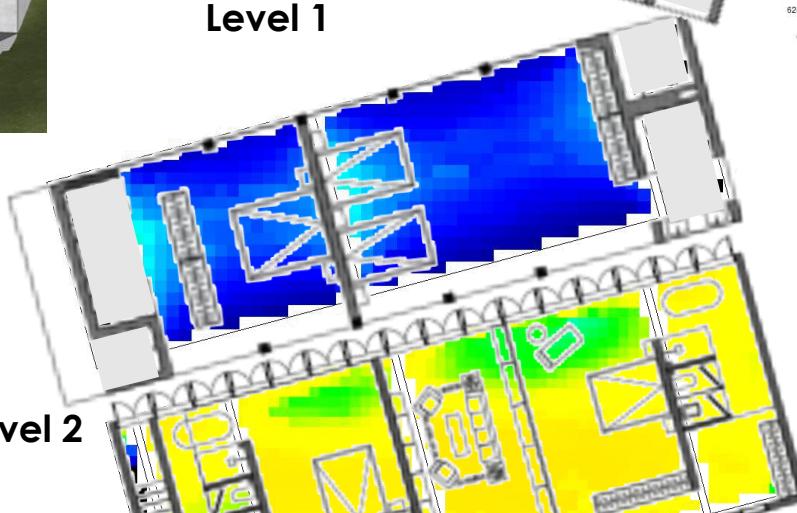


# Villa 400 sq. m – Type 2 : Useful Daylight Luminance Analysis (100 to 2000 Lux)

Huong  
Giang



Level 1



Level 2

Level 3

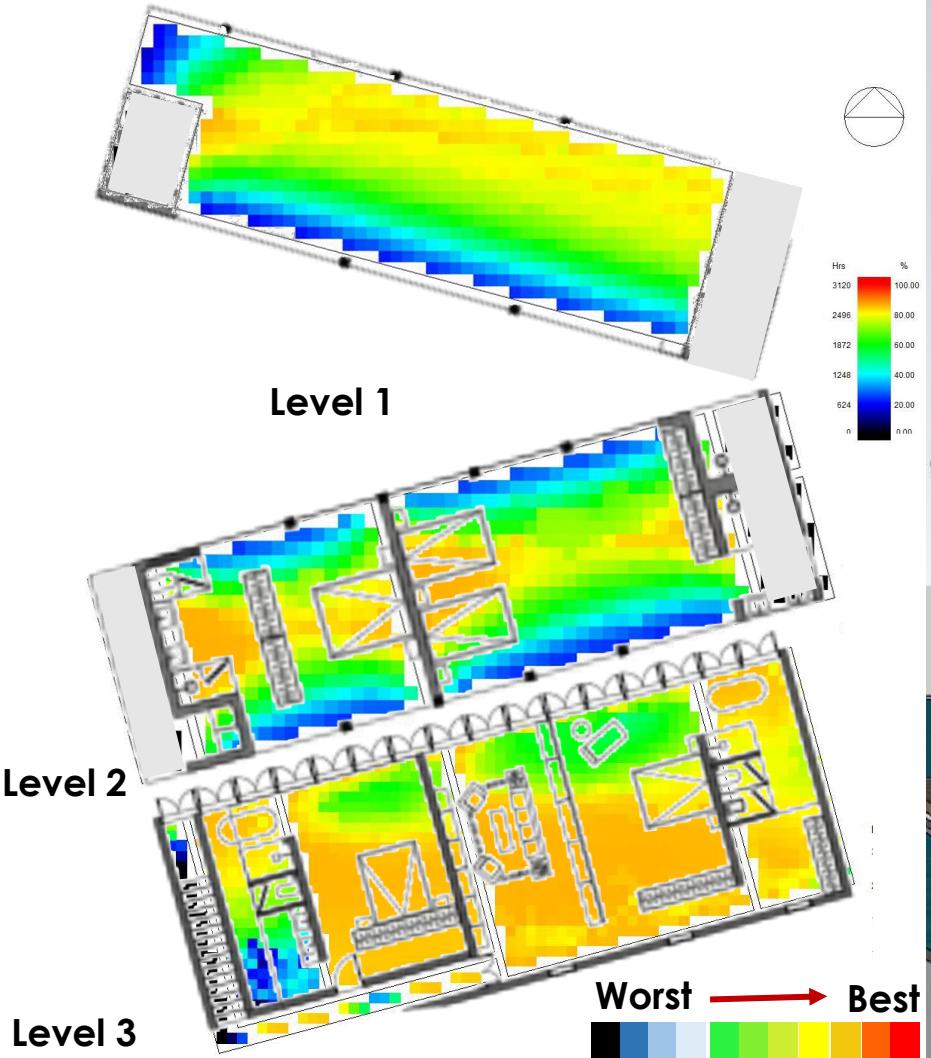


Worst → Best



## Recommendation

- Useful daylight is observed for **40 to 95%** time over approximately **100 % of the occupiable floor area** at all levels by reduction of window to wall ratio to **40%**.



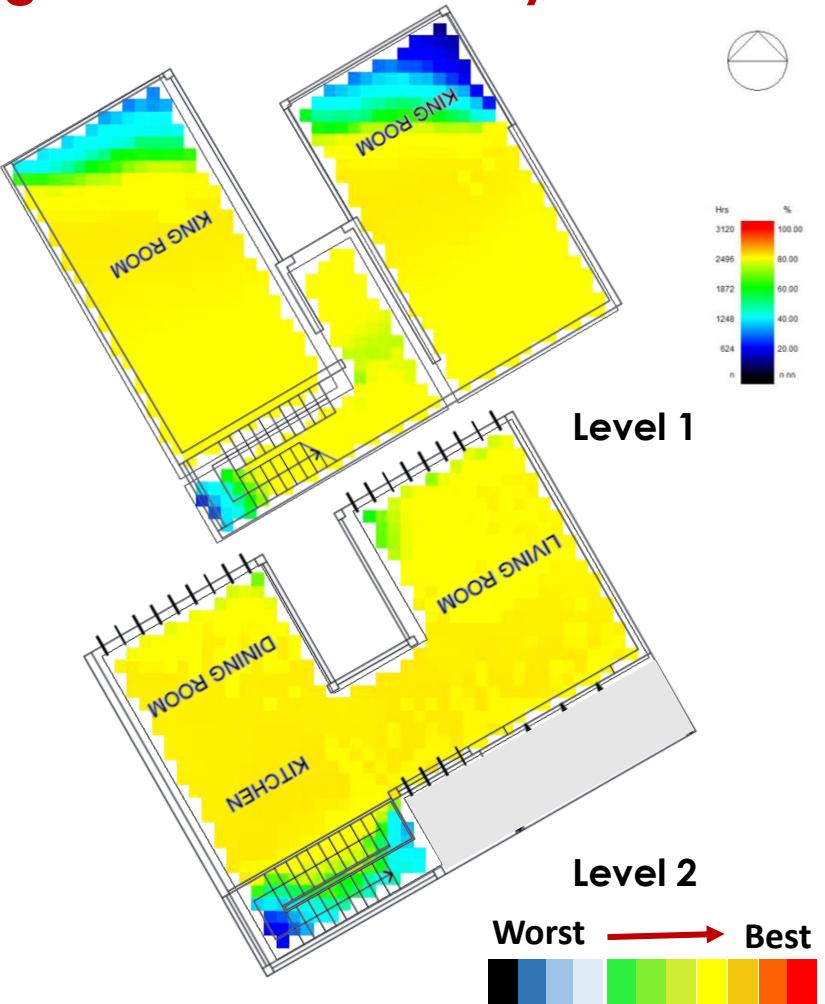
Huong  
Giang



# Villa 120 – Type 1 : Useful Daylight Luminance Analysis (100 to 2000 Lux)



- Useful daylight is observed for **20 to 90 %** time over approximately **100 % of the occupiable floor area** at all levels.



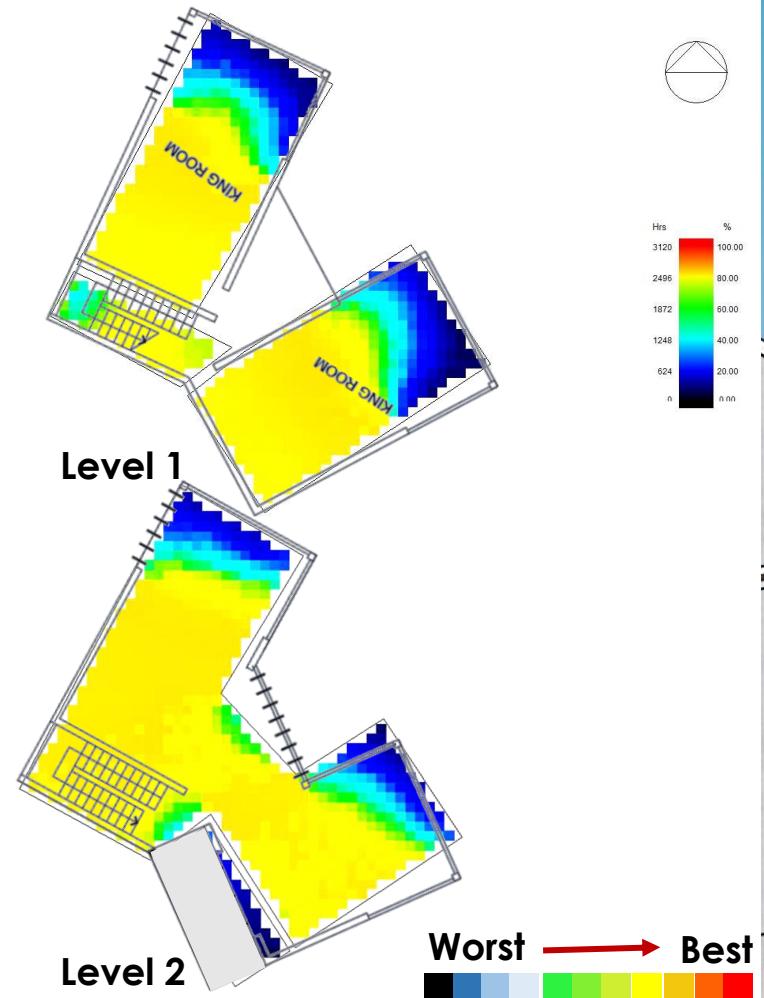
VyDA

# Villa 120 – Type 2: Useful Daylight Luminance Analysis (100 to 2000 Lux)

VyDA



- Useful daylight is observed for **20 to 90 %** time over approximately **100 % of the occupiable floor area** at all levels.

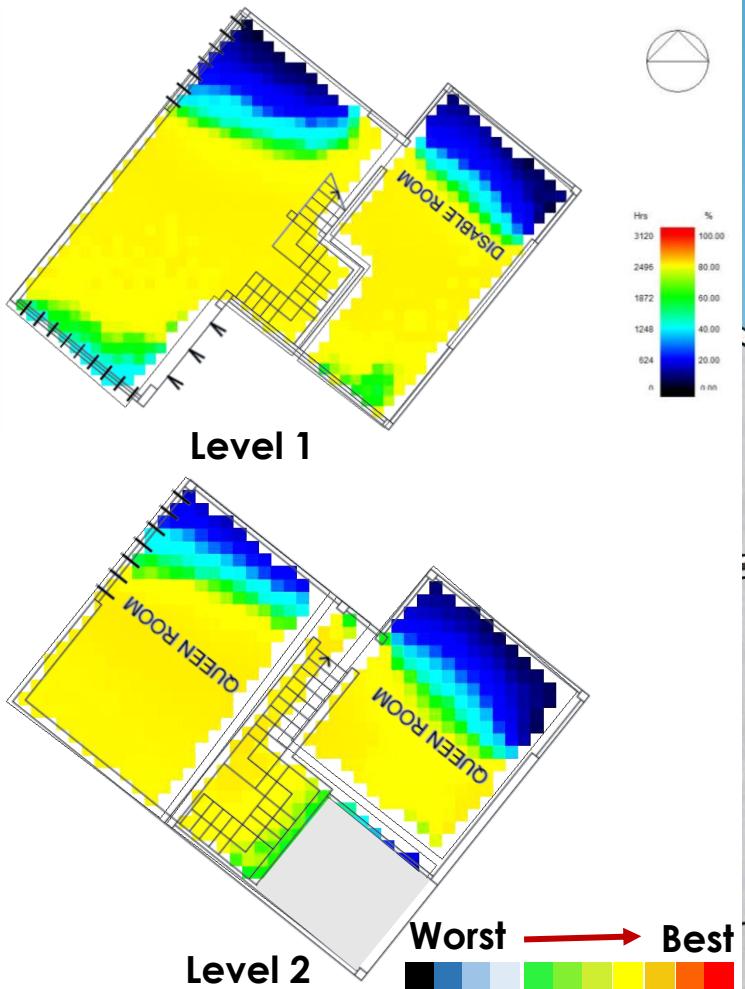


# Disable Villa : Useful Daylight Luminance Analysis (100 to 2000 Lux)

VyDA

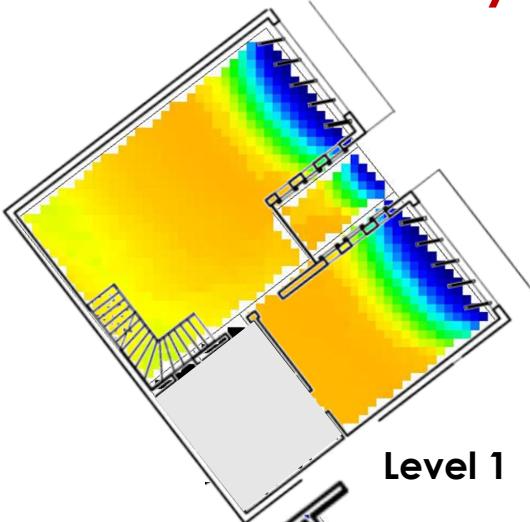
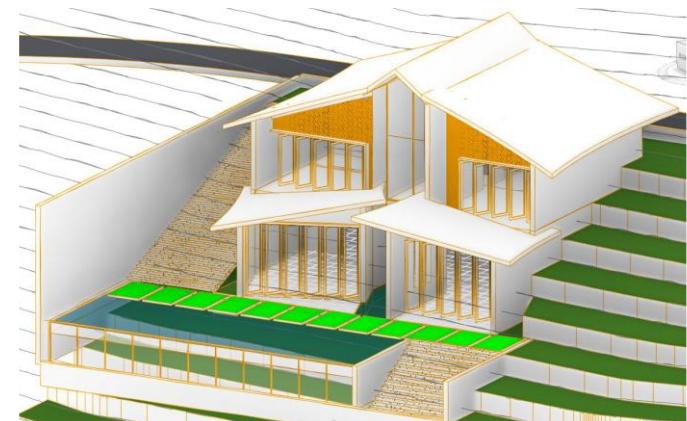


- Useful daylight is observed for **20 to 90 %** time over approximately **100 % of the occupiable floor area** at all levels.

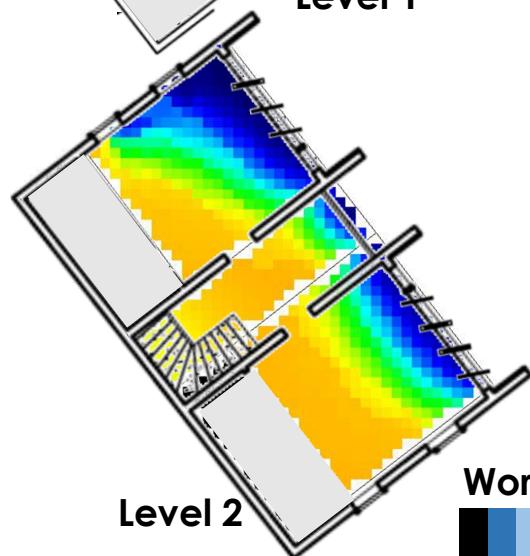


# Villa 175 sq. m : Useful Daylight Luminance Analysis (100 to 2000 Lux)

VyDA



Level 1



Level 2

Worst → Best

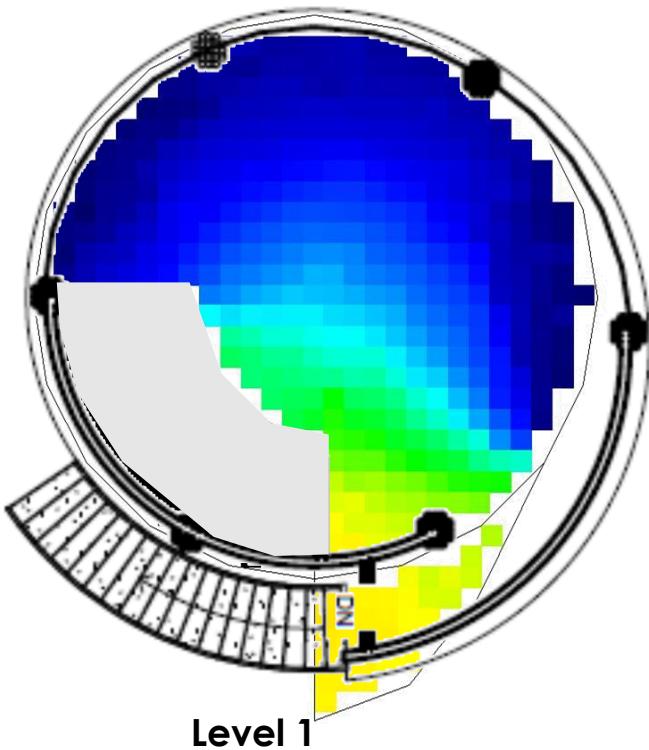


# Bungalow: Useful Daylight Luminance Analysis (100 to 2000 Lux)

VyDA



- Useful daylight is observed for **20 to 60%** time over approximately **100 % of the occupiable floor area**.



Level 1

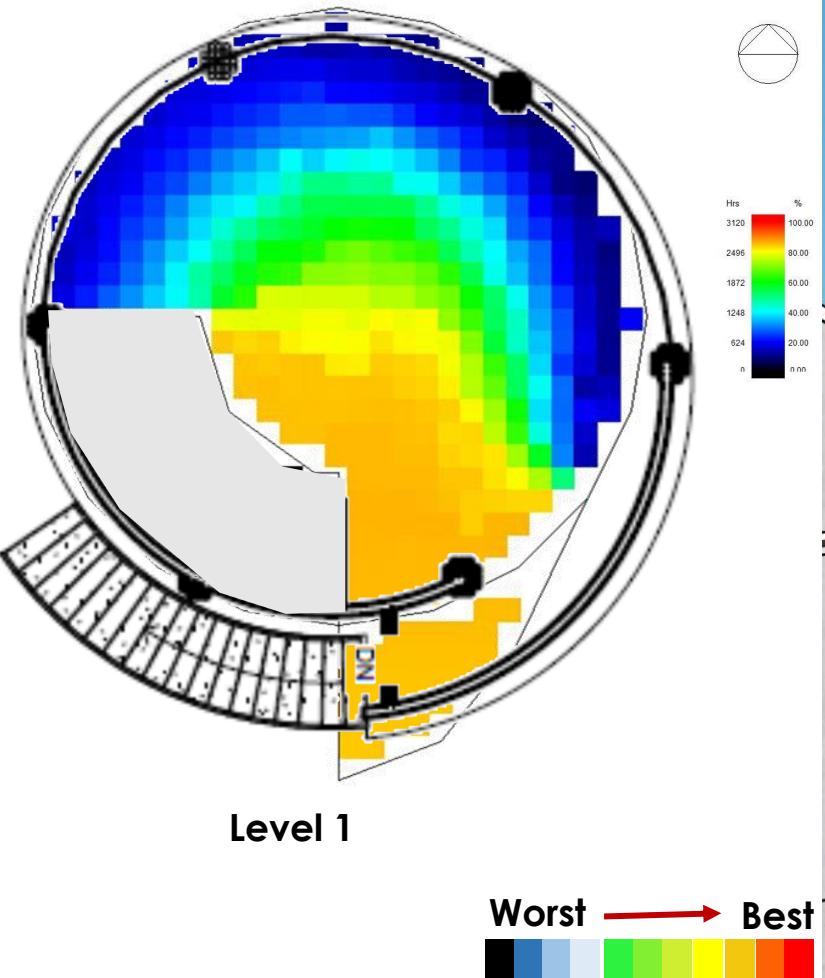
Worst → Best

A horizontal color bar legend with a black arrow pointing from left to right. The colors transition from black (labeled "Worst") through blue, green, and yellow to red (labeled "Best").

