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The Trust Company (Australia) Ltd AFT WH Redfern Trust

# 104-116 Regents St, Redfern NSW

# Alternative Performance Solution for Natural Ventilation

20E-21-0052-TRP-25845-0

9 December 2021

| | |
|---|---|
| **Job Title:** | 104-116 Regents St, Redfern |
| **Report Title:** | Alternative Performance Solution for Natural Ventilation |
| **Document Reference:** | 20E-21-0052-TRP-25845-0 |

| **Prepared For:** | **Prepared By:** |
|---|---|
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| | | |
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| **Reviewer:** | M. Tsinonis.<br>9 December 2021 | Office Administration |
| **Issued By:** | B. Shojaei<br>9 December 2021 | Senior ESD Engineer |

**Revision History:**

| *Rev. #* | *Comments / Details of change(s) made* | *Date* | *Revised by:* |
|---|---|---|---|
| Rev. 00 | Original issue | 9 Dec 21 | |

# Executive Summary

VIPAC Engineers and Scientists have been engaged to perform CFD assessment and comment on the effectiveness of the proposed mechanical ventilation system for the student accommodation development at 104-116 Regent St, Redfern NSW.

Dynamic simulation (using Design Builder software) has been used to determine the percentage of the year in which minimum performance requirements have been met for the habitable rooms provided with alternative means of ventilation due to external noise level conditions. The proposed mechanical ventilation design has been evaluated using Computational Fluid Dynamic (CFD) simulation to determine the overall impact on the following:

- Energy Efficiency – reduction in the Air-conditioning energy consumption (given the reduced reliance on active air-conditioning),
- Age of the indoor air,
- Thermal Comfort (PMV).

Applicable rooms have been evaluated to demonstrate the following performance requirements are achieved for a minimum 90% of all hours of the year:

- If the habitable area is less than the threshold area: 10 litres/second/person for each apartment, where the number of people equals the number of bedrooms plus 1, or
- If the habitable area is more than or equal to the threshold area: 0.3 litres/second/m2 for each apartment.

Each habitable room provided with alternative means of natural ventilation has also been assessed for adequate ventilation of 10 litres/second per person.

A tabulated summary of results is presented in Table 1 below. The results demonstrate that the assessed habitable rooms meet the minimum performance requirements for greater than 90% of all hours of the year. As such, the minimum level of ventilation has been met and adequate ventilation is achieved via the alternative ventilation proposal.

*Table 1. Result Summary.*

| Unit Type | Apartment area (Conditioned area) ($m^2$) | Number of occupants | Required volume flow rate (l/s) | % of year achieved |
|---|---|---|---|---|
| Type 1: Unit 05.06 - Studio A | 13 $m^2$ | 1 | 10 | 100% |
| Type 2.1: Unit 05.01 – Bedroom 1 | 8 $m^2$ | 1 | 10 | 100% |
| Type 2.2: Unit 05.01 – Bedroom 2 | 8 $m^2$ | 1 | 10 | 100% |
| Type 3.1: Unit 05.14 – Bedroom 1 | 8 $m^2$ | 1 | 10 | 100% |
| Type 3.2: Unit 05.14 – Bedroom 2 | 8 $m^2$ | 1 | 10 | 100% |

Furthermore, the simulation has demonstrated that the proposed ventilation design will result in the following improvements:

- Overall Energy Efficiency,
- Thermal Comfort (i.e. PMV),
- Age of air (freshness of the air).

The improvements are listed in **Error! Reference source not found.**.

*Table 2.Improvements.*

| | Without Ventilation | With Ventilation | Improvement (%) |
|---|---|---|---|
| Heating (KWh p.a. for all tested units) | 87 | 591 | |
| Cooling (KWh p.a. for all tested units) | 1789 | 978 | |
| Total (KWh) | **1876** | **1569** | ↑ **16.4%** |
| Energy Per Conditioned Building Area (KWh/m2) | 42 | 35 | ↑ 16.4% |
| Fraction Operation Hours between 21-24 degrees (%) | 98.3% | 98.8% | ↑ 0.5% |
| Fraction Operation Hours PMV with between -1 and 1 (% Thermal Comfort) | 98.2% | 98.5% | ↑ 0.3% |

The simulations also demonstrated that the energy generated by the proposed Solar PV system will be sufficient to offset the energy consumption of the proposed mechanical ventilation system (Table 3).

*Table 3. Solar Energy Generation.*

| **Solar Energy Generation vs. Mechanical Ventilation Energy Consumption** | |
|---|---|
| Estimated Annual Energy Consumption for Mechanical Ventilation | **22,037 kWh p.a.** |
| Estimated Annual Solar PV Energy Generation | **60,866 kWh p.a.** |

# Table of Contents

# 1 Introduction

This report has been prepared for the proposed student accommodation development at 104-116 Regent St, Redfern NSW. The location of the development is shown in Figure 1.