# Recommendations

VyDA

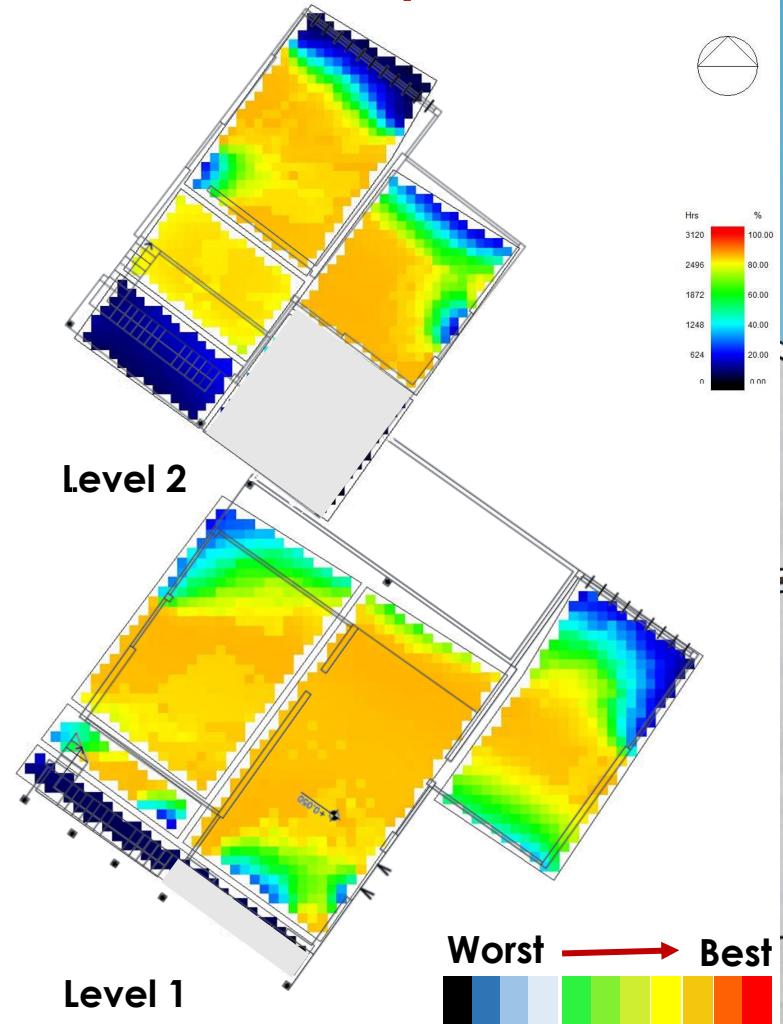
- Useful daylight is observed for 20 to 95% time over approximately **100 % of the occupiable floor area** with addition of blinds/jaalies on east façade instead of wall.



# Villa 200 sq. m : Useful Daylight Luminance Analysis (100 to 2000 Lux)



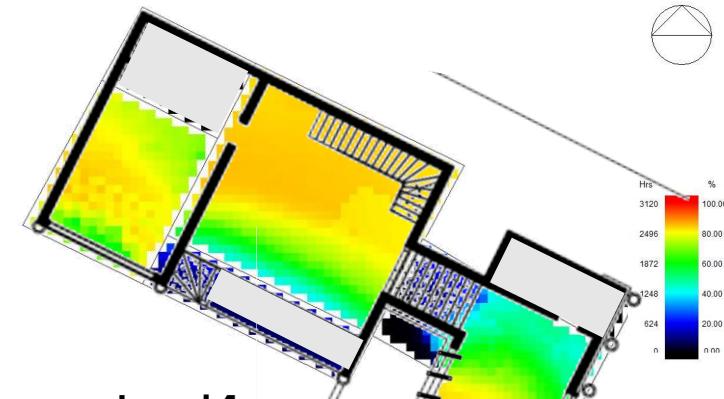
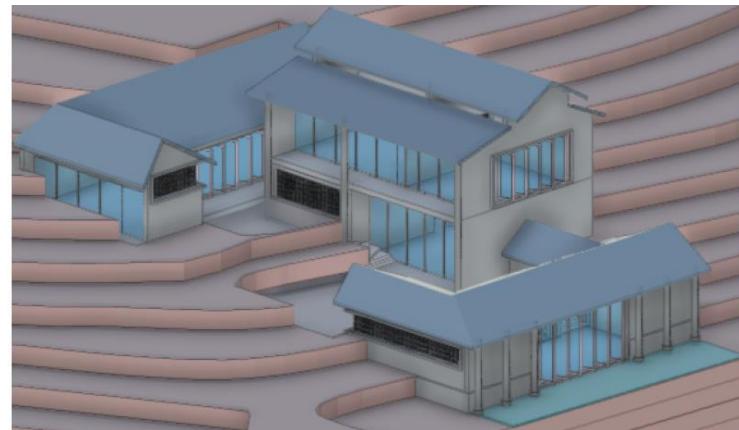
- Useful daylight is observed for **20 to 90% time** over approximately **100 % of the occupiable floor area** at level 1 and 2.



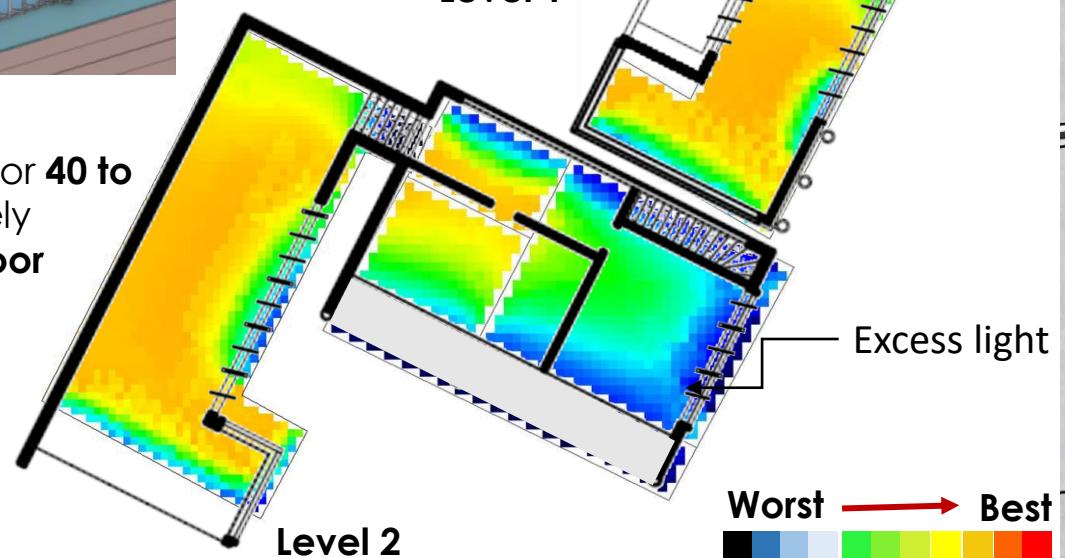
VyDA

# Villa 400 sq. m : Useful Daylight Luminance Analysis (100 to 2000 Lux)

VyDA



Level 1



Level 2



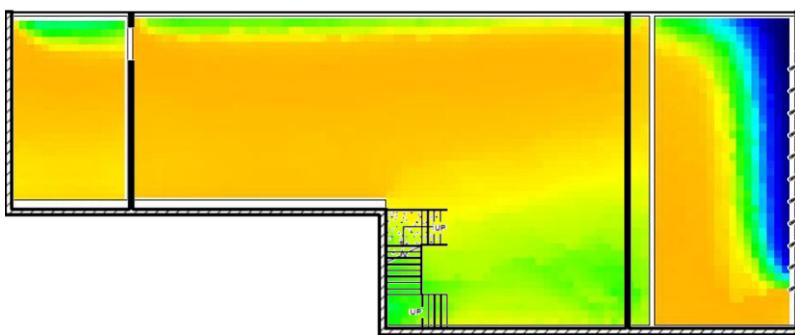
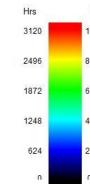
# Vip Villa 400 sq.m: Useful Daylight Luminance Analysis (100 to 2000 Lux)



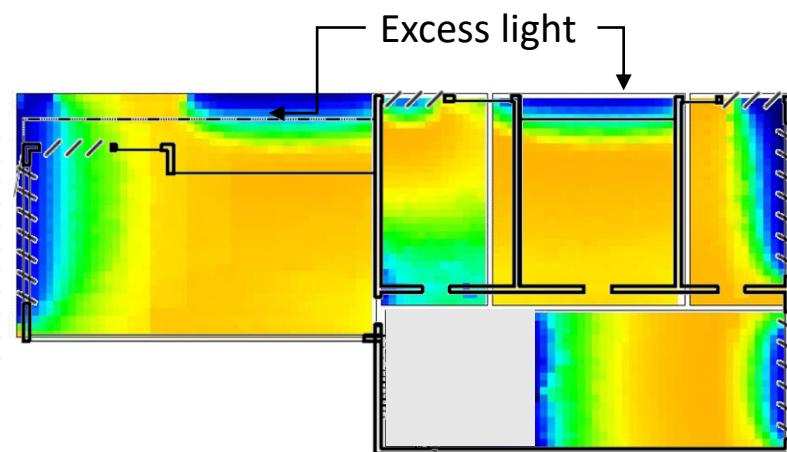
VyDA



- Useful daylight is observed for **20 to 95 %** time over approximately **100 %** of the **occupiable floor area** at **level 1 and 2**.



Level 1



Level 2

Worst → Best



## Inferences

- Overall daylight is observed for 20% to 90% of analysis hours over approximately all occupied spaces in all villas.

## Recommendations

- It is recommended to provide shading devices in Ao Dai to achieve maximum daylight for 40% to 95% time over all occupied spaces.
- It is recommended to restrict window to wall ratio to 40% to achieve daylight over all occupied spaces for 40 to 95% time.

## Findings

- Huong Giang shows uniform daylight distribution compared to Ao Dai and Vy Da.



# Energy Performance Analysis

[

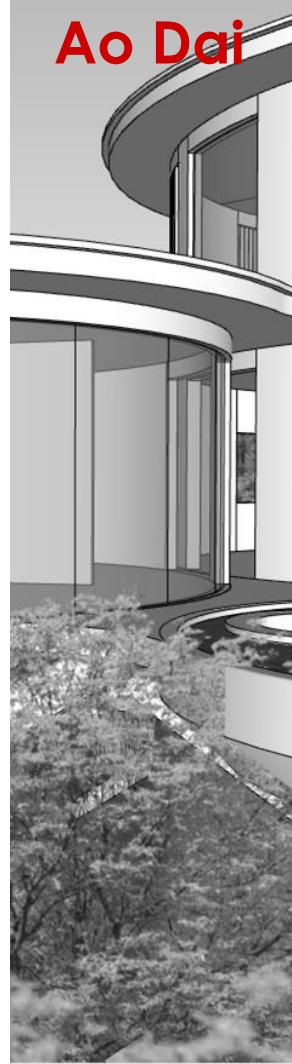
Each concept option is assessed considering standard baseline parameters and the baseline performance is recorded. Measures are recommended to improve the baseline performance and contribute towards Net-Zero Energy.

## Baseline Simulation Parameters

| Parameter                       | Baseline Case                | Specification                      |
|---------------------------------|------------------------------|------------------------------------|
| External Wall                   | ASHRAE 90.1 Standard Wall    | U-value - 0.704 W/sq.m.K           |
| External Roof                   | ASHRAE 90.1 Standard Roof    | U-value - 0.357 W/sq.m.K           |
| External Glazing                | ASHRAE 90.1 Standard Glazing | U-value - 6.92 W/sq.m.K. 0.25 SHGC |
| Window-Wall-Ratio               | As per design                | As per design                      |
| HVAC System                     | Variable Refrigerant Flow    | EER – 10.1                         |
| Lighting Power Density (W/sq.m) | ASHRAE 90.1 Standard LPD     | 11.7 W/sq.m                        |

Conditioned Areas – Bedrooms, Living Rooms, Kitchen/Dining, Unconditioned Areas - WCs

## Simulation Criteria



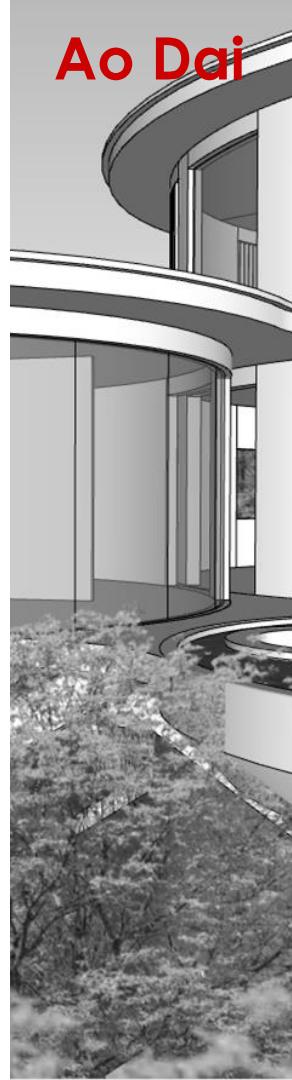
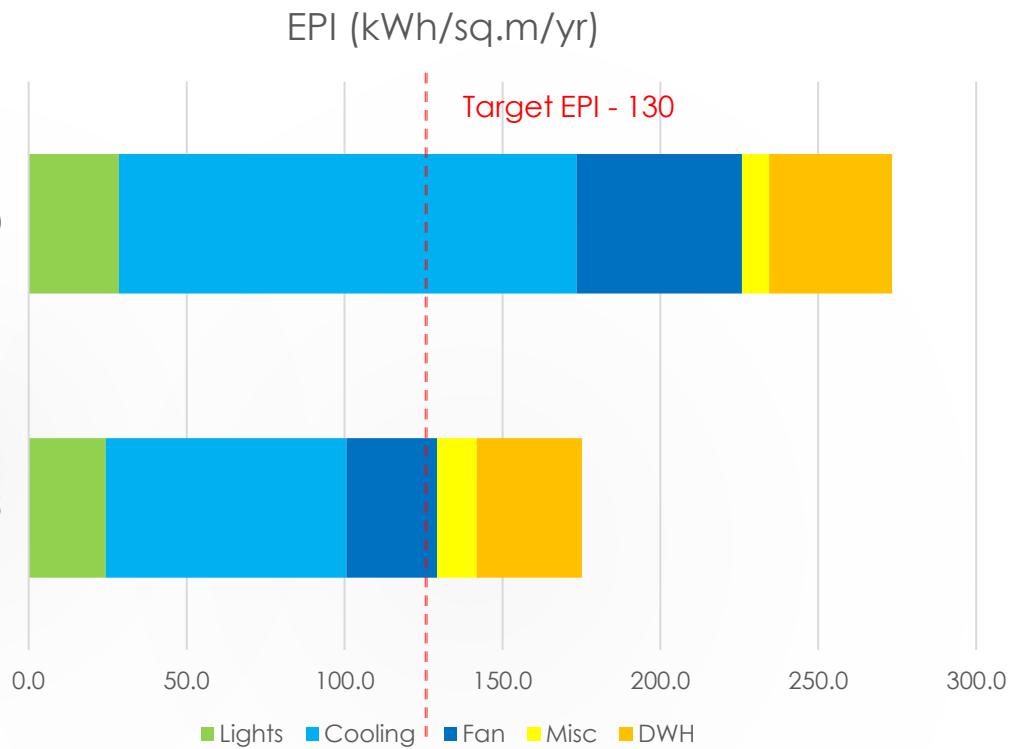
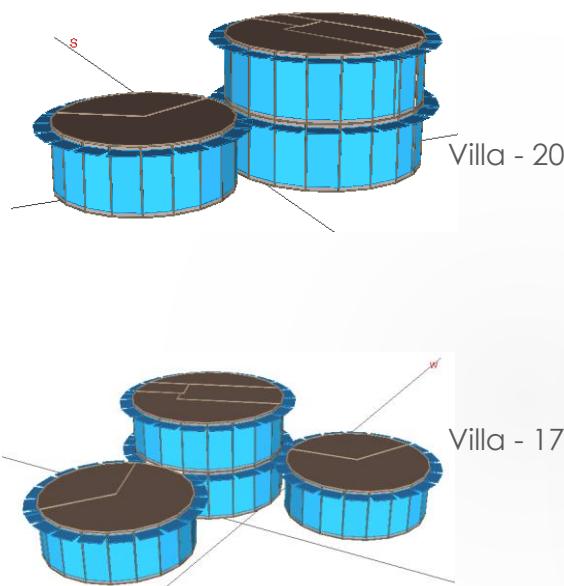
EPI (kWh/sq.m/yr)

Target EPI - 130

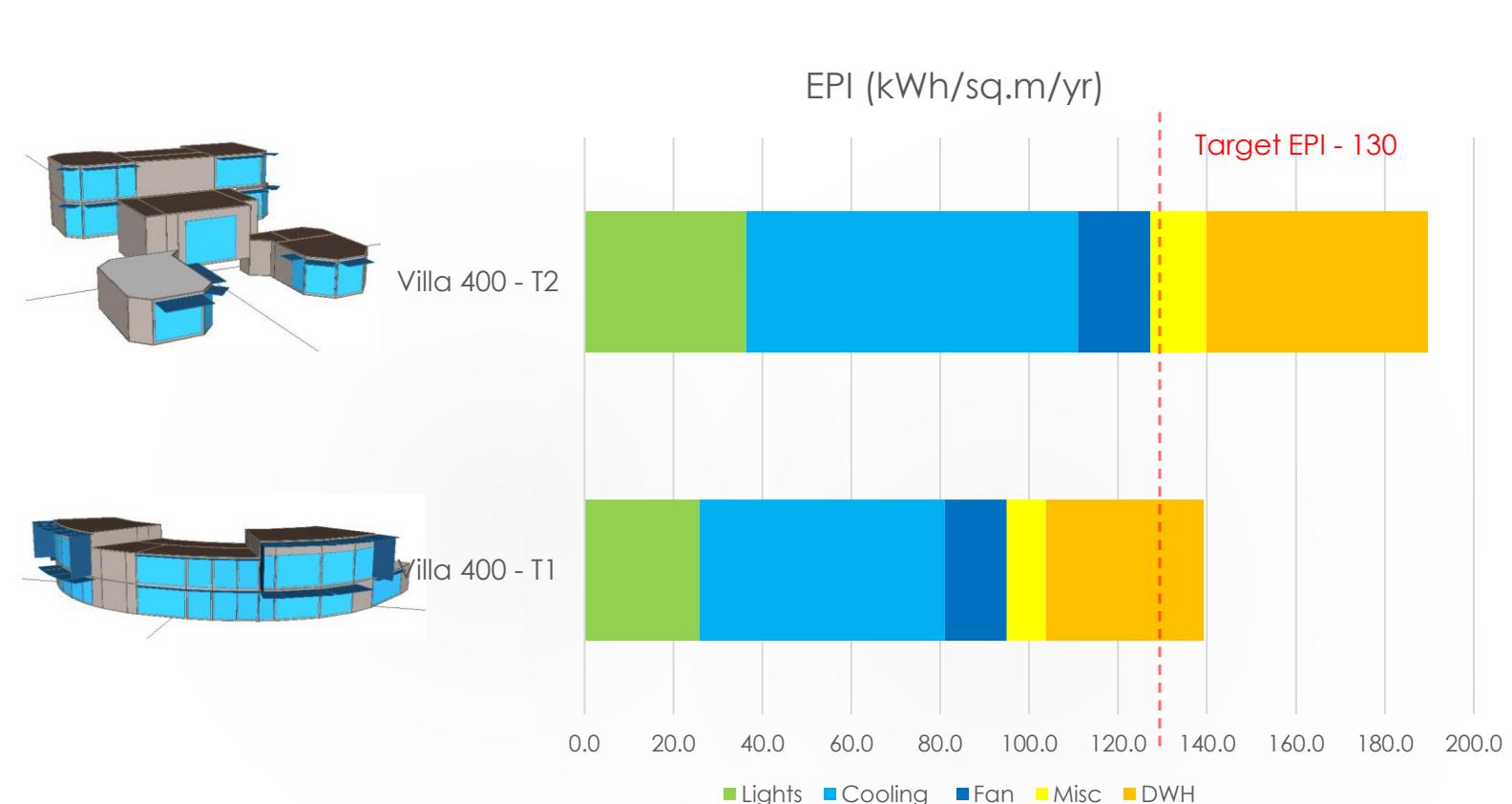
Villa 150



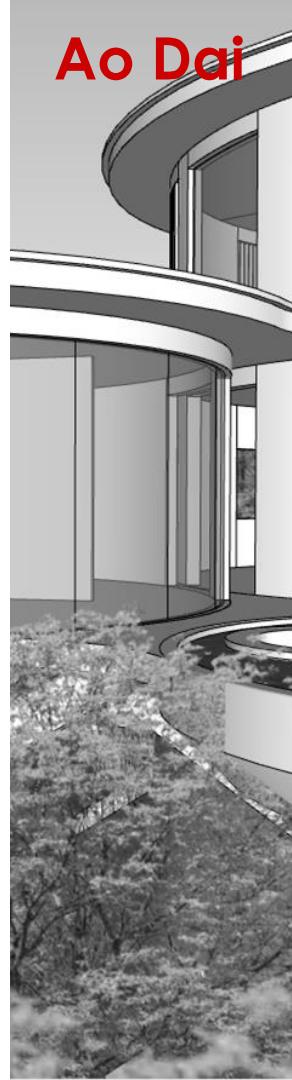
# Baseline Performance

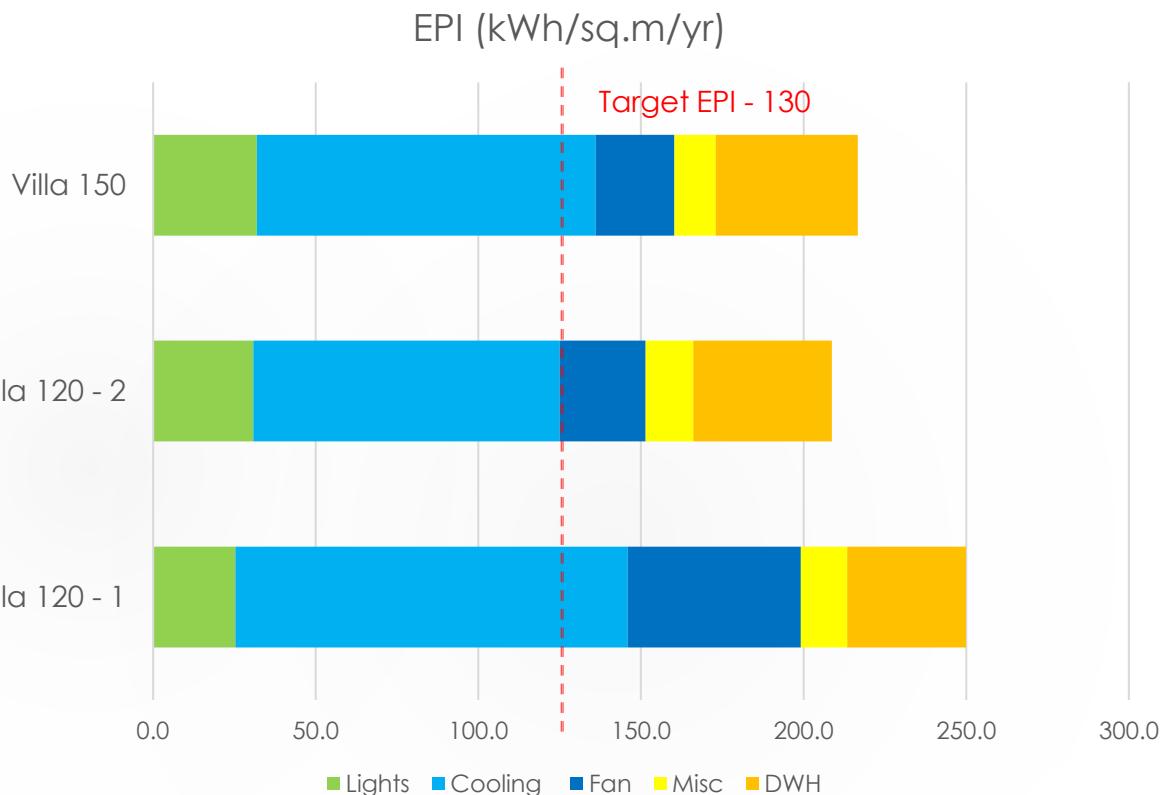
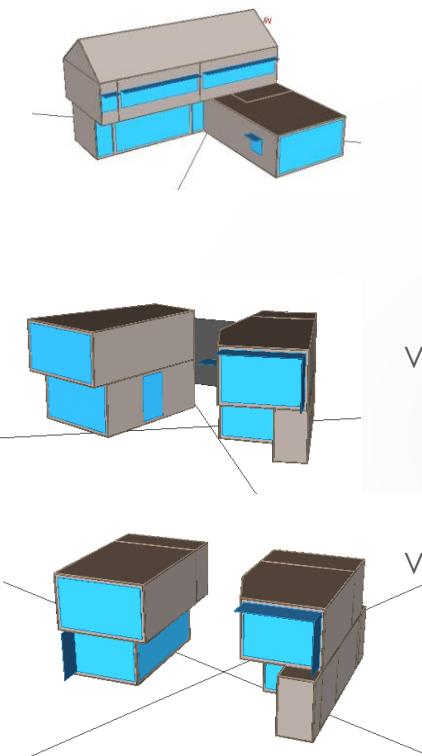


## Baseline Performance



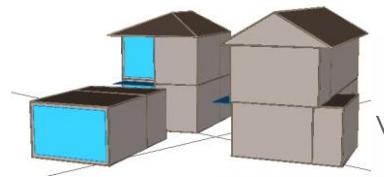
## Baseline Performance



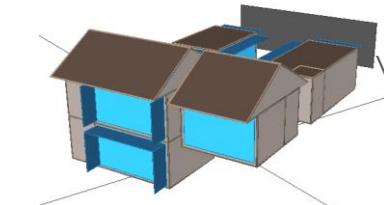


## Baseline Performance

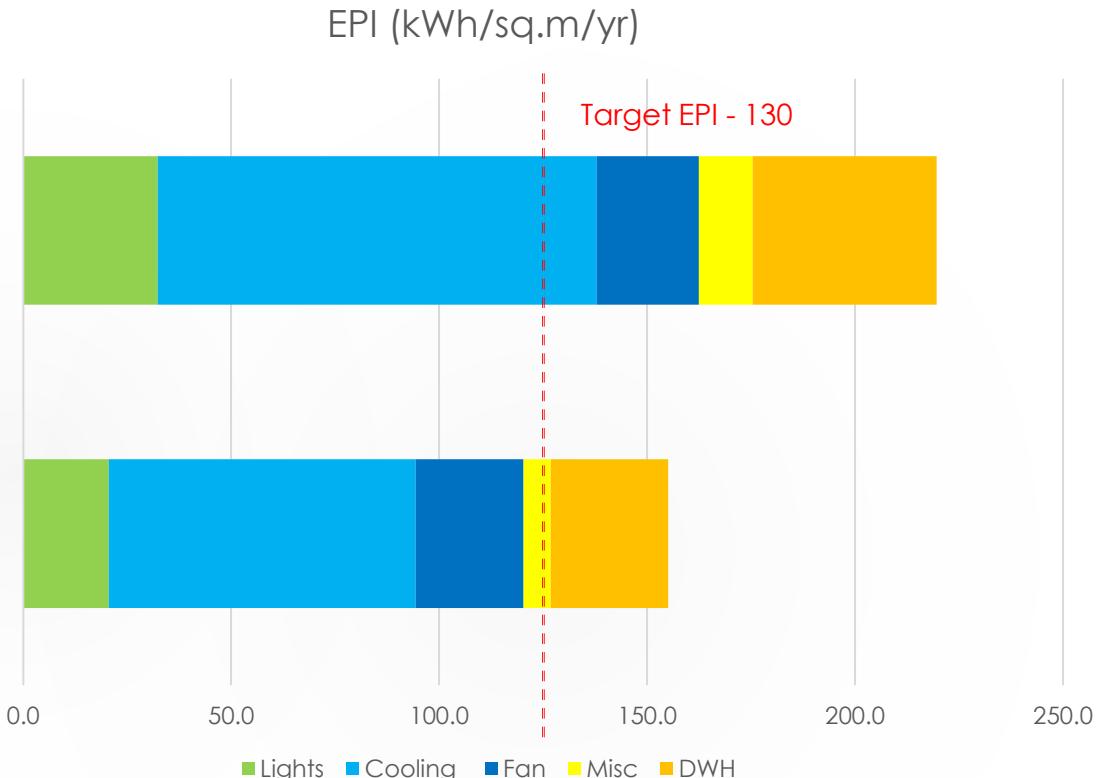




Villa - 200



Villa - 175

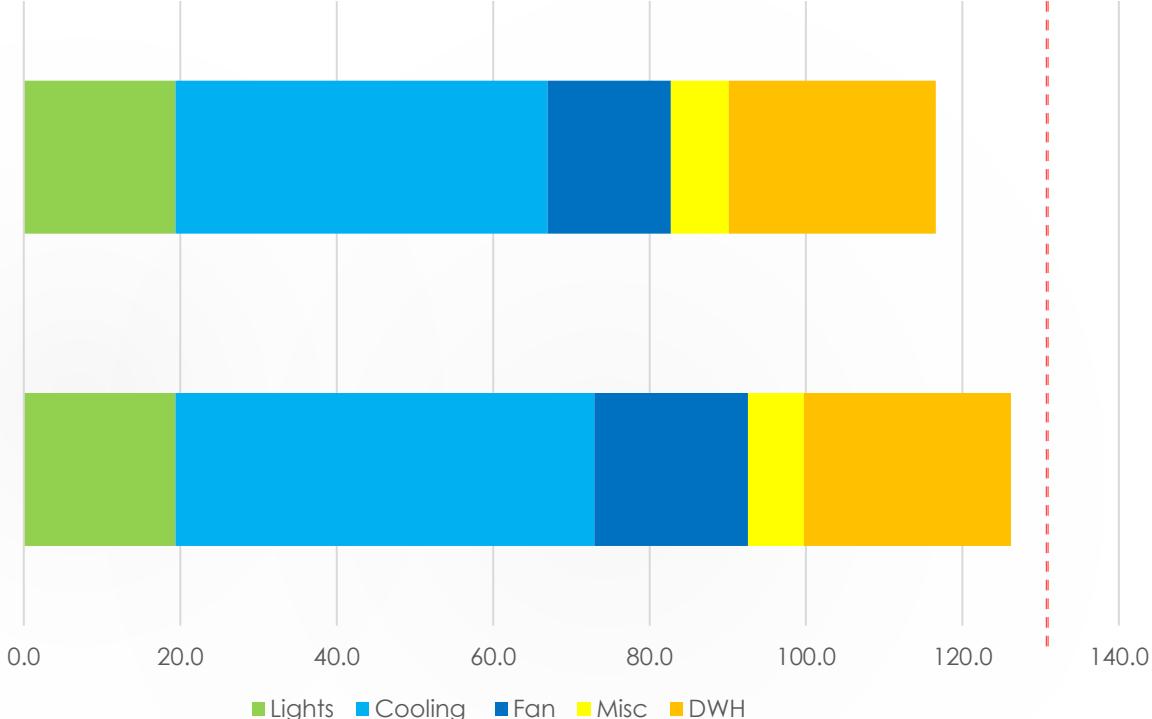
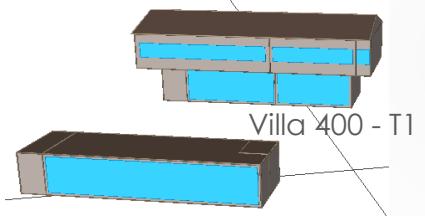
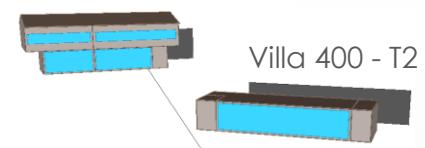


## Baseline Performance



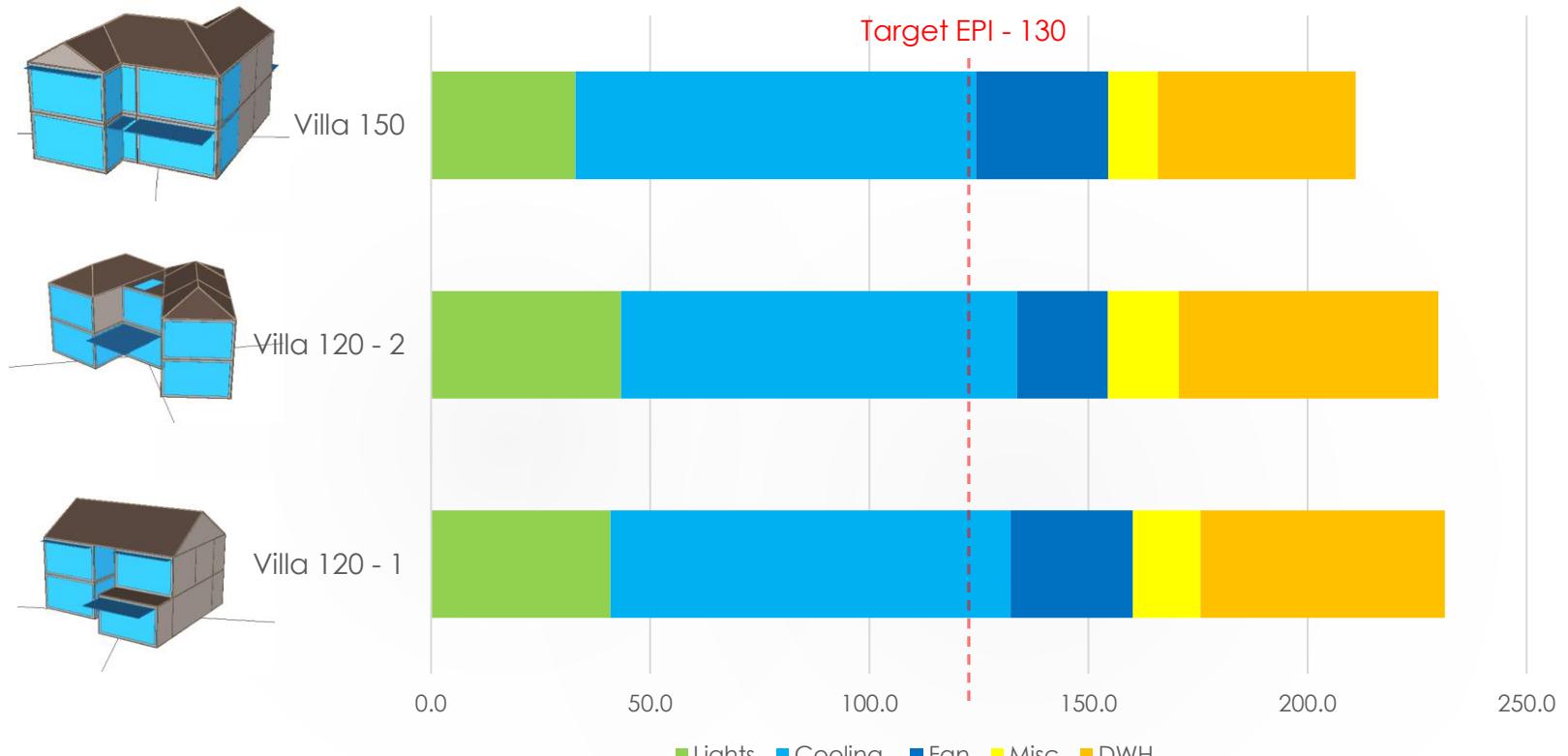
EPI (kWHe/sq.m/yr)