The purpose of this study is to assess the effectiveness of the proposed mechanical ventilation design for the habitable rooms provided with alternative means of ventilation due to external noise level conditions.

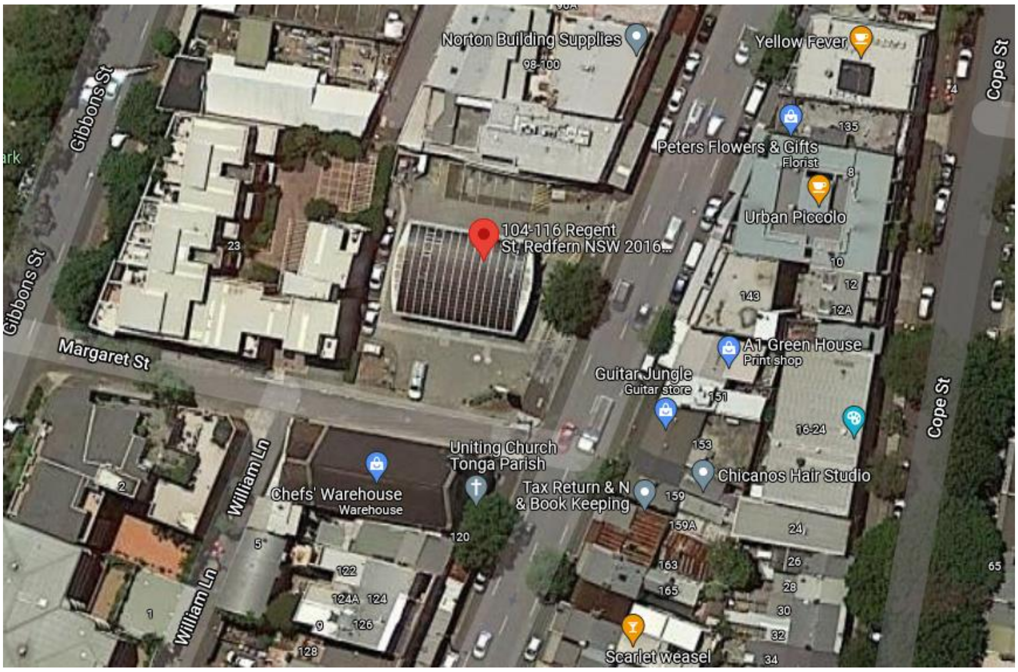



*Figure 1. Location of the development – 104-116 Regent St Redfern NSW– Source: Google Map.*

## 1.1. Reference Documents

The assessment is based on the following architectural drawings prepared by Antoniades Architects (Table 4).

*Table 4. Drawing List.*

| Drawing Title | Drawing Number |
|---|---|
| GA Plans | DA3.02 to DA3.10 |
| Sections | DA4.01 |
| Elevations | DA5.01 to DA5.03 |

# 2 Modelling Parameters

## 2.1. Software

The ventilation simulations in this report are performed using the Design Builder (v7.0.0.082) modelling software.

## 2.2. Weather File

Historical hourly local weather data, in the form of twelve months' data, was used to represent the building external ambient data at the building location and to accurately model the dynamic nature of building thermal response. The weather data contains hourly records of radiation, temperature, humidity, sunshine duration and wind speed and direction for a typical meteorological year.

Based on the location of the development, the weather data from the closest weather station was used for the simulation of all models (Sydney Observatory Hill NSW, approx. 4km from the site). The weather station distance from site is illustrated in Figure 2. Table 5 outlines details of the simulation weather file. The Typical Meteorological Year (TMY) weather file represents a year without unusual extremes in temperature or typical average conditions, suitable for energy simulation modelling.

*Table 5. Simulation weather file details.*

| Weather File Property | Value |
|---|---|
| Location | Sydney Observatory Hill |
| Weather File Type | The Typical Meteorological Year (TMY) |