Target EPI - 130

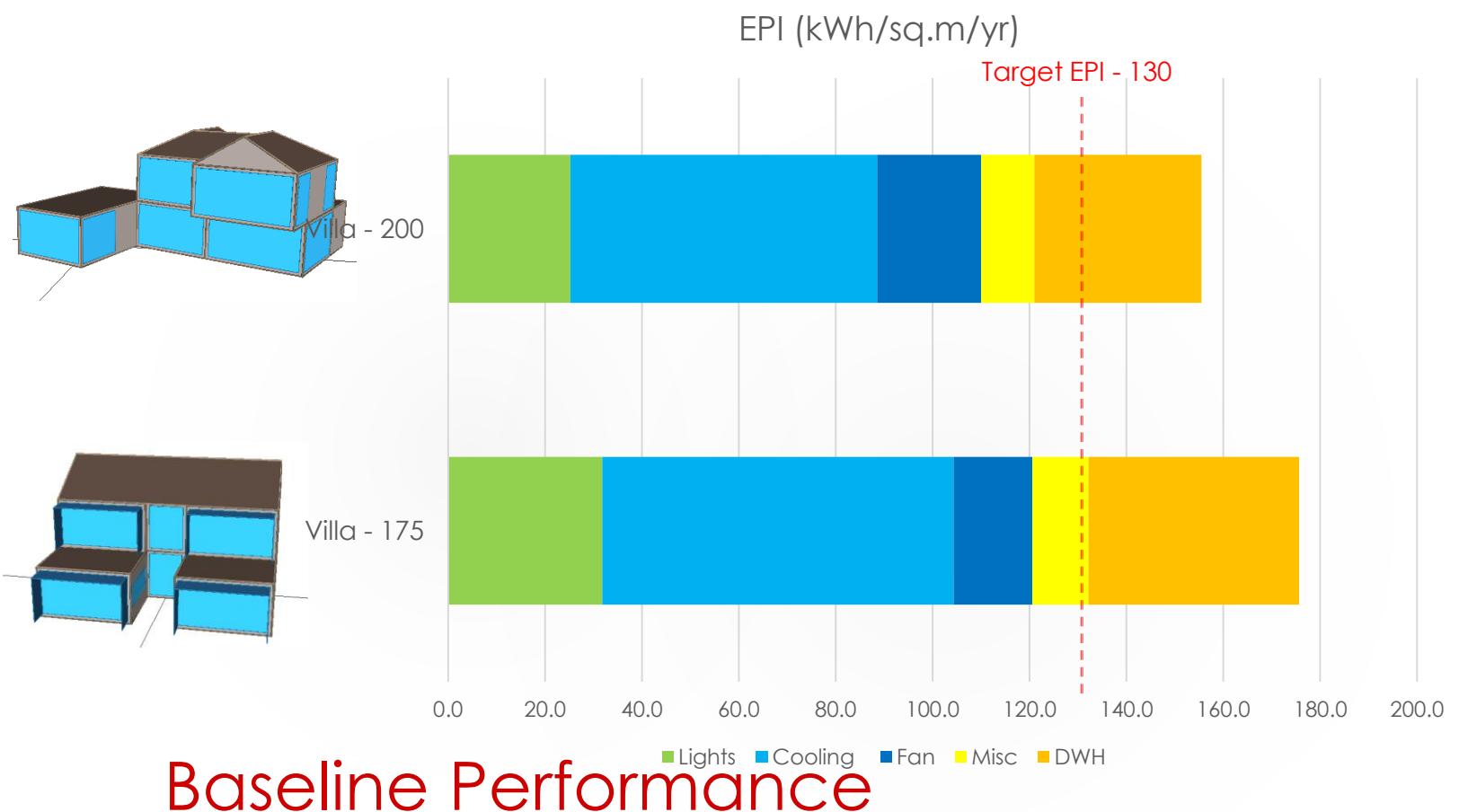


Baseline Performance

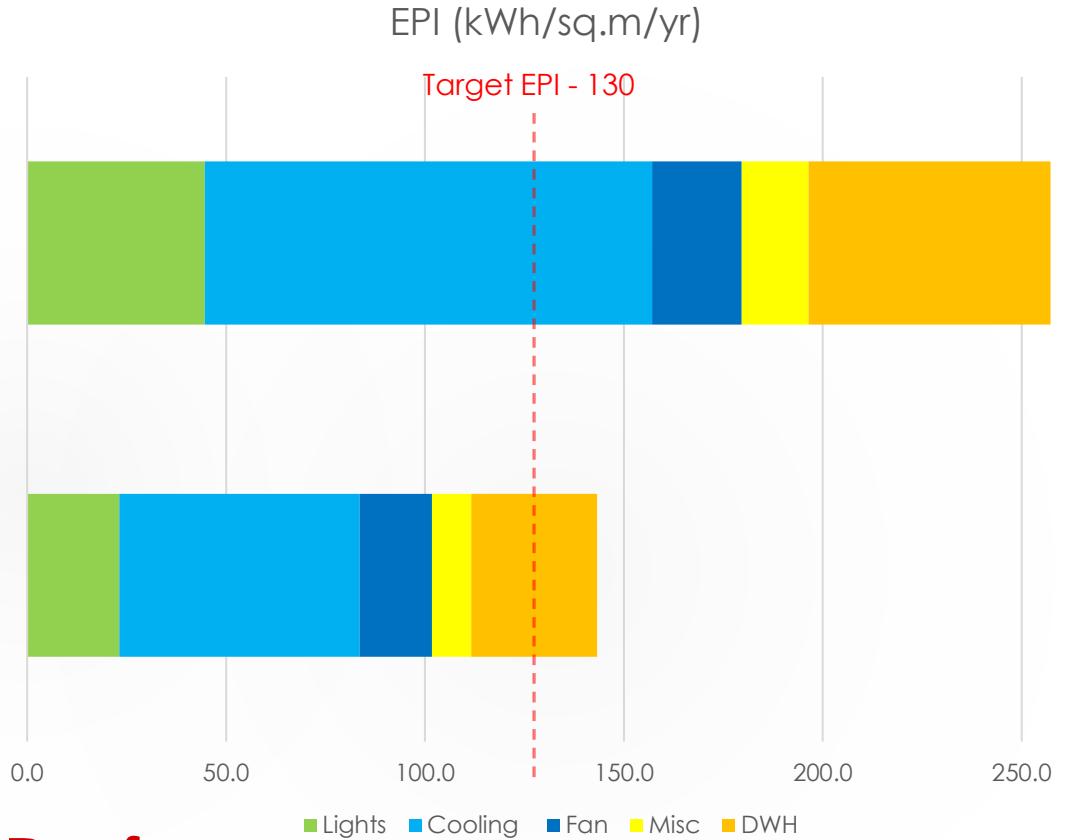
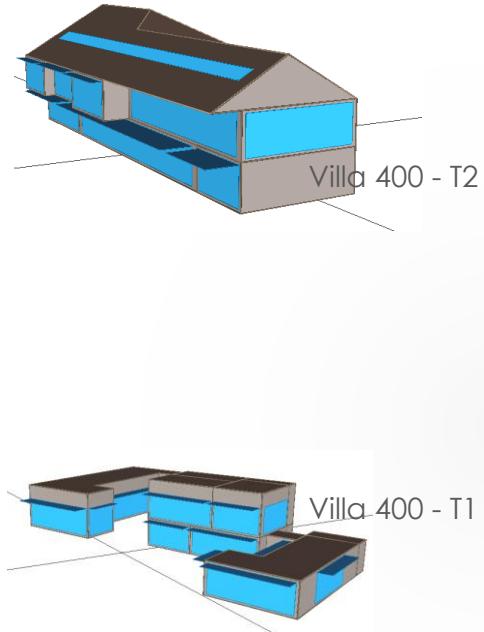
EPI (kWh/sq.m/yr)



## Baseline Performance



Vy DA



Baseline Performance



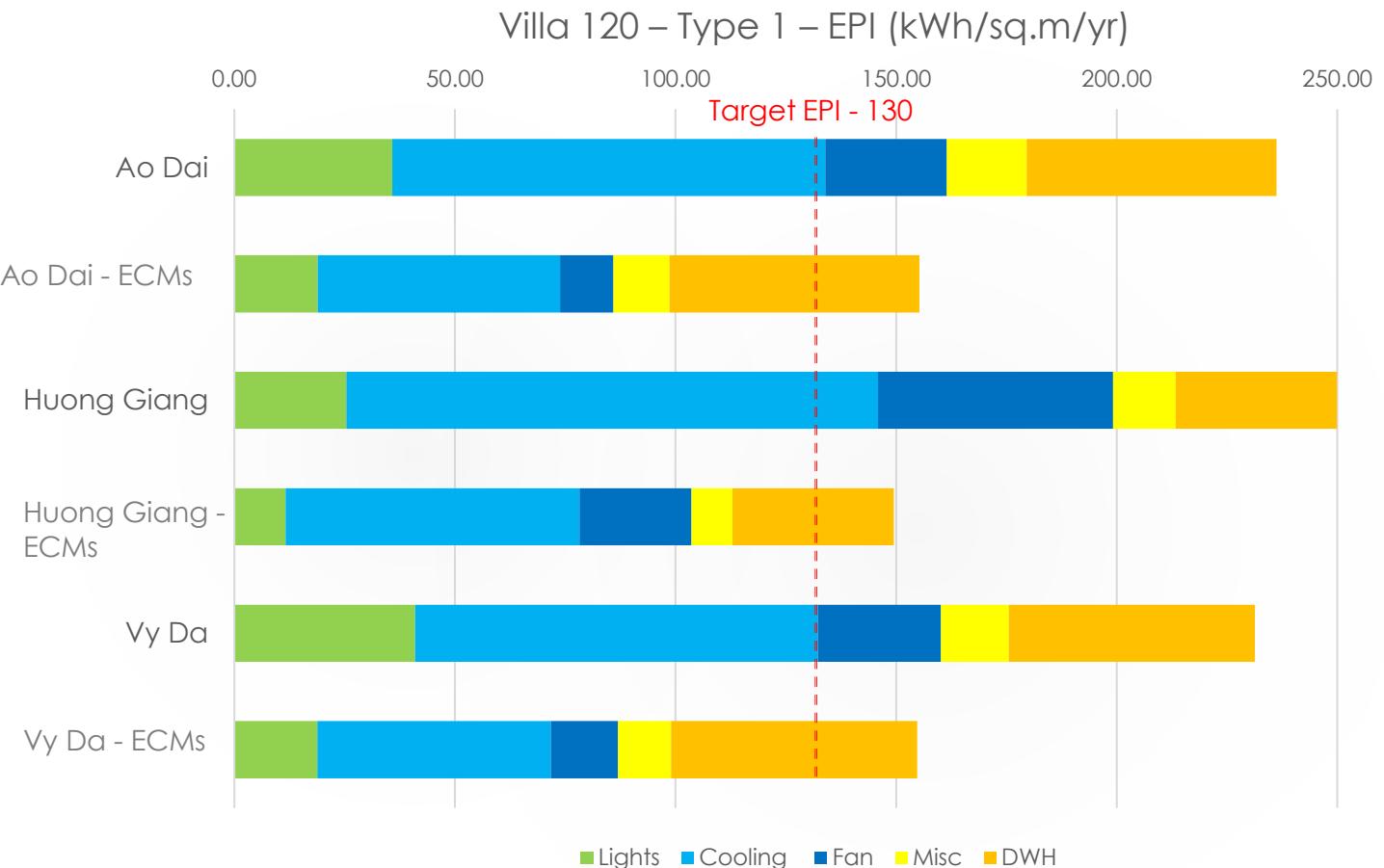
The target baseline EPI for Net Zero Energy performance is approx. 130 kWh/sq.m/yr. To approach this target, stringent energy conservation measures are assessed for the envelope and the building systems . In the next stage of analysis, further investigation will be conducted in the active systems it's efficiency with its contribution towards reducing EPI.. The ECMs are as follows:

## Energy Conservation Measures

| Parameter                       | Baseline Case                | ECM                                |
|---------------------------------|------------------------------|------------------------------------|
| External Wall                   | ASHRAE 90.1 Standard Wall    | U-value – 0.22 W/sq.m.K            |
| External Roof                   | ASHRAE 90.1 Standard Roof    | U-value - 0.2 W/sq.m.K             |
| External Glazing                | ASHRAE 90.1 Standard Glazing | U-value – 2.2 W/sq.m.K., 0.25 SHGC |
| Window-Wall-Ratio               | As per design                | Maximum 40% on each facade         |
| HVAC System                     | Variable Refrigerant Flow    | EER – 13                           |
| Lighting Power Density (W/sq.m) | ASHRAE 90.1 Standard LPD     | 5.4 W/sq.m                         |

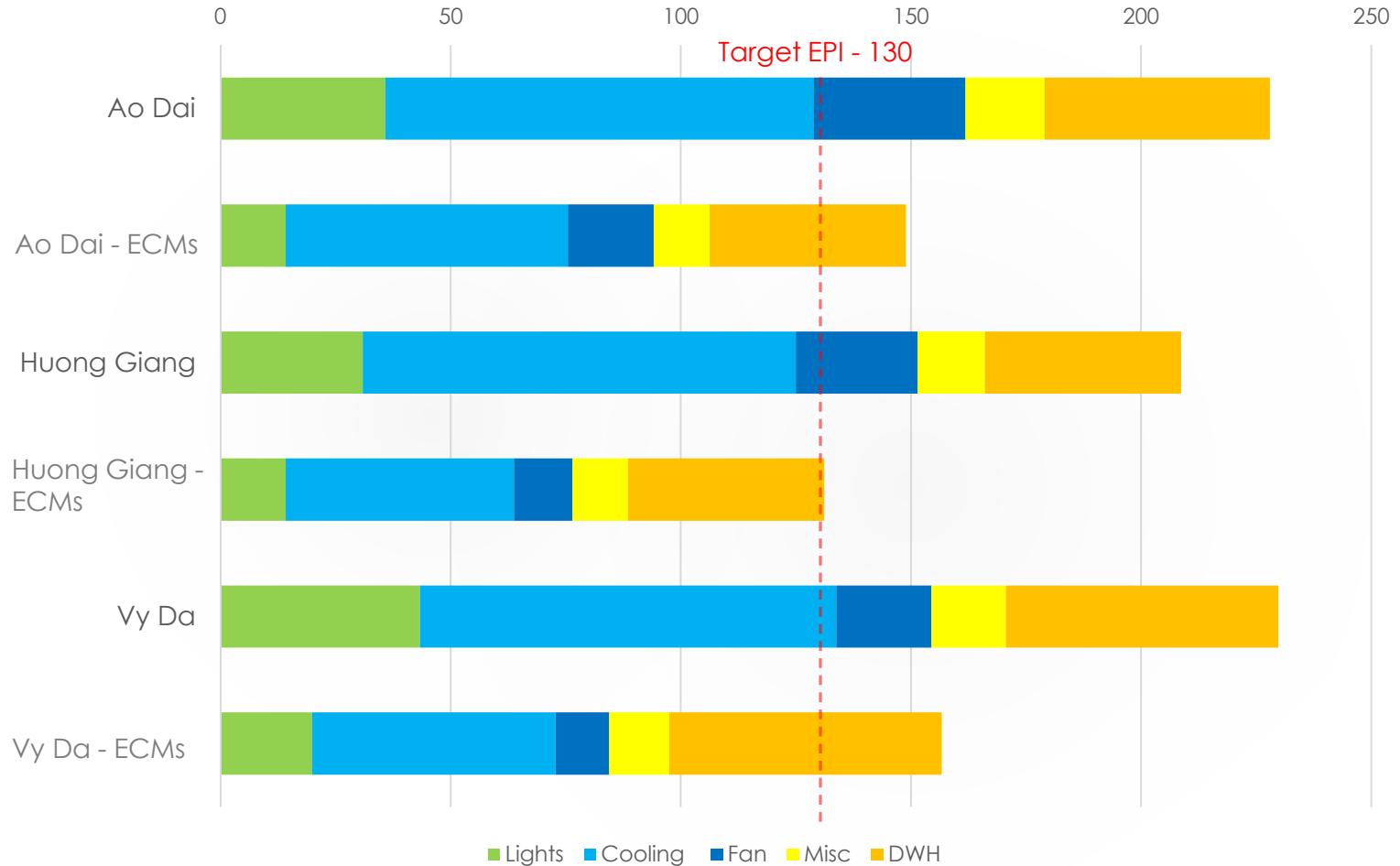
## Energy Conservation Measures

# Comparison

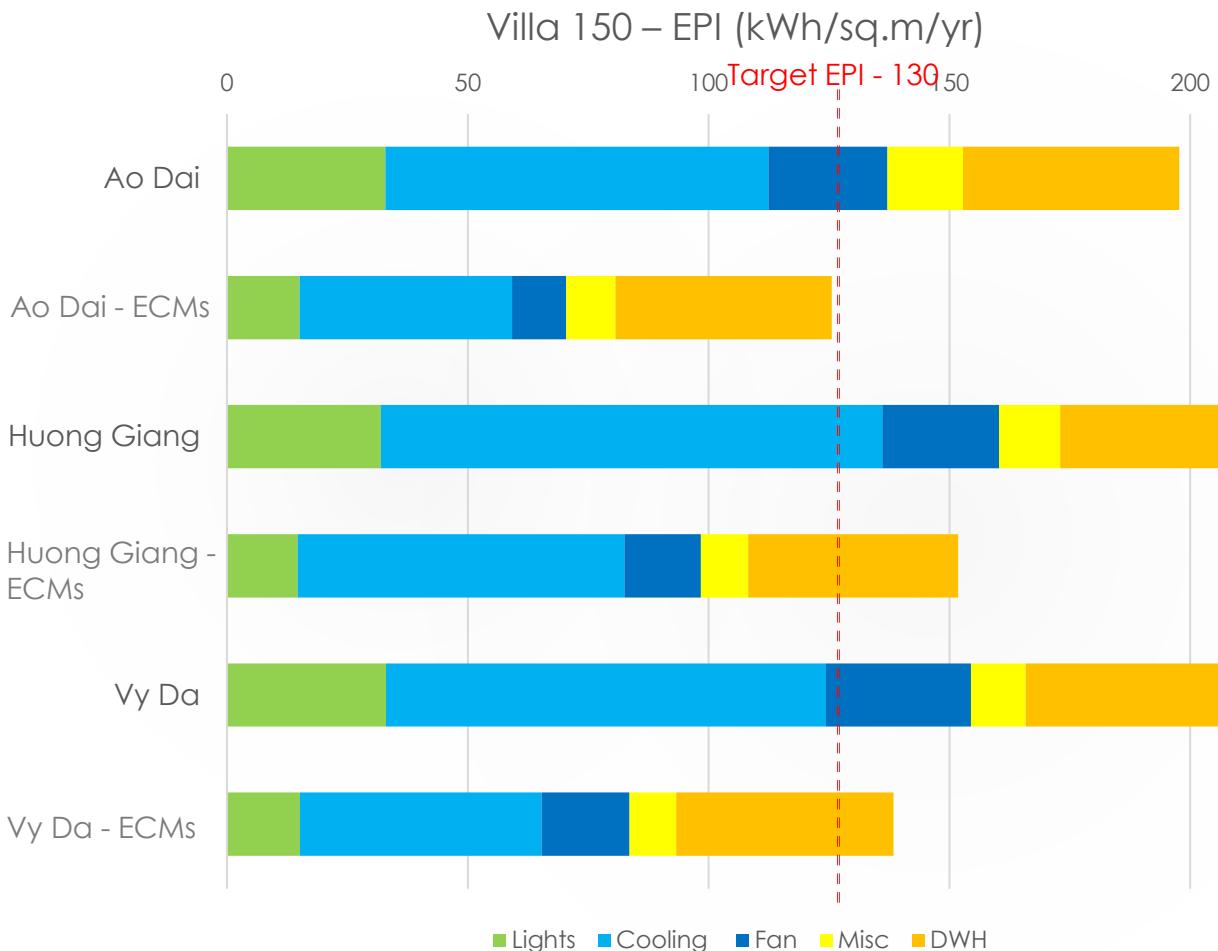


# Comparison

Villa 120 – Type 2 – EPI (kWh/sq.m/yr)