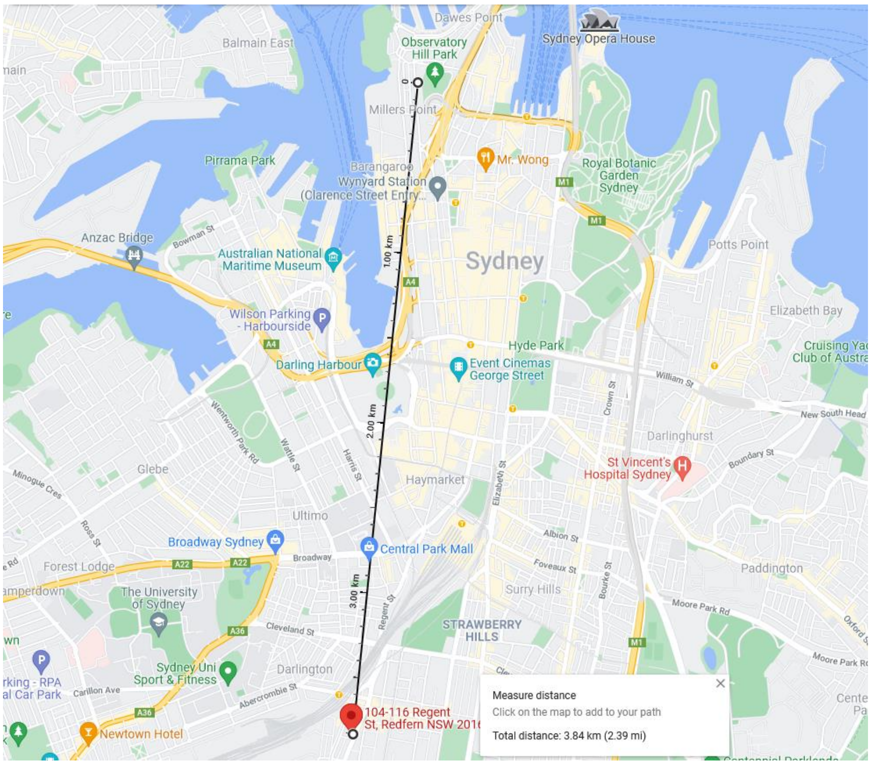



*Figure 2. Weather Station distance from site.*

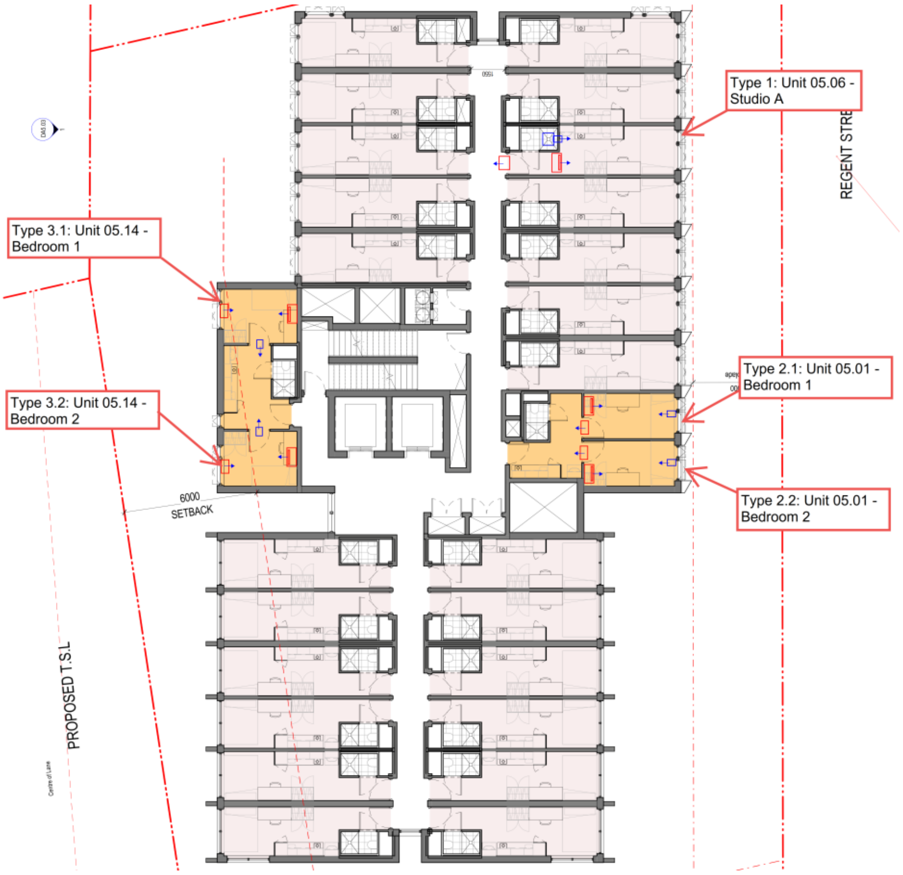
## 2.3. Site Data

In accordance with the Guidelines, a 'City' terrain type has been selected within the model.