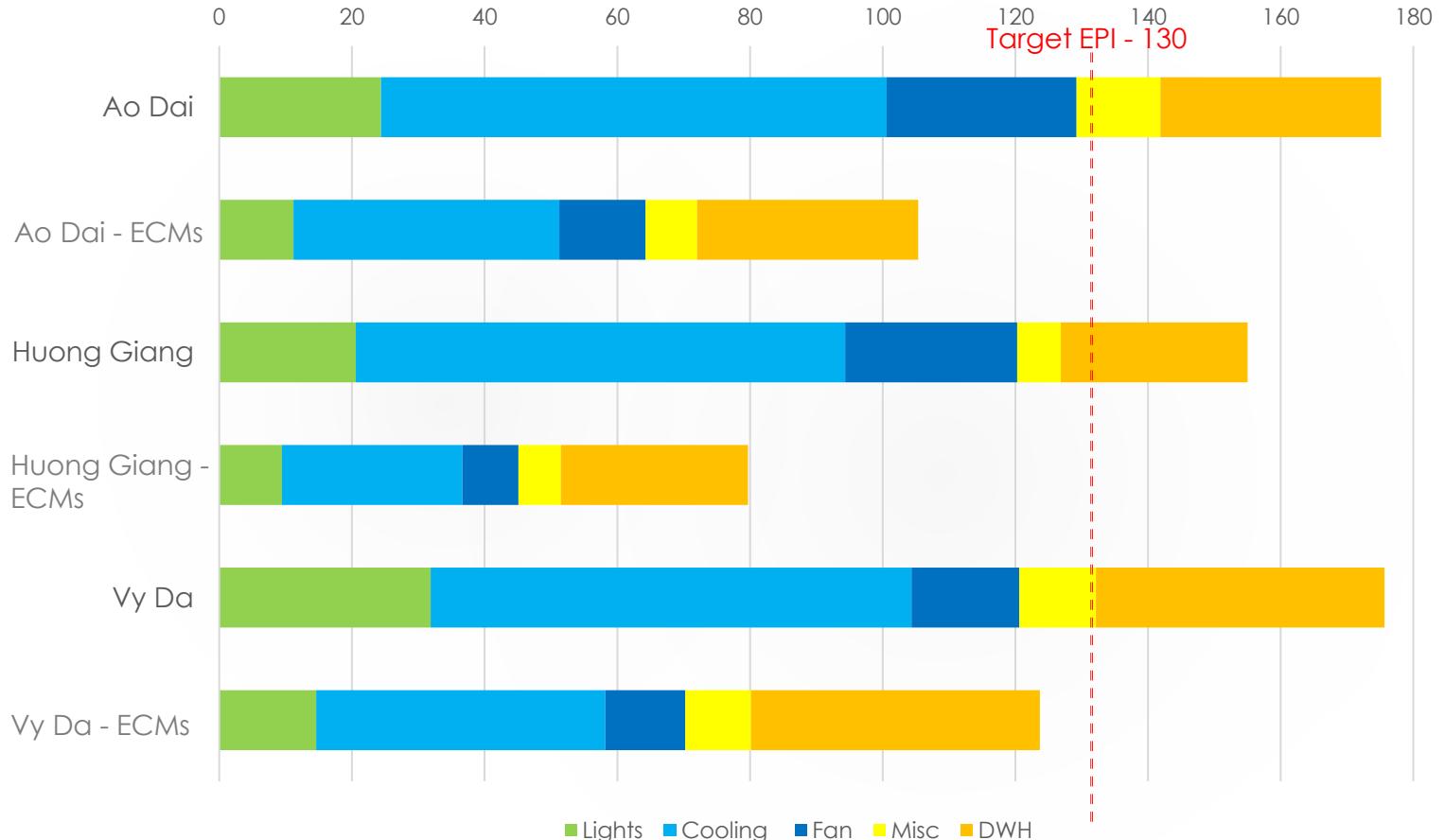


# Comparison



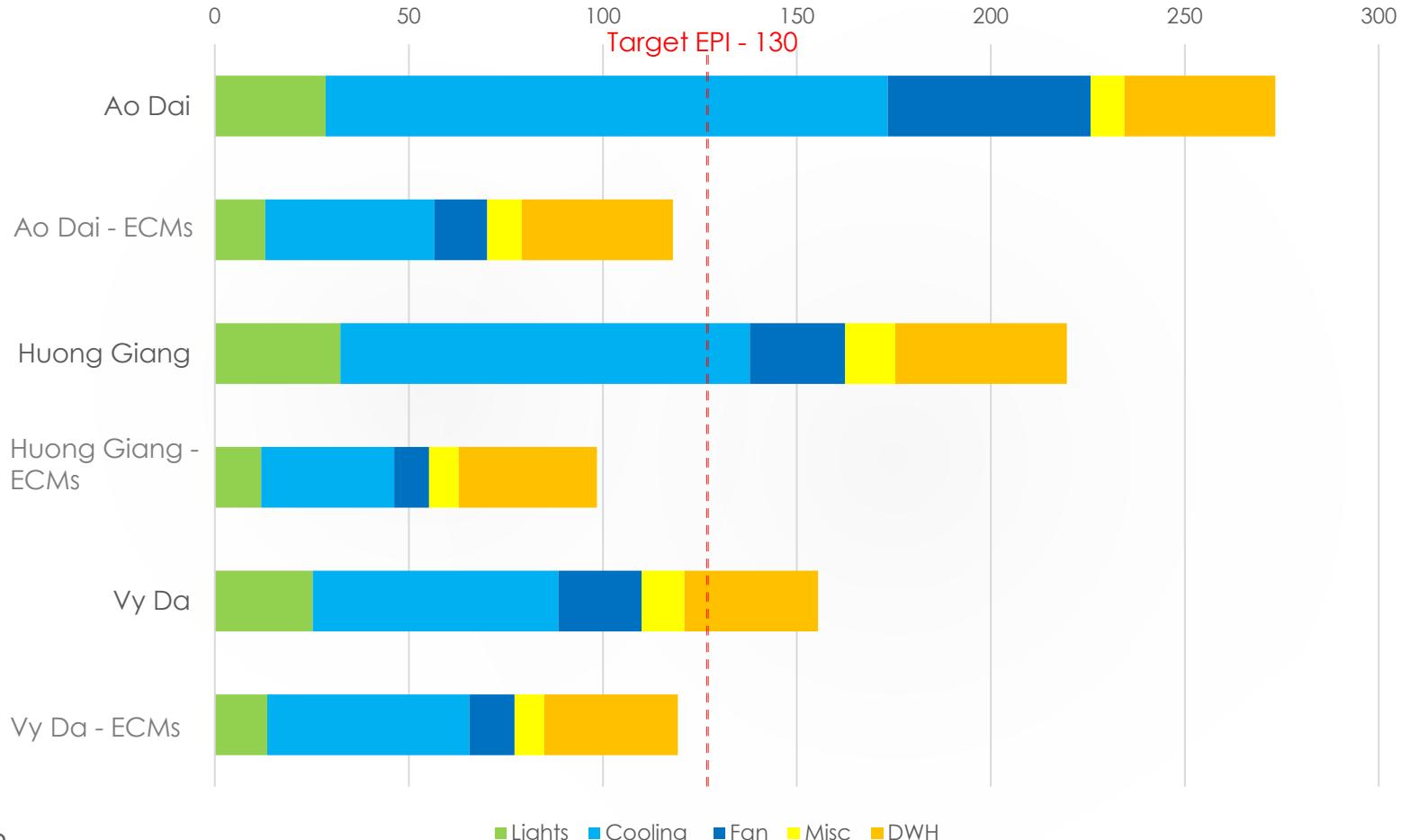
# Comparison

Villa 175 – EPI (kWh/sq.m/yr)

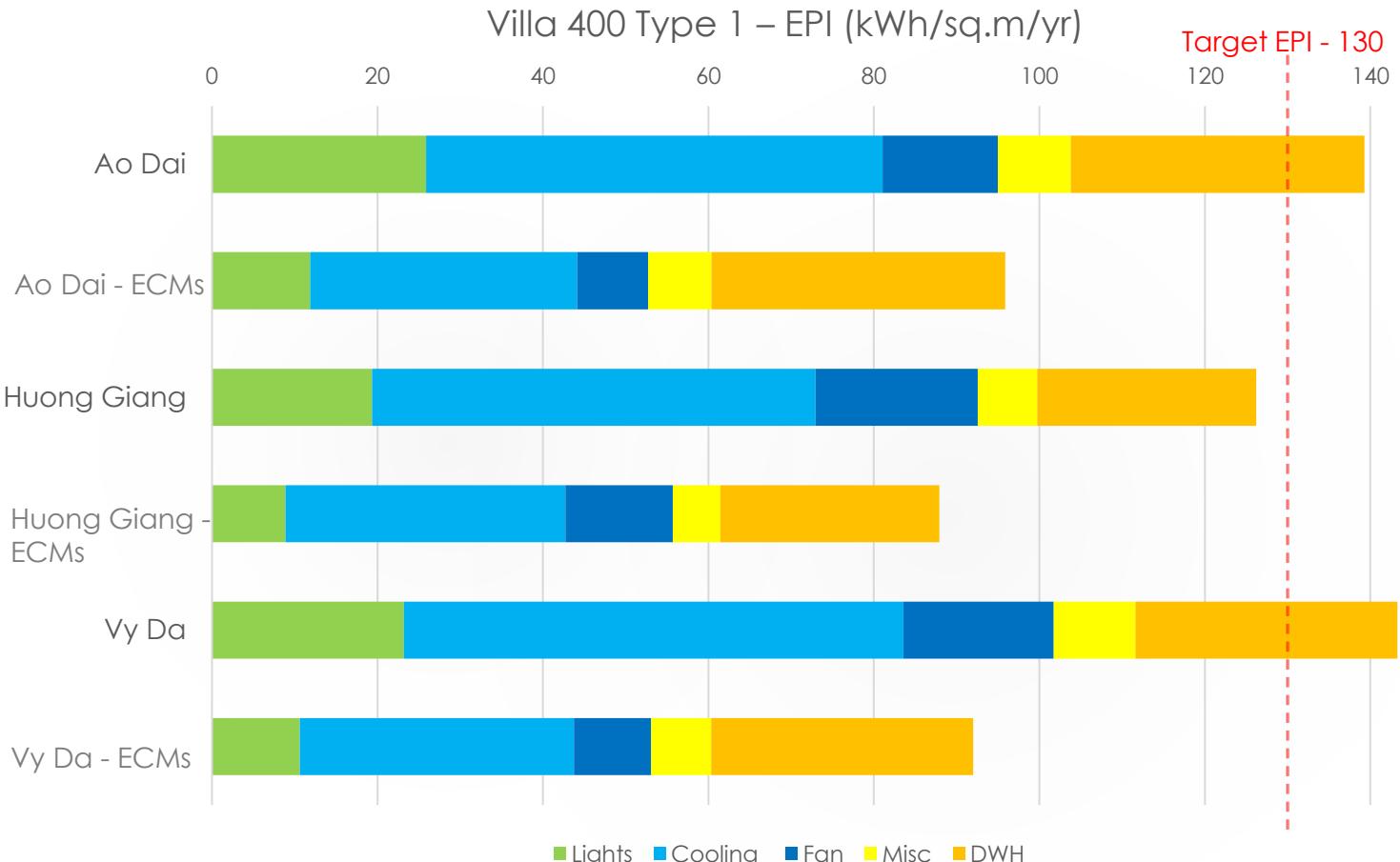


# Comparison

Villa 200 – EPI (kWh/sq.m/yr)

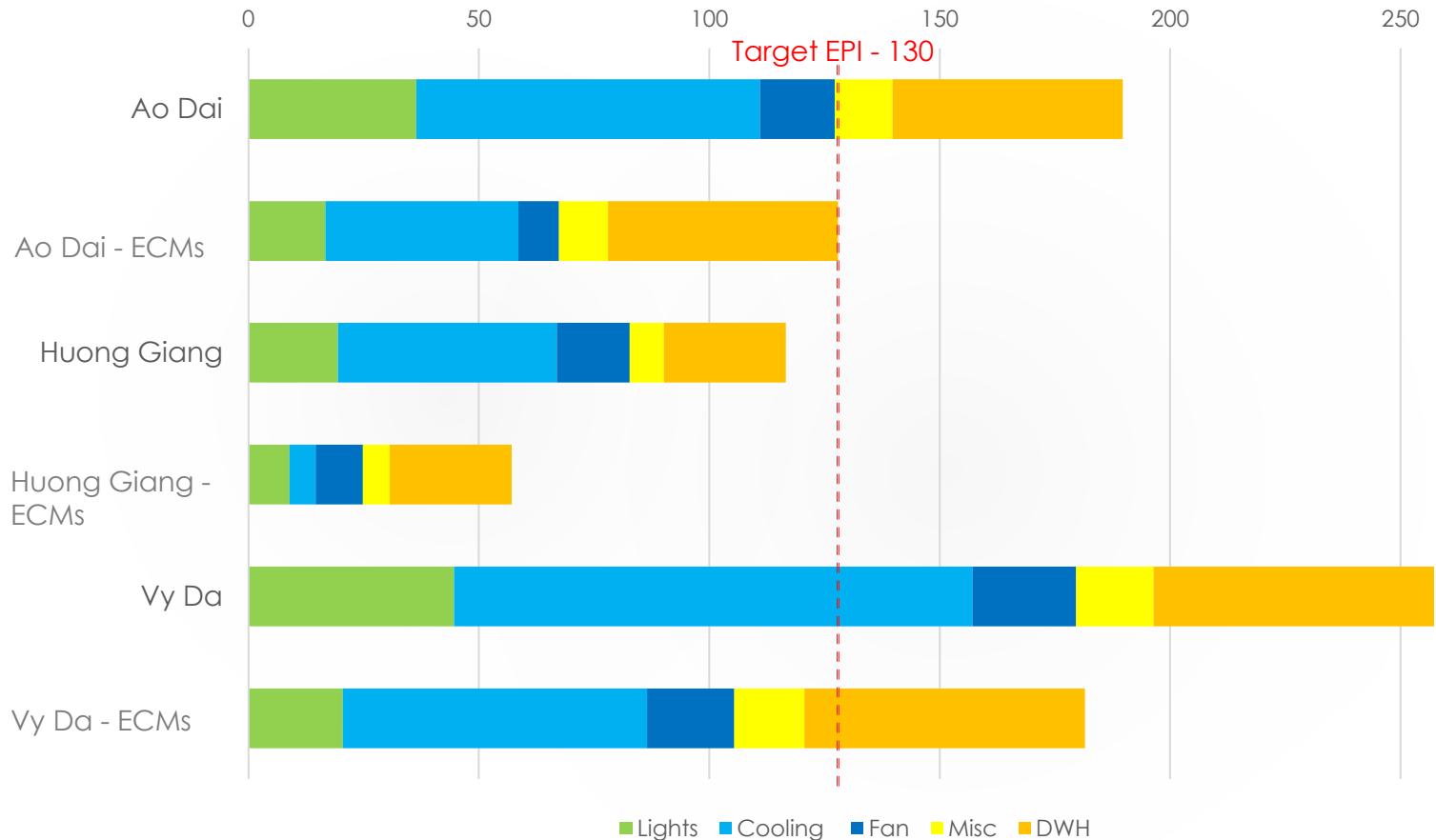


# Comparison

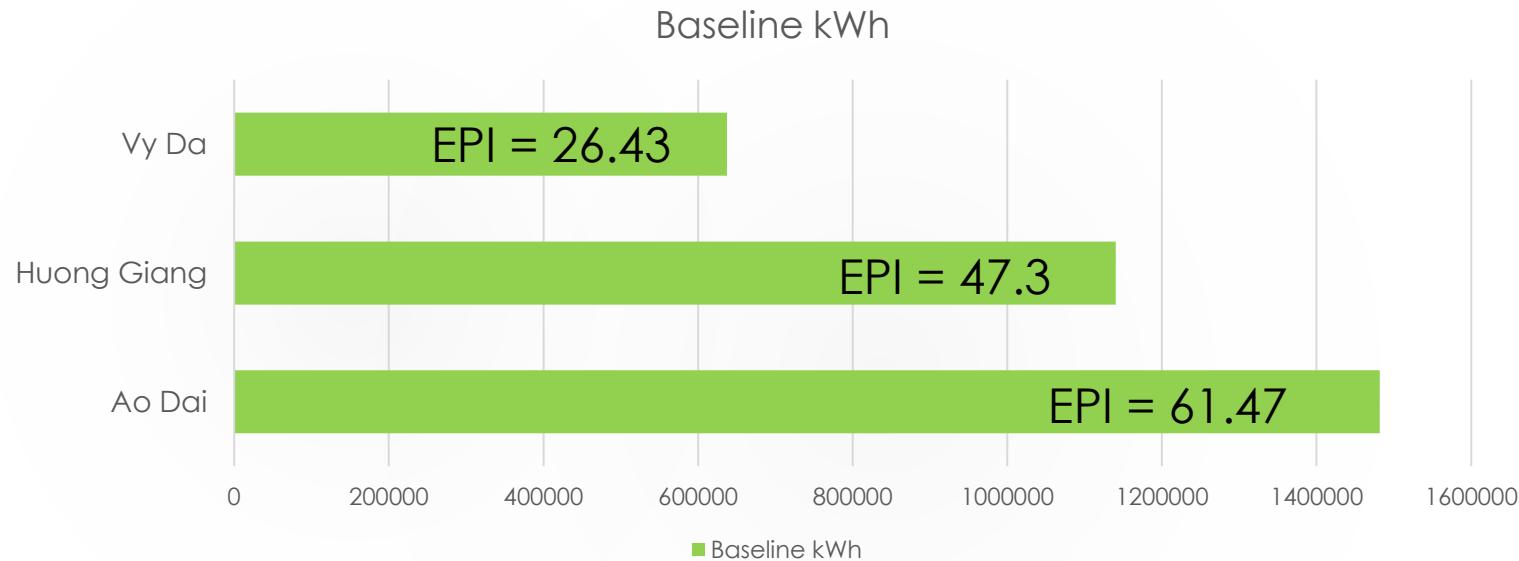


# Comparison

Villa 400 – Type 1 – EPI (kWh/sq.m/yr)

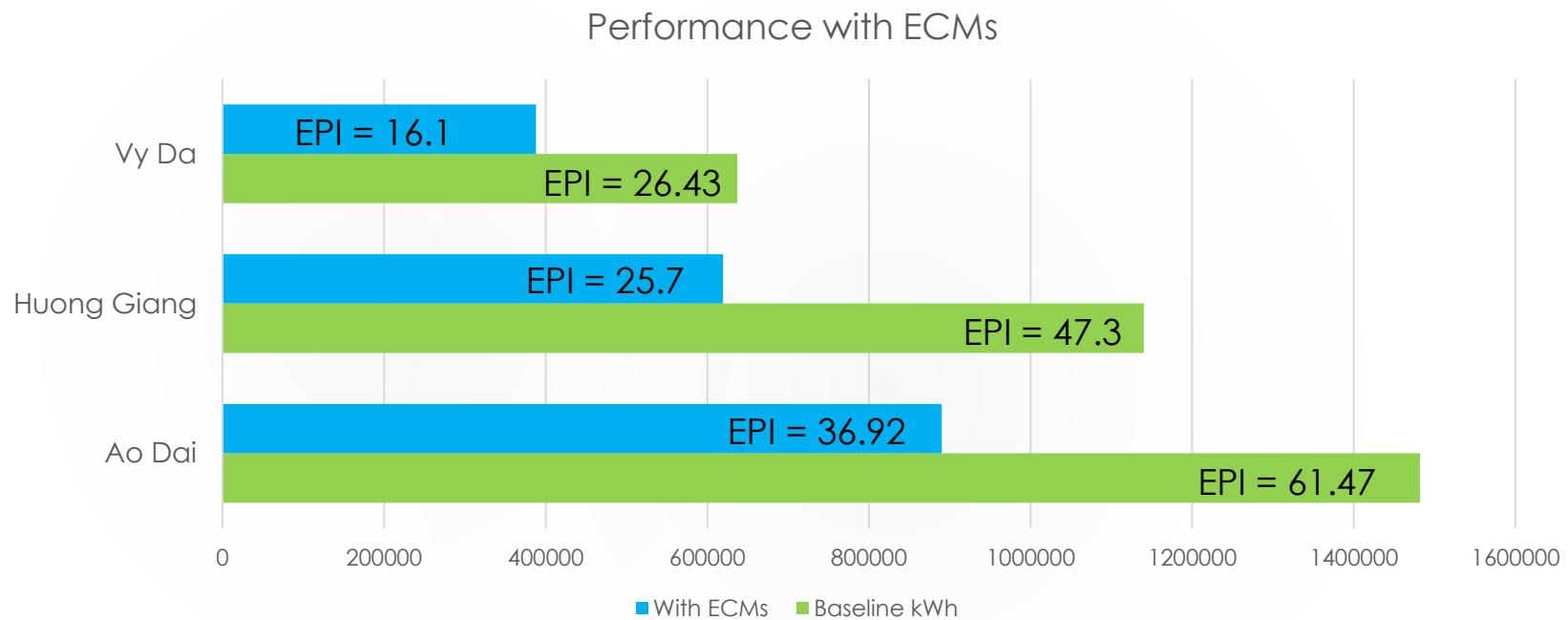


Preliminary energy analysis was carried out at a concept level for the public areas. The proposed concept design options demonstrate varying baseline results.



## Public Areas - Baseline

ECMs were applied to the public area buildings and the performance re assessed. The performance shows significant reduction by implementing ECMs.



## Public Areas – With ECMs

- Option 2 – Huong Giang has better performance for living areas towards contributing to Net Zero, as compared to Ao Dai and Vy Da.
- Option 3 - Vy Da Public Areas shows better performance for the preliminary energy analysis based on concept design.

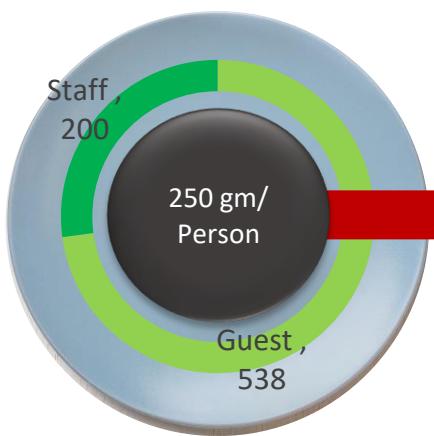
## Findings

A stylized graphic of a tree on the left side of the slide. The tree has a single, thin, light gray trunk. From the trunk, several branches extend upwards and outwards. The leaves are represented by large, overlapping circles that resemble spirals or swirls, also in a light gray color. The overall aesthetic is minimalist and modern.

# Renewable Energy Analysis

[

# Food Waste



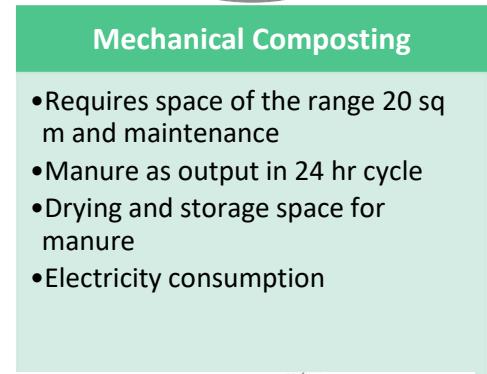
## Vermicomposting

- Requires larger space and maintenance .Manure as output in 45 day cycle
- 7 covered pits of size 3.5m x 2.5m x 1.2 m and drying & conditioning space of 20 sq m
- Soak pit Or STP connection for leachate management



## Mechanical Composting

- Requires space of the range 20 sq m and maintenance
- Manure as output in 24 hr cycle
- Drying and storage space for manure
- Electricity consumption

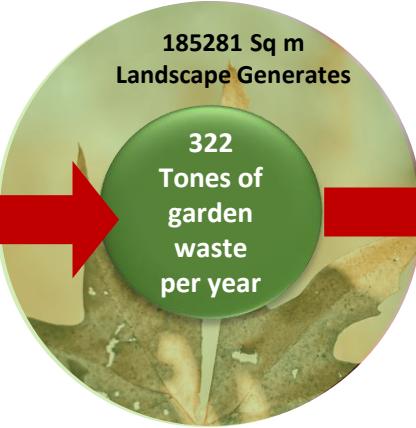
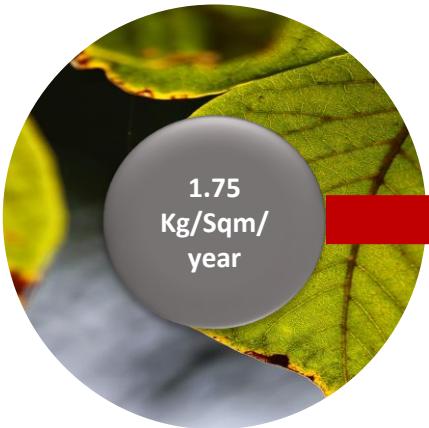


## Biogas Generation

- Requires to set up biogas plant
- Regular maintenance required
- Bio gas as out put – Generation potential equal to 17.5 kwh /Day



# Garden Waste



## Burning in Open Air / Landfilling

- Releases CO<sub>2</sub>
- Can not be done in Monsoon
- Inappropriate method



## Composting

- Requires huge space for installing compost pits
- Manure production in 45 days cycle.
- Requires drying and storage space for ready compost



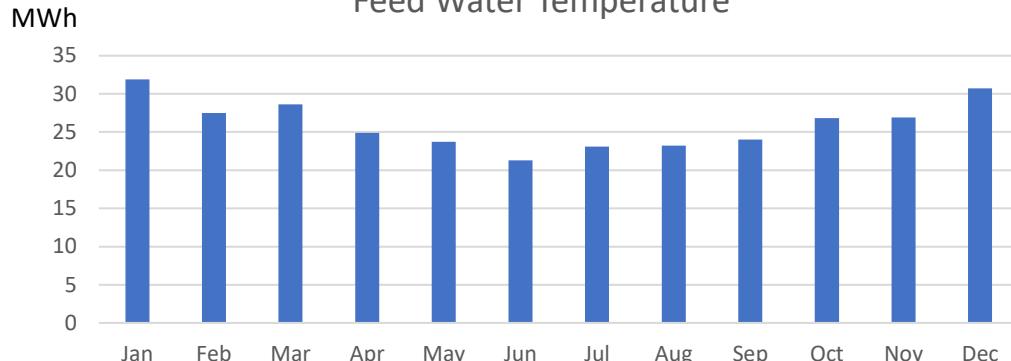
## Biomass gasification

- Requires to set up gasification plant
- Produced gas can be used for generating heat or electricity
- Approximately 2,00,000 kWh/year can be generated.



# Hot Water

Estimated Monthly Electricity Savings Based on the Feed Water Temperature



Required space to install solar hot water system approx. 620 Sq. m for the project .  
Approx. 3 sq m for each villa



Hot Water Requirement for Kitchen  
3,000 lit/day



Hot Water Requirement for Guest in all Villas  
26,900 lit/day



Hot Water Requirement for other purpose  
1,000 lit/day



Total Hot water requirement  
30,900 lit/day



Biomass based hot water system for Kitchen



Individual hot water system for Villas

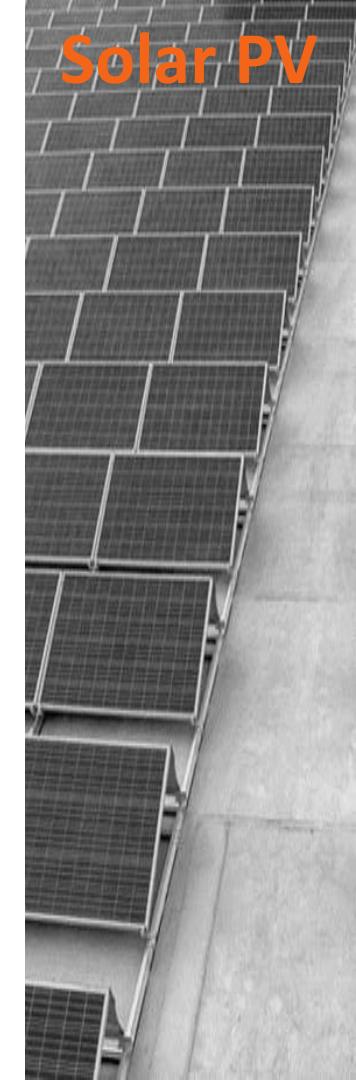
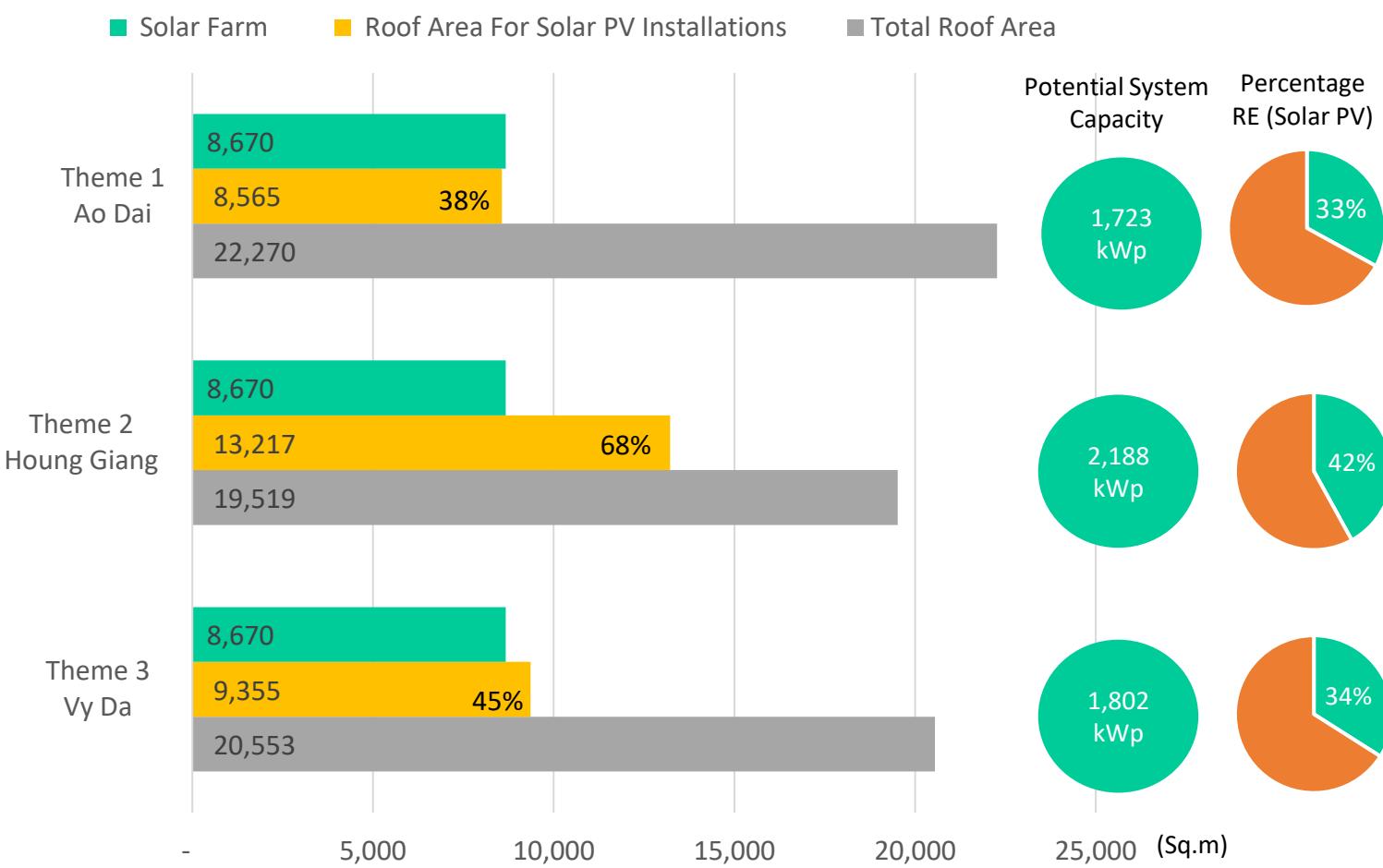


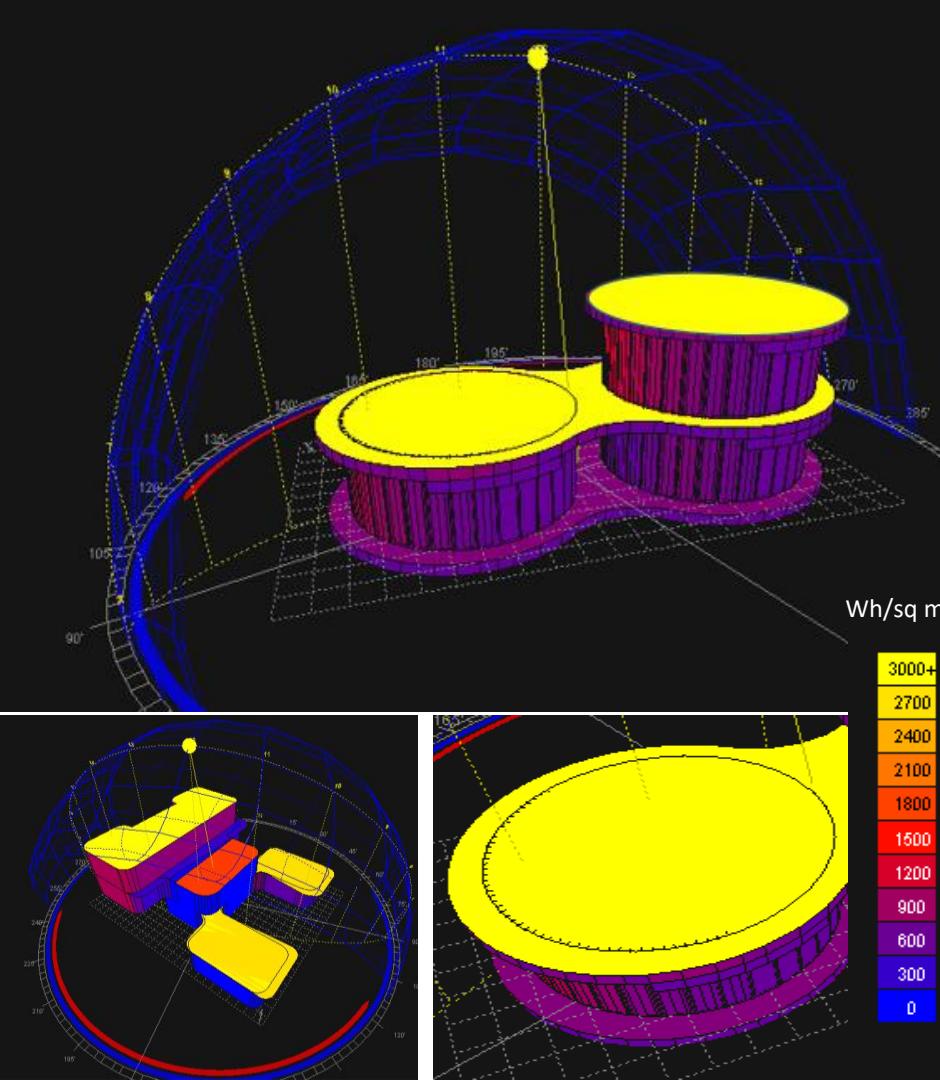
Heat pump based hot water system



Nearly Zero Electricity for hot water system

# Solar PV



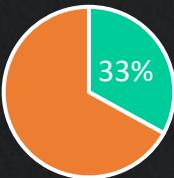


Available flat roofs can be used to install Solar Photovoltaic panels

35 % to 40 % of the total roof areas can be used for solar installation

Structural design of roof to be designed to bear weight of solar PV system.

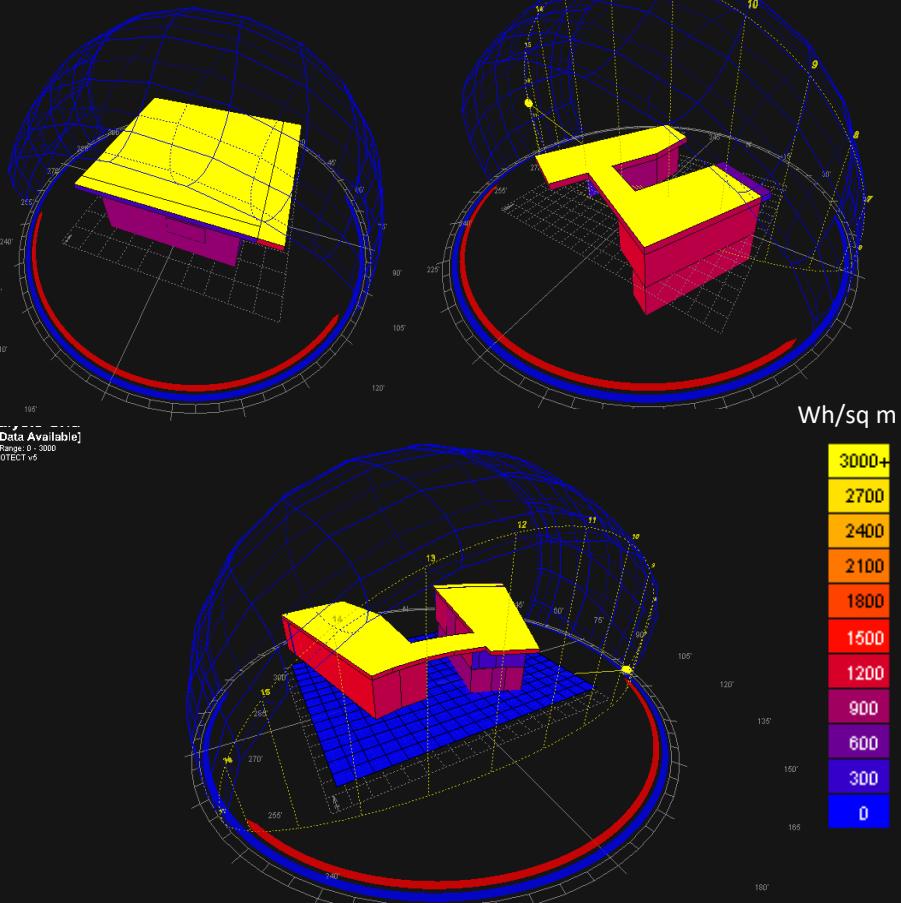
**Solar PV Location**  
**Theme 1**  
**(Ao Di)**



Use of renewable energy  
1723 kWp



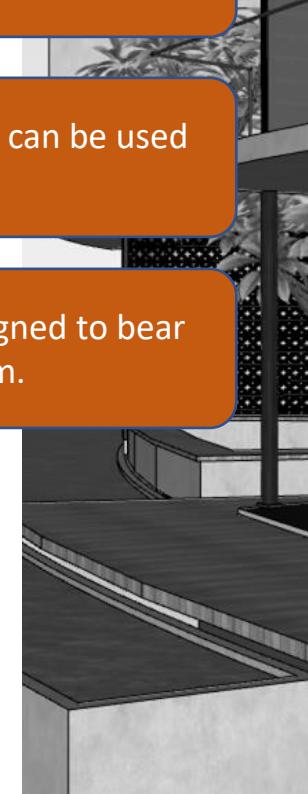
- Proposed solar PV Area
- Potential solar PV Area



All available flat roofs can be used to install Solar Photovoltaic panels

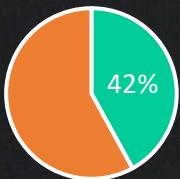
60 % to 70 % of the total roof areas can be used for solar installation

Structural design of roof to be designed to bear weight of solar PV system.



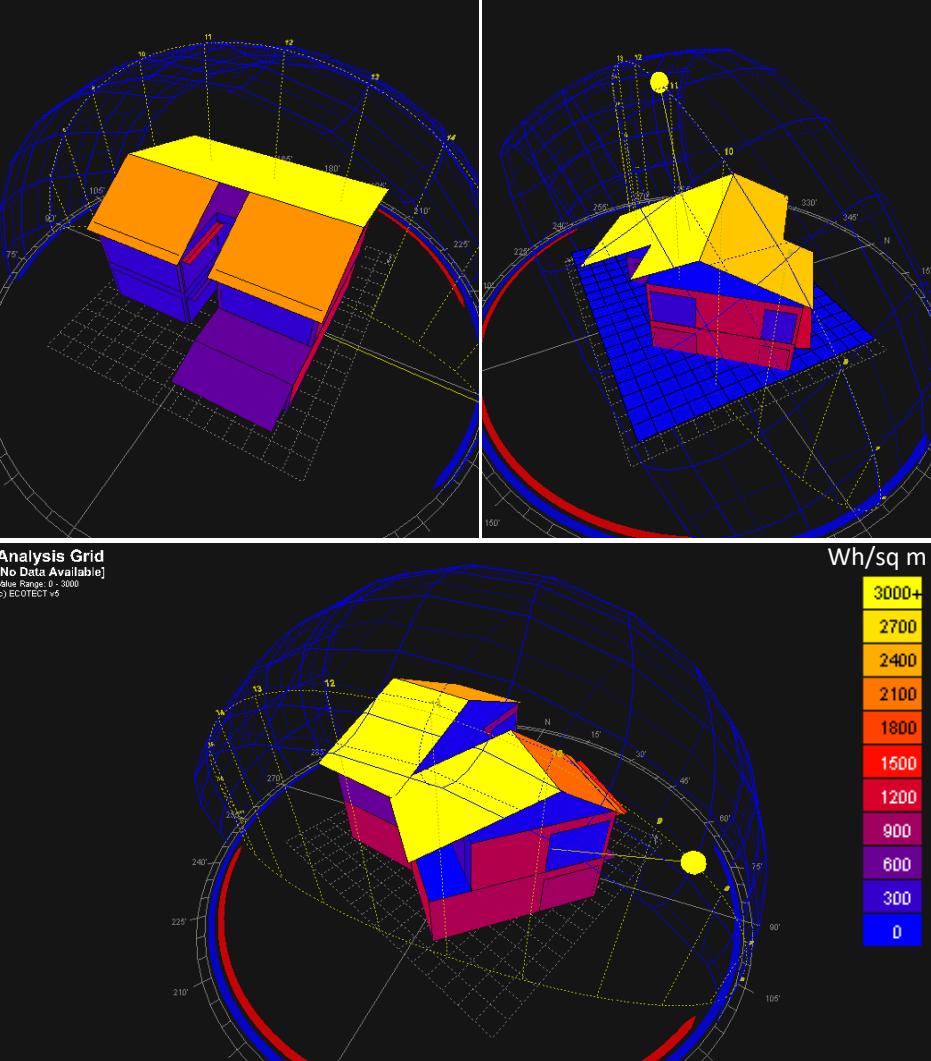


**Solar PV Location**  
**Theme 2**  
**(Houng Giang)**



Use of renewable energy  
2188 kWP

- Proposed solar PV Area
- Potential solar PV Area



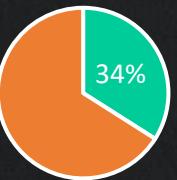
Sloping roofs can be used to install Solar Photovoltaic panels

Roofs at south as well as few roofs towards north can be used to install solar photovoltaic system

45 % to 50 % of the total roof areas can be used for solar installation

South facing roof areas can be increased to increases solar PV potentials.