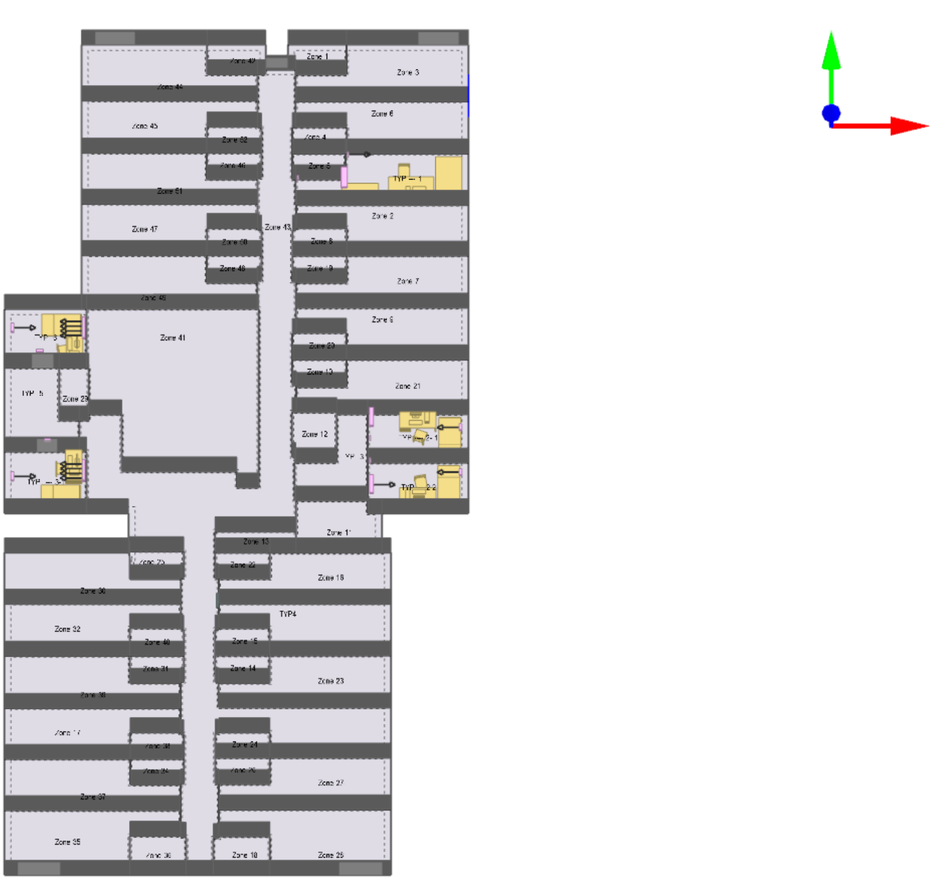
## 2.4. Assessed Rooms

The following worst-case scenario rooms (each unique layouts designs) have been assessed as part of this analysis. Arrangement and features of units have been modelled in the simulation.

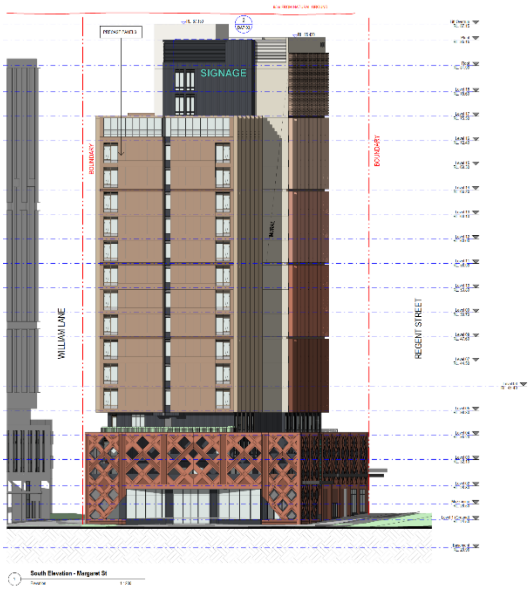
**Floor Plans – Level 05 to 08 – Assessed Units:**