**Solar PV Location**  
**Theme 3**  
**(VY DA)**



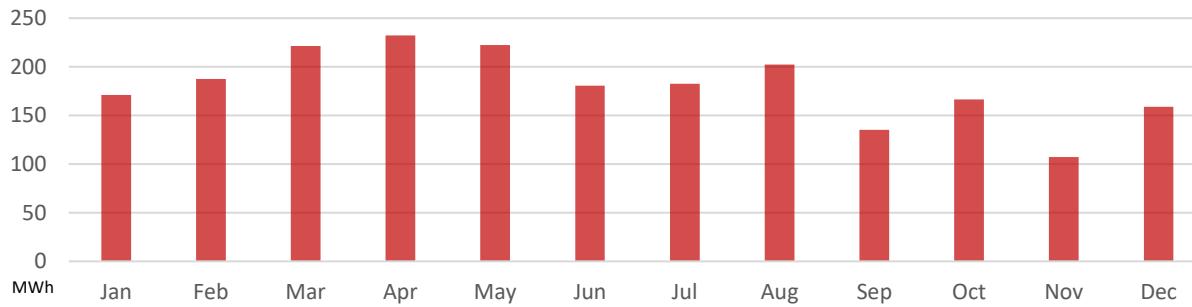
Use of renewable energy  
1802 kWp



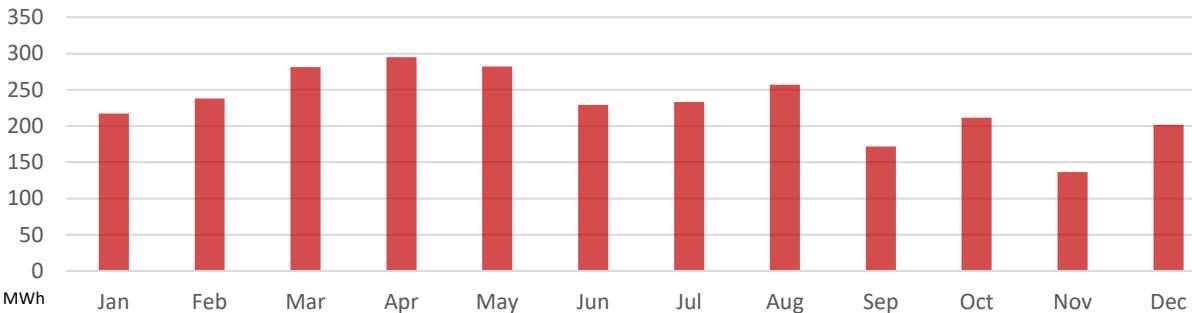
- Proposed solar PV Area
- Potential solar PV Area



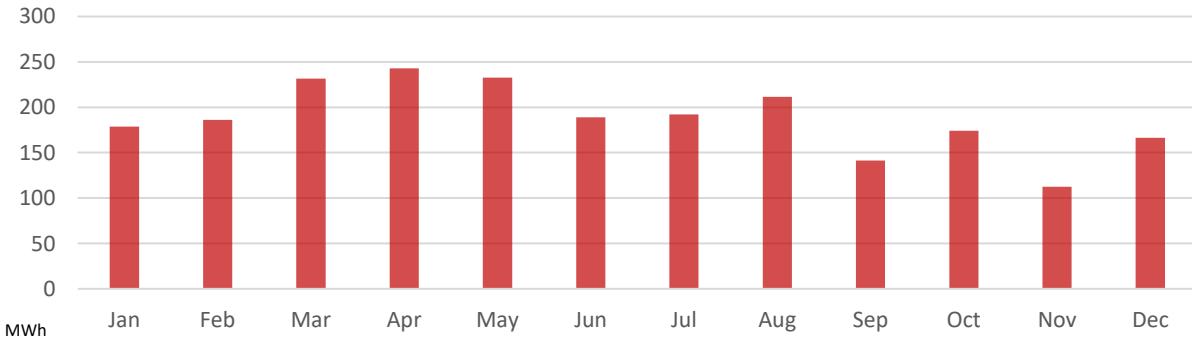
Ao Di  
**1723 kWp**



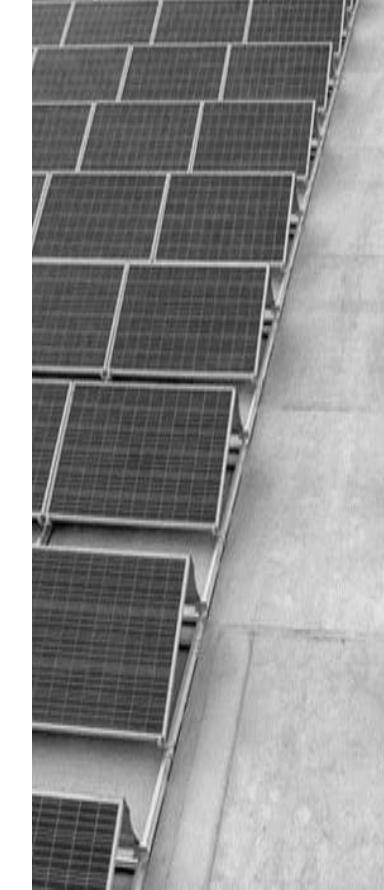
Houng Ginag  
**2188 kWp**



Vy DA  
**1802 kWp**



# Solar PV Generation



N

## Prevailing Winds

Wind Frequency (Hrs)

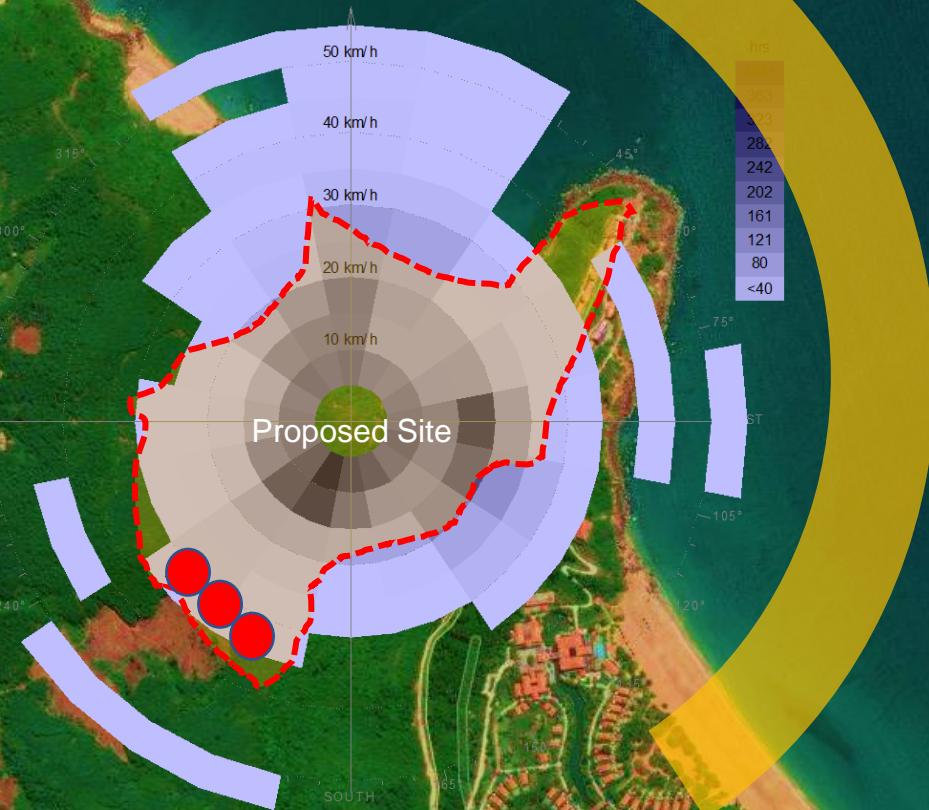
Location: Da Nang Intl AP, VNM (16.0°, 108.2°)

Date: 1st January - 31st December

Time: 00:00 - 24:00

© Weather Manager

Potential Location for Installation  
of Wind Turbine

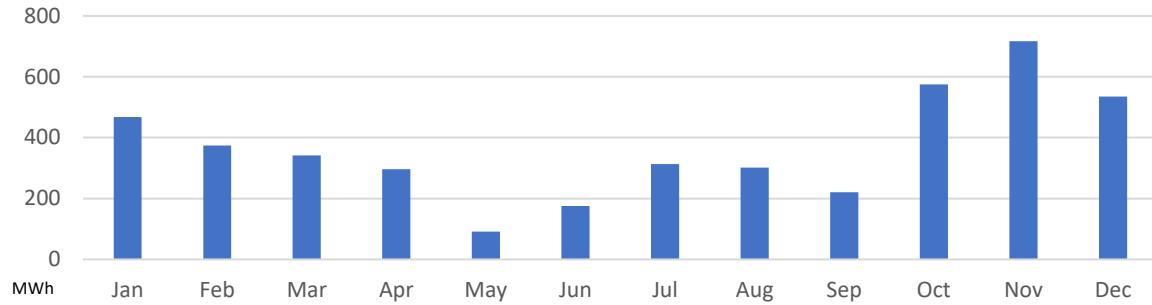


Prevailing Winds



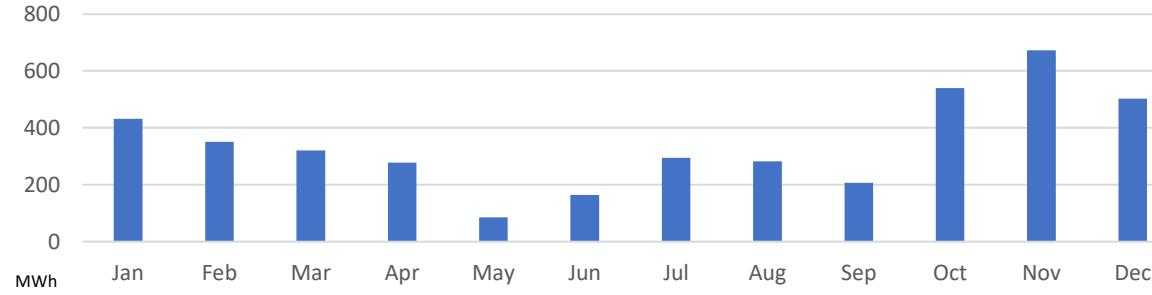
Theme 1

Ao Di  
**3250 kW**



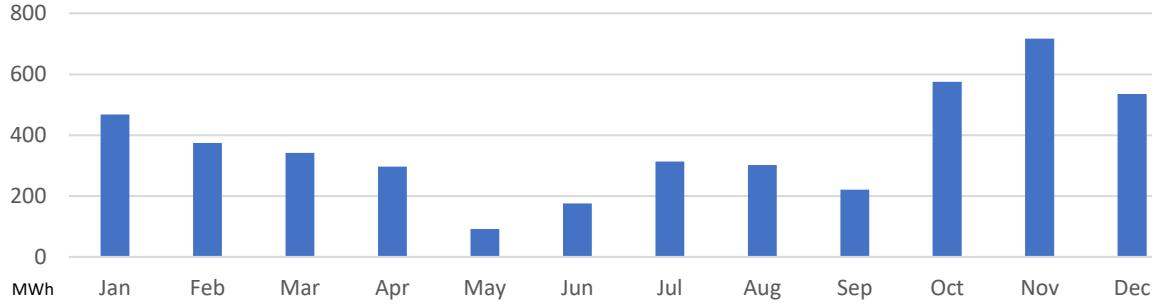
Theme 2

Houng Ginag  
**3050 kW**



Theme 3

Vy DA  
**3250kW**



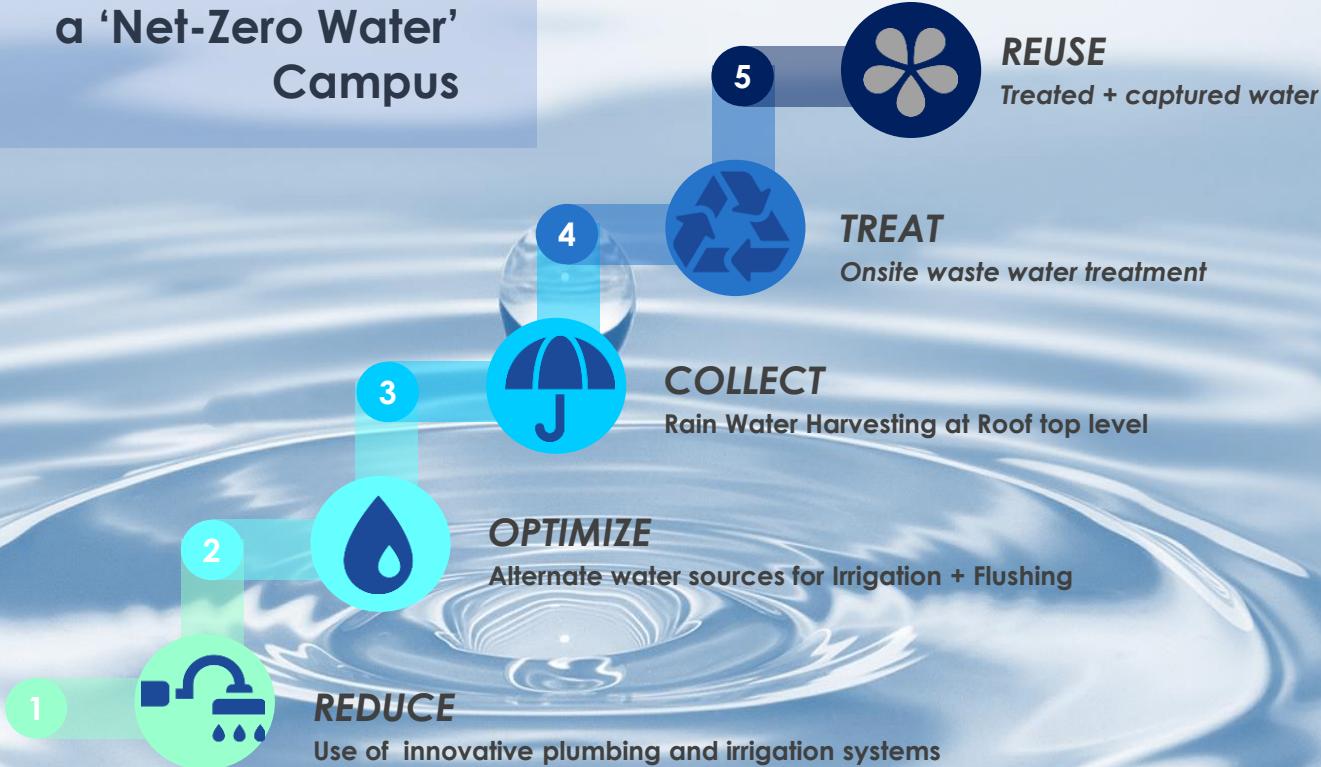
| Renewable energy system requirements for Net Zero Energy Building |   |                  |                        |                  |
|---|---|------------------|------------------------|------------------|
|   |   | Theme 1<br>Ao Di | Theme 2<br>Houng Giang | Theme 3<br>Vy Da |
| 1   | Total construction Area ( Sq m)                       | 50,499           | 50,499                 | 50,499           |
| 2   | Energy consumption (kWh/Sqm/year)                     | 130.5            | 130.5                  | 130.5            |
| 3   | Total estimated consumption (MWh/ year)               | 6,590 MWh        | 6,590 MWh              | 6,590 MWh        |
| 4   | Total estimated solar PV system size ( kWp)           | 1,723            | 2,188                  | 1,802            |
| 5   | Potential RE generation through solar PV (kWh/year)   | 2169 MWh         | 2754 MWh               | 2268 MWh         |
| 6   | Potential RE generation through solar PV (%)          | 33%              | 42%                    | 34%              |
| 7   | Potential Wind generation through solar PV (kWh/year) | 4,421 MWh        | 4,402 MWh              | 4,322 MWh        |
| 8   | Potential RE generation through Wind power (%)        | 67%              | 58%                    | 66%              |



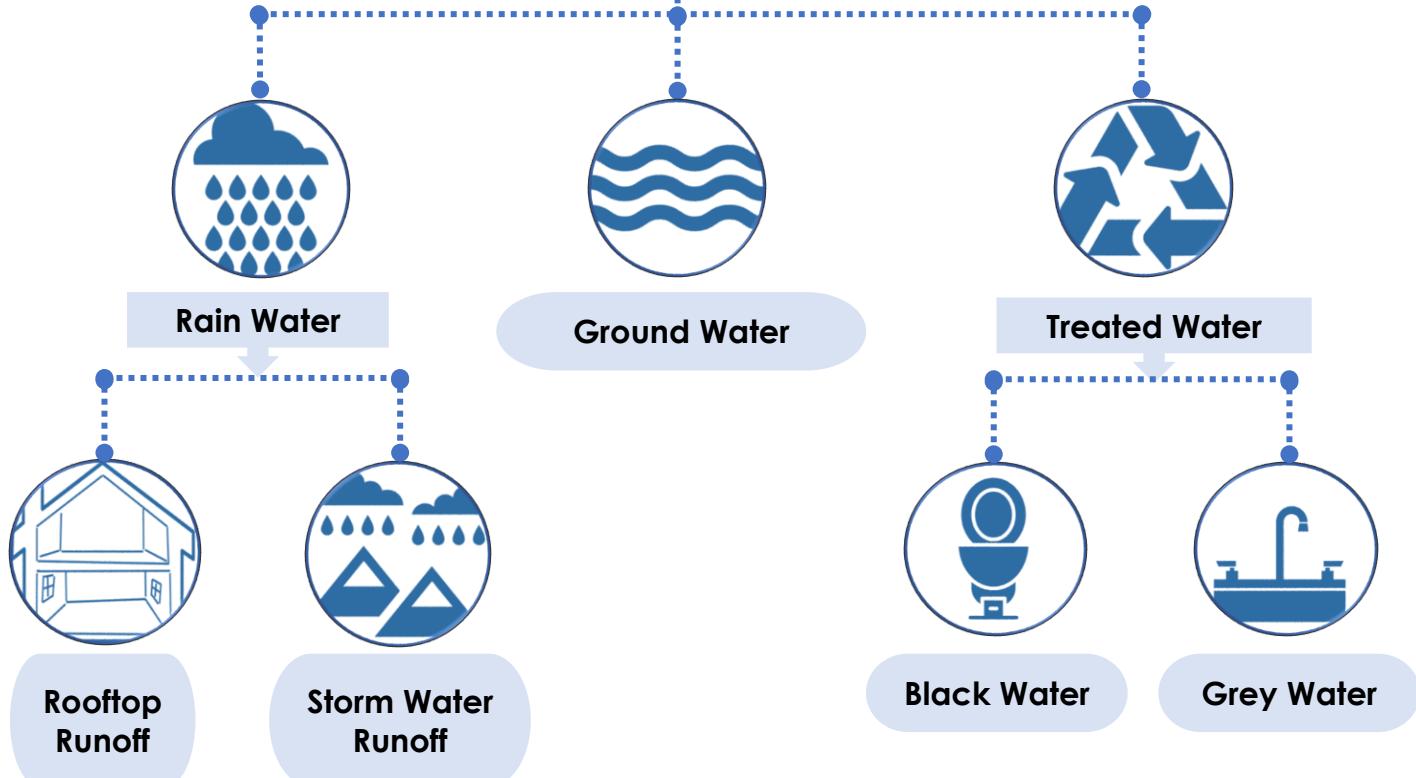
## Water Management

[

# Strategies for achieving a 'Net-Zero Water' Campus



## Alternative water sources



# Calculating the Water Demand

While calculating the daily Water demand, following assumptions were made:

TCVN 4513:1988

3.2 A periodic water use parameters in accordance with the standard "Urban water supply, design standard".

## Domestic uses:

Includes drinking, hand washing, cleaning, dish washing, etc. all other uses except flushing and bathing.

## Bathing:

Bathing water demand is considered based on a standard flow rate shower running for around 5 minutes duration.

## Flushing:

Considering that each person may use 4 half flush and 2 full flush during the 24 hours occupancy and the standard dual flush cistern of 3/6 LPF.

$$\text{Flushing water requirement} = (4 * 3) + (2 * 6) = 24 \text{ Litre/person/day}$$

Rounding off the flushing requirement to **30 Litre/person/day**.

For staff , considering an 8hr shift, the flushing requirement is considered as (1 full flush +2 half flush) as the standard requirement.

| Water use place  | Unit              | Daily water use standard about the maximum on 1/day |
|--|-------------------|---|
| 1  | 2                 | 3   |
| Building with each flat has a shared tap of all daily living requirement.            | 1 person          | From 80 to 100                                      |
| Building has sanitary equipment: shower, washing tap, toilet in sift contained flat. | 1 person          | From 100 to 150                                     |
| Building has sanitary equipment: Perfume shower, washing, toilet, shower special.    | 1 person          | From 150 to 200                                     |
| Building with each flat has bathroom, local water supply.                            | 1 person          | From 350 to 400                                     |
| Hostel with each floor has toilet, urinal, bath – wash tap, kitchen.                 | 1 person          | From 75 to 100                                      |
| Hostel with each room has toilet, urinal, bath – wash tap, kitchen.                  | 1 person          | From 100 to 120                                     |
| Hotel – Level III  | 1 person          | From 100 to 120                                     |
| - Level II   | 1 person          | From 150 to 200                                     |
| -Level I   | 1 person          | From 200 to 250                                     |
| - Special level  | 1 person          | From 250 to 300                                     |
| Food companies, food outlets   |                   |   |
| a) Food spot   | 1 dish            | 12  |
| b) Food to take home   | 1 dish            | 10  |
| Collective kitchen   | 1 person / 1 meal | From 18 to 25                                       |

Extract from TCVN standard

## Daily & annual Water Demand calculations

| No | Activity                          | Water Required<br>(For Guests considering<br>24 hours occupancy)<br>(Litre/person/day) | Water Required<br>(For Staff considering<br>8 hours occupancy)<br>(Litre/person/day) | No. of Guests | No. of Staff | No. of working days | Total Annual Demand (KL) |
|----|-----------------------------------|--|--|---------------|--------------|---------------------|--------------------------|
| 1  | Domestic                          | 75   | 60   | 182           | 36           | 365                 | 5771                     |
| 2  | Bathing                           | 45   | -  | 182           | 36           | 365                 | 2989                     |
| 3  | Flushing                          | 30   | 15   | 182           | 36           | 365                 | 2190                     |
| 4  | Restaurant<br>(Including Kitchen) | 70   | -  | 55*           | -            | 365                 | 1405                     |
| 5  | Club House                        | 45   | -  | 55            | -            | 365                 | 903                      |

\* Considering 30% occupancy in the club house and restaurant spaces.

## Calculating irrigation Water Demand

|                                    | Ja<br>n | Feb    | Mar    | Apr    | May   | June   | July  | Aug    | Sept   | Oct    | Nov    | Dec    |
|------------------------------------|---------|--------|--------|--------|-------|--------|-------|--------|--------|--------|--------|--------|
| No. of working days                | 31      | 28     | 31     | 30     | 31    | 30     | 31    | 31     | 30     | 31     | 30     | 31     |
| Avg. Precipitation (mm)            | 60.08   | 22.35  | 48.43  | 57.67  | 37.37 | 60.62  | 139.8 | 138.58 | 399.87 | 428.83 | 458.43 | 469.03 |
| No. of rainy Days                  | 14      | 8      | 6      | 7      | 10    | 9      | 10    | 12     | 15     | 20     | 20     | 18     |
| No. of days irrigation is required | 0       | 4      | 13     | 9      | 1     | 3      | 1     | 0      | 0      | 0      | 0      | 0      |
| Irrigation Water Demand (KL)       | 0.0     | 1483.0 | 4819.9 | 3336.9 | 370.8 | 1112.3 | 370.8 | 0.0    | 0.0    | 0.0    | 0.0    | 0.0    |

(Considering irrigation water demand as 29 litre/sq.m & total landscape area = 1,85,381 Sq.m)

# Rain Water Collection Potential



Roof area: 22,420 Sq.m



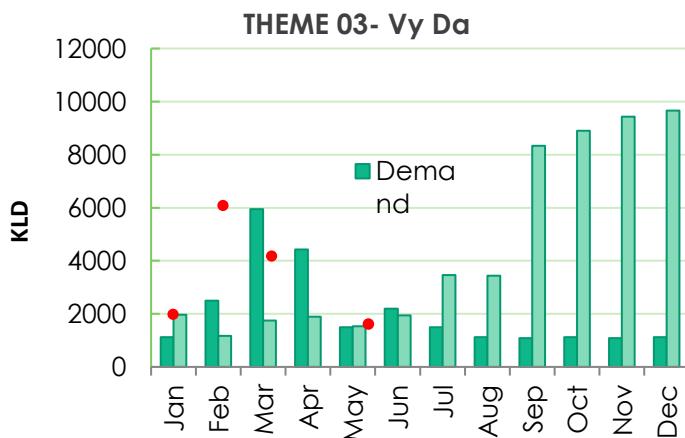
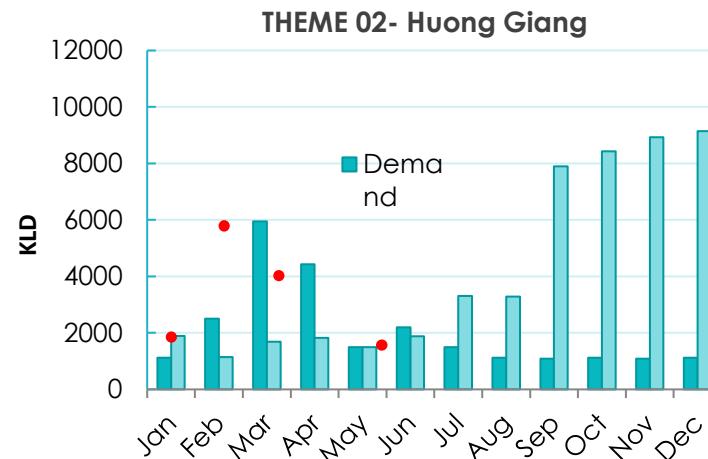
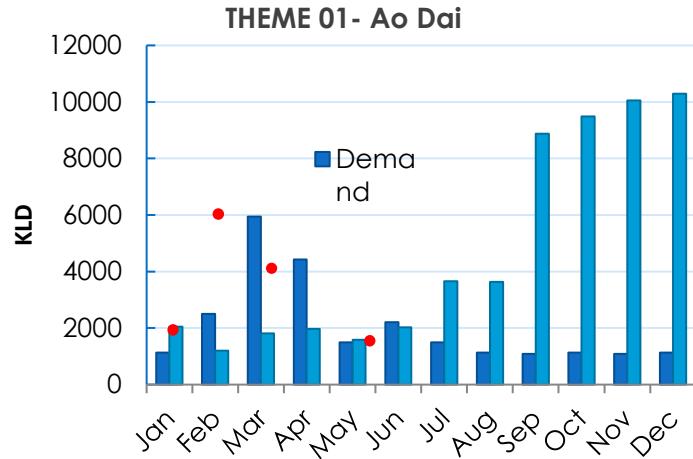
Roof area: 19,691 Sq.m



Roof area: 20,924 Sq.m

| RW Collection Potential           | Jan  | Feb | Mar | Apr  | May | June | July | Aug  | Sept | Oct  | Nov  | Dec  |
|-----------------------------------|------|-----|-----|------|-----|------|------|------|------|------|------|------|
| Theme 01:<br>Ao Dai (KL)          | 1212 | 451 | 977 | 1164 | 754 | 1223 | 2821 | 2796 | 8068 | 8653 | 9250 | 9464 |
| Theme 02:<br>Huoung Giang<br>(KL) | 1065 | 396 | 858 | 1022 | 662 | 1074 | 2478 | 2456 | 7086 | 7600 | 8124 | 8312 |
| Theme 03:<br>Vy Da (KL)           | 1131 | 421 | 912 | 1086 | 704 | 1142 | 2633 | 2610 | 7530 | 8076 | 8633 | 8833 |

# Monthly Water Balance



- For dry months of the year i.e. February, March, April & June the water demand exceeds supply in all the three options.
- This is mainly due to increased water demand for irrigation purpose.
- However, this demand can be tackled by using the rain water collected during months with high rainfall.

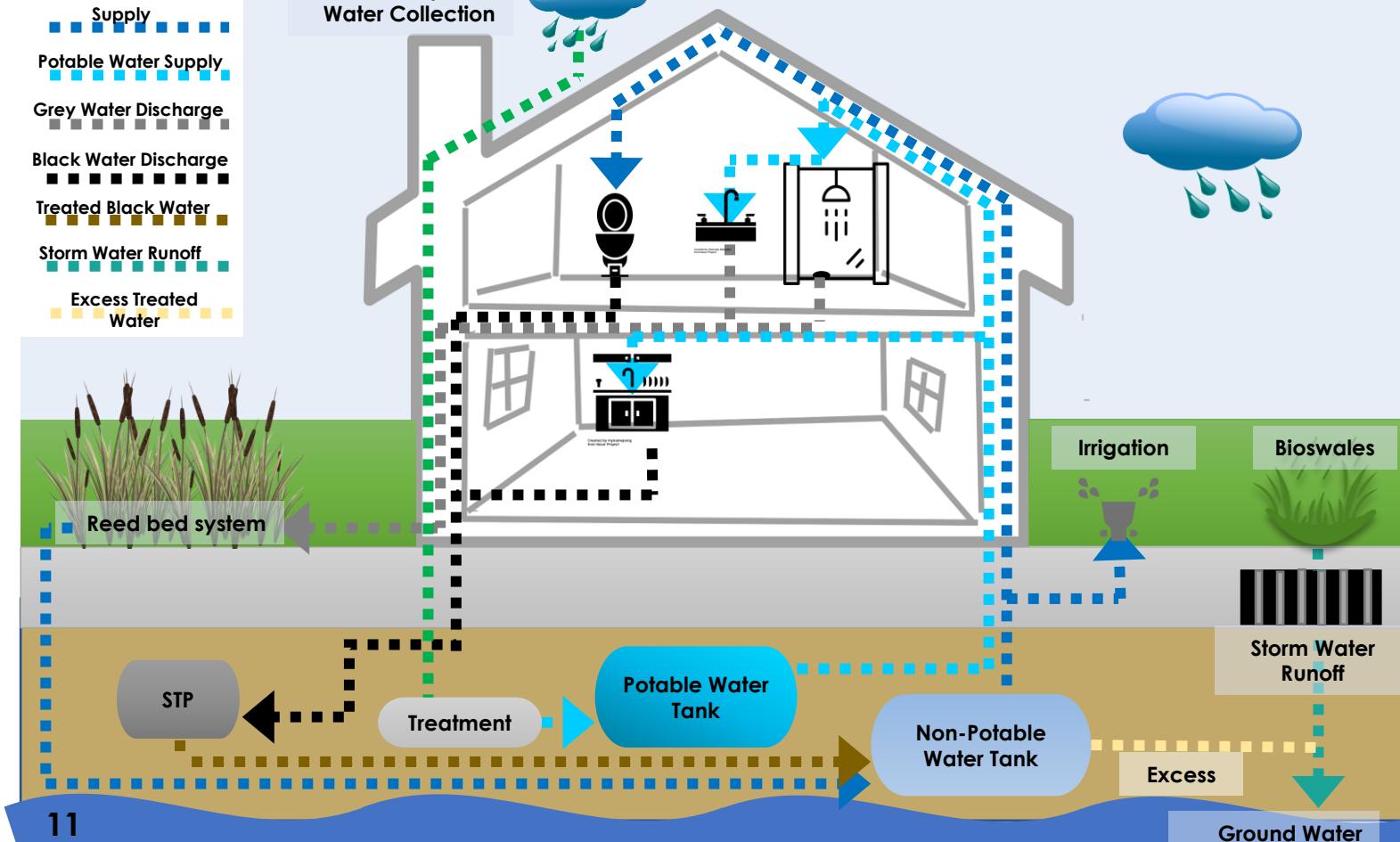
## Design Recommendations

| Options     | Total Annual Water Demand (KL) | Total Annual Water Supply (KL) (Rainwater+Treated water) | Excess Water (KL) | Storage Capacity Required (KL) |
|-------------|--------------------------------|--|-------------------|--------------------------------|
| Ao Dai      | 24,746                         | 56,639   | 31,892            | 9,700                          |
| Huong Giang | 24,746                         | 50,939   | 26,192            | 10,300                         |
| Vy Da       | 24,746                         | 53,514   | 28,768            | 10,000                         |

- The campus can be designed as a net Zero Water campus by reusing Roof top storm water runoff and implementing onsite treatment facilities.
- To meet the annual water demand, excess water from wet months can be stored, treated and reused.
- Additionally the huge amount of excess water can also be reused for landscaping or water bodies in future phases.
- The storm water runoff from landscape and hardscape areas can be infiltrated directly in the ground or can be directed offsite.

# Closed Loop System

- Rain Water Supply
- Non-Potable Water Supply
- Potable Water Supply
- Grey Water Discharge
- Black Water Discharge
- Treated Black Water
- Storm Water Runoff
- Excess Treated Water



## On-Site Storm water Collection & Waste Water treatment processes

### Sewage Treatment Plant

- Compact solution.
- Controlled conditions
- Higher process rate.
- Needs energy to operate.



### Reed Bed System

- Ecological Process
- Low maintenance
- Low operation and maintenance costs
- Can be combined with local communities.
- Last a long time.



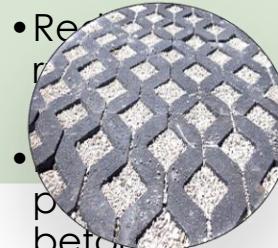
### Bioswales

- Infiltration to ground water
- Aesthetic Value
- Improves quality of surface water
- Reduces rain water runoffs hence reducing soil erosion.



### Permeable surfaces

- Pervious paver blocks can be installed in the hardscaped areas.
- Enables infiltration of storm water runoff.
- Reduces soil erosion before infiltration.



## On-Site Waste Water Collection & treatment - Bioswales

Bioswales / Vegetated swales are drainage channels designed to collect and convey storm water while removing debris and pollution.

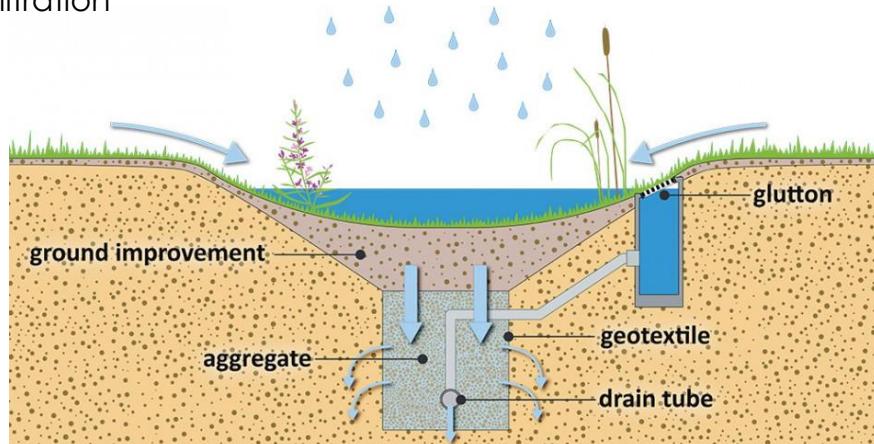
### Application

- Parking Lots
- Roadside swales
- In landscaped areas



### Function

- Storm water collection
- Storm water filtration
- Infiltration

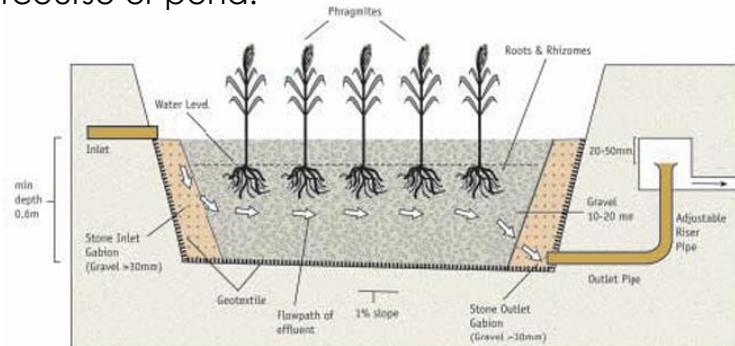


Typical section of a bioswale

## Grey water treatment – REED Bed system

REED Bed systems act as a natural waste treatment systems.

A vertical flow reed-bed is a reed-bed in which the effluent is periodically dosed uniformly over the surface of the bed by means of a network of pipes. The effluent percolates vertically down through the media and is collected by drainage pipes at the bottom which discharge to the next reed-bed in a series or directly into a watercourse or pond.



Typical section of a Vertical REED Bed system

### REED Bed Sizing calculations

Total water consumed per day = 30,000 Litres

Waste Water generated per day =  $30,000 * 0.8$   
= 24 Cu.m/day

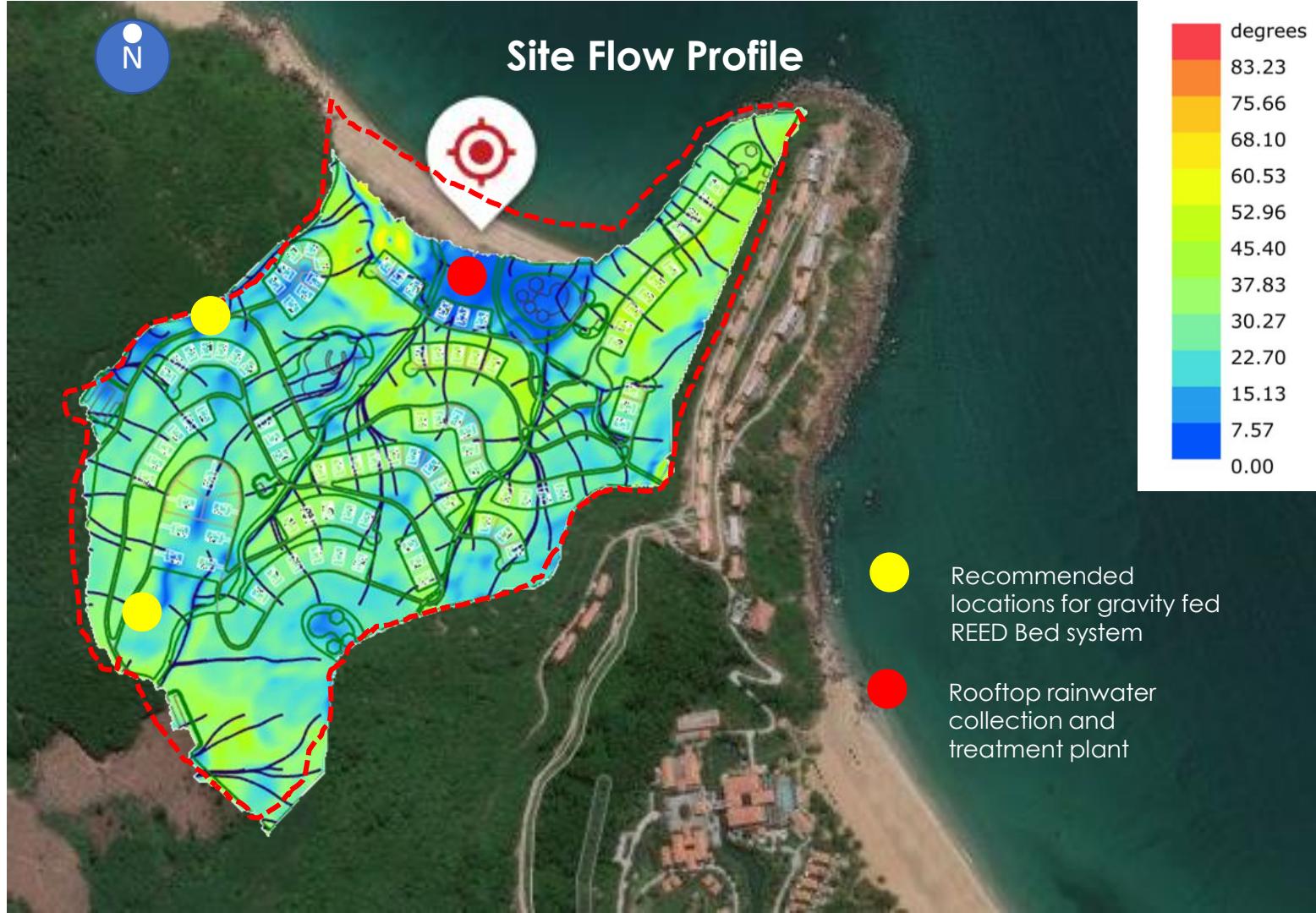
Area of the plant bed filter required\* = **96 Sq.m**

The REED Bed size required for the project is

**5m x 19 m**

\*considering 4 sq/m /Cu.m of waste water







Thank You