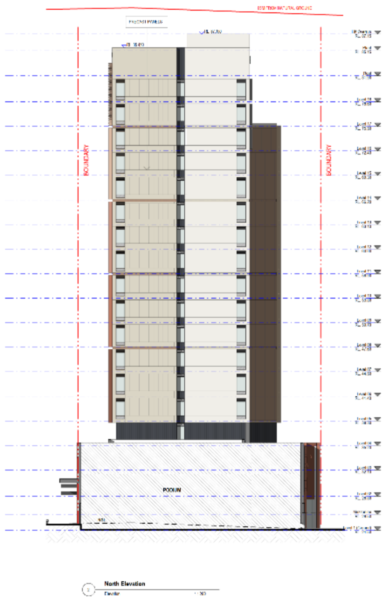



**Design Builder Model of Level 5 to 8 and Assesses Uni6ts:**

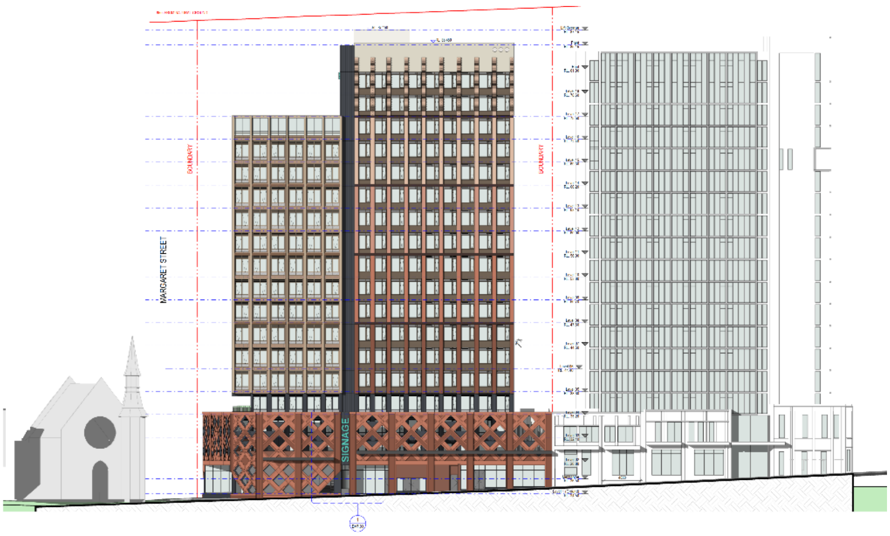


**North and South Elevations**

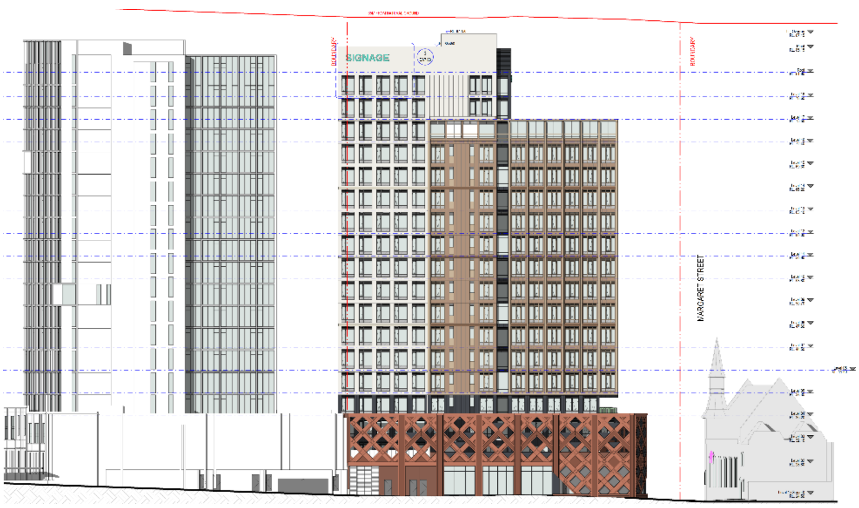



**East Elevation**




**West Elevation**



# 3 Simulation And Modelling Outcomes

## 3.1. Modelling

The CFD and energy simulations were performed using Design Builder (v7.0.0.082) modelling software.

## 3.2. Description of the Model

The following model was built to represent part of the CFD model represents the air that passes through the plenum from the outside to the rooms. The model geometry for the building is shown in Figure 3 below.

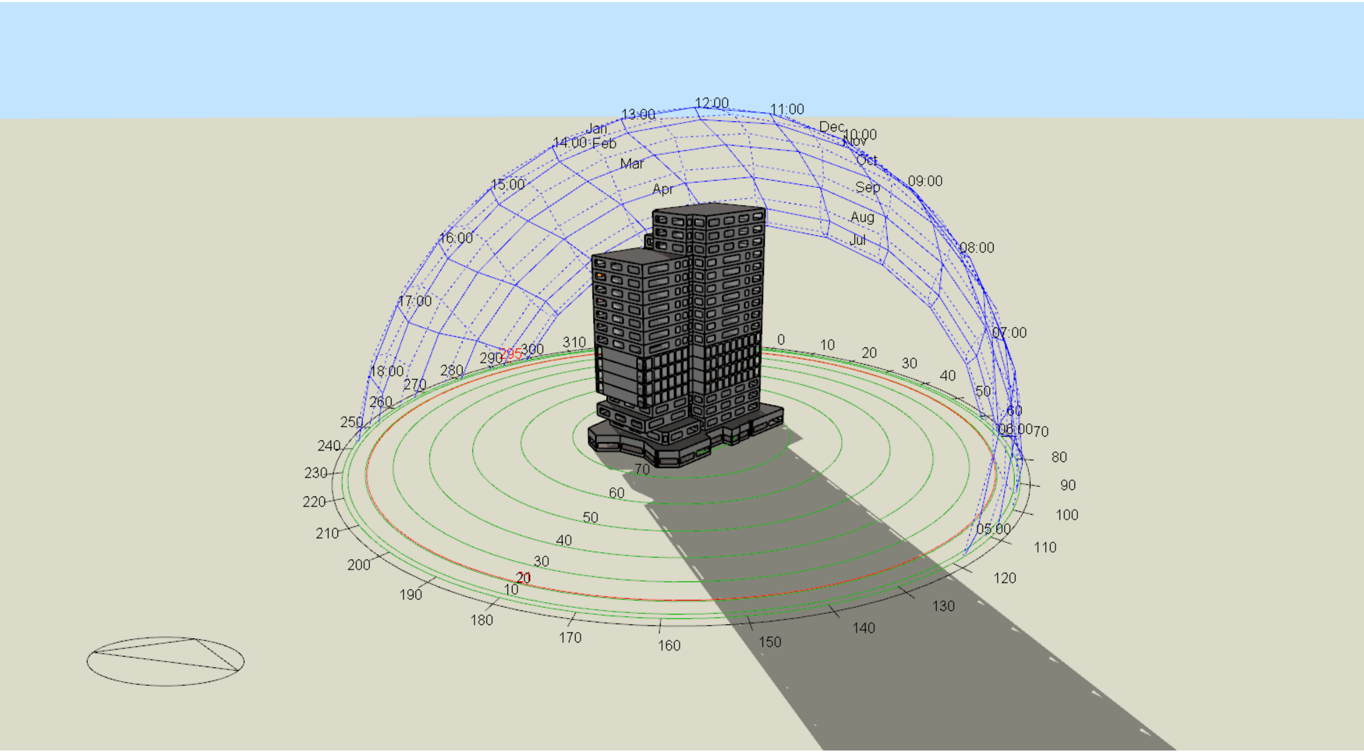


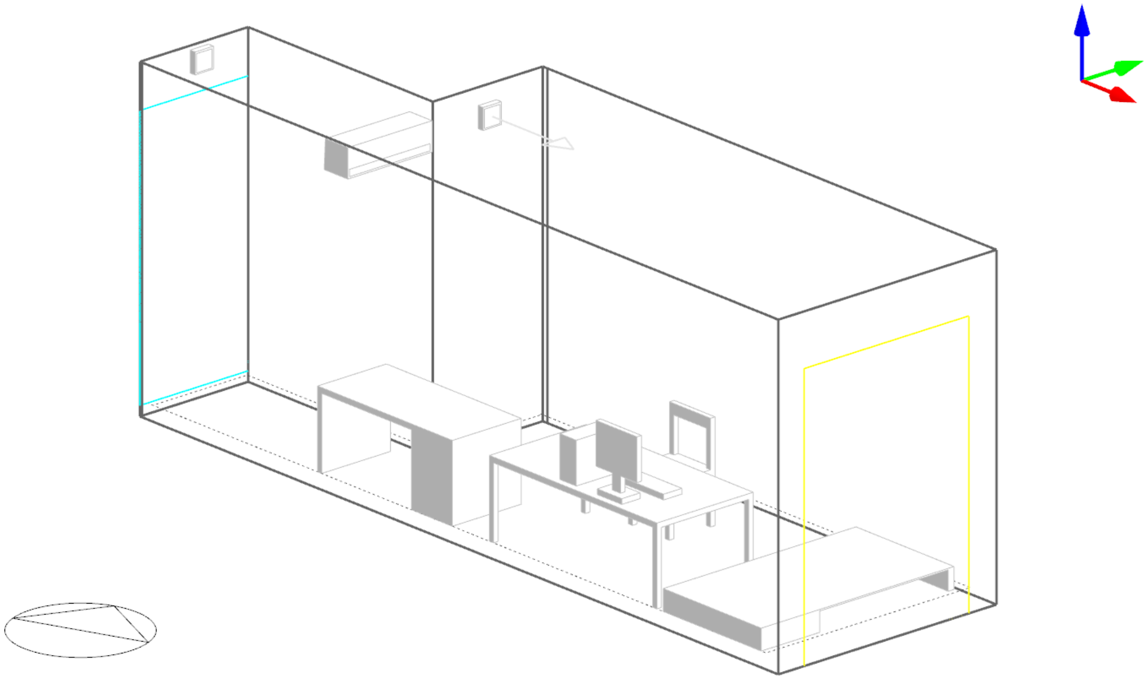

*Figure 3. Design Builder Model Geometry – Overall View.*

## 3.3. CFD Modelling Inputs

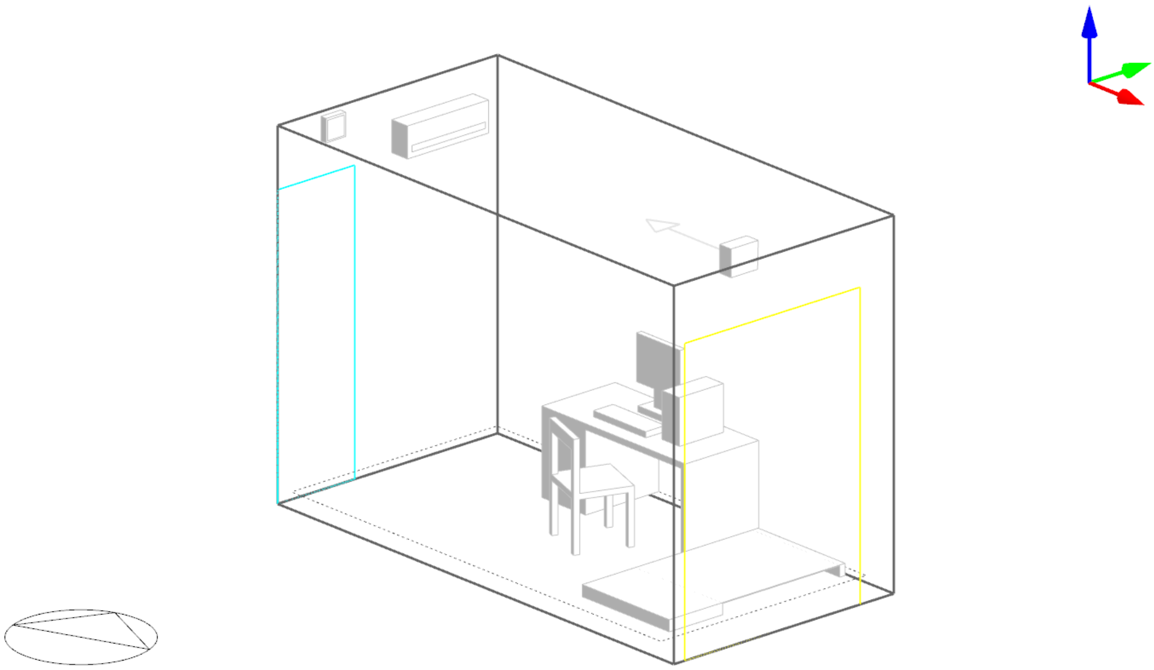
### 3.3.1. Geometry

Air is passed from the supply inlet to the ceiling mounted grill connected to the corridor via a rigid duct. All ventilation openings have been modelled to satisfy the mechanical design requirements for each layout type.

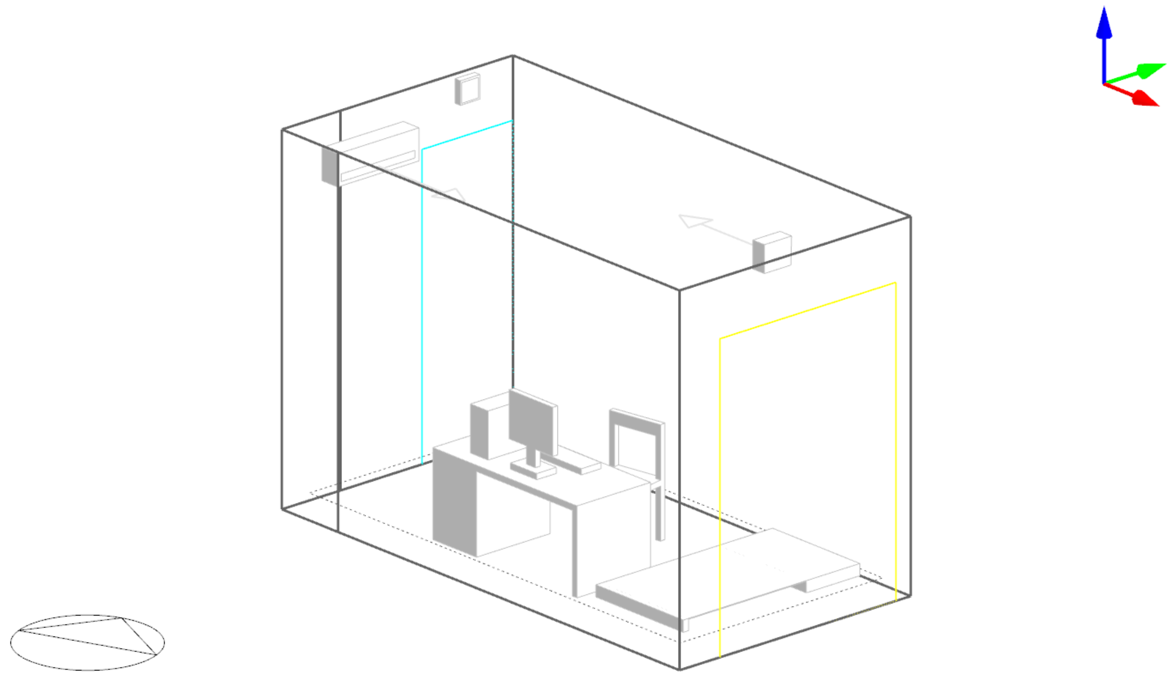
**Type 1: Unit 05.06 - Studio A**



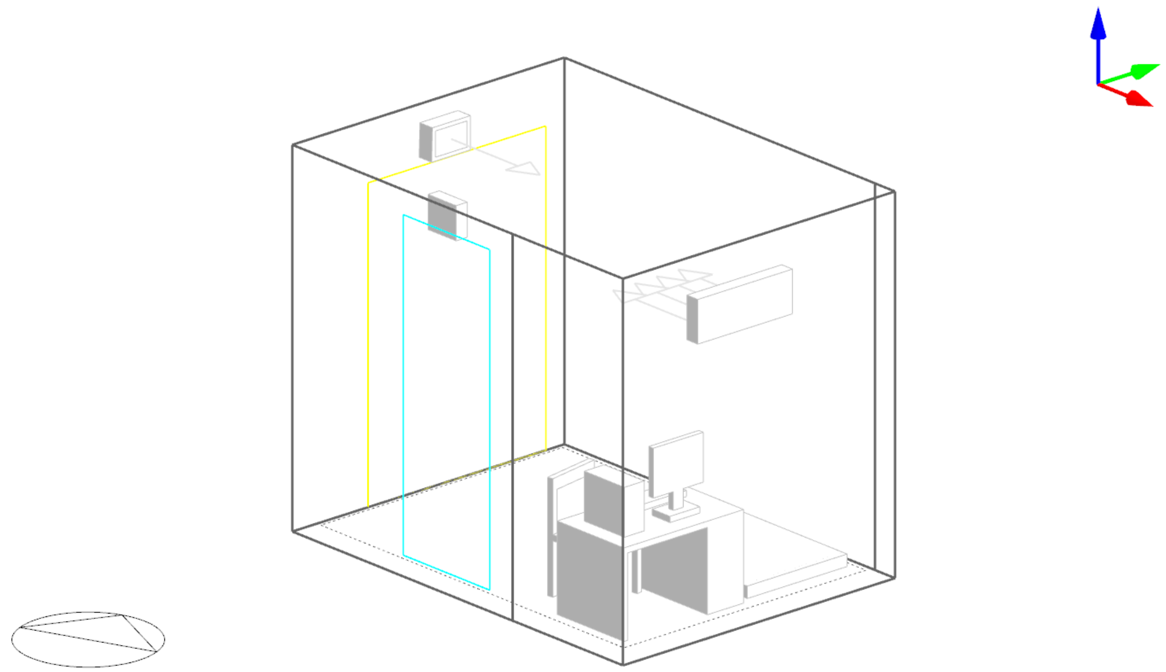
**Type 2.1: Unit 05.01 – Bedroom 1**



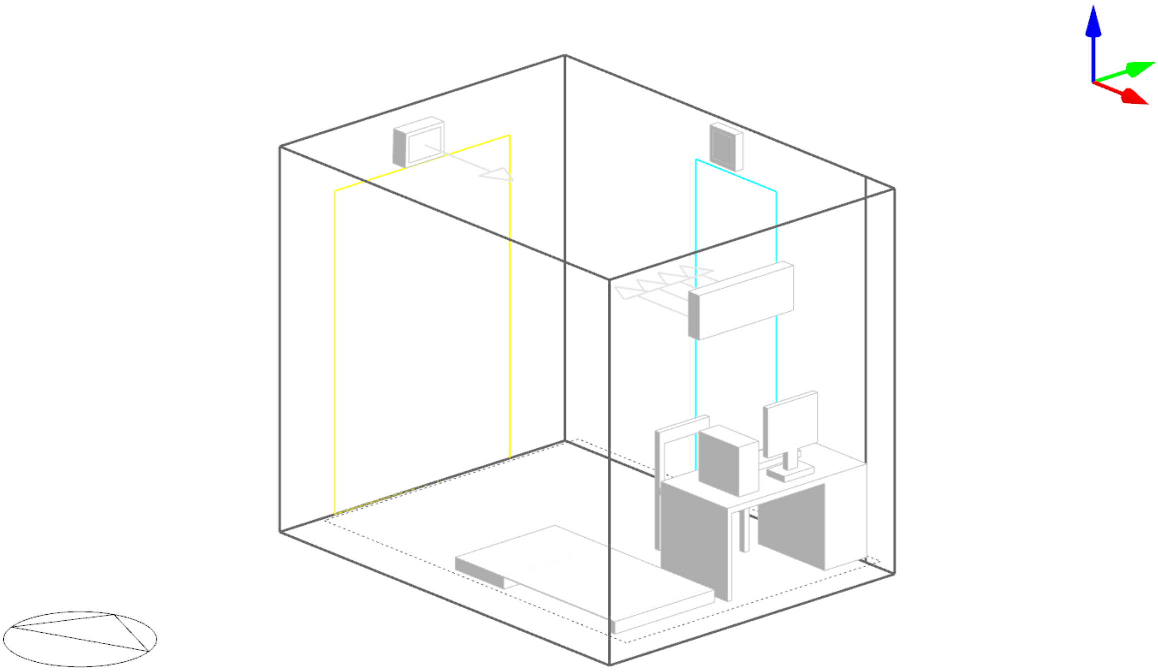
**Type 2.2: Unit 05.01 – Bedroom 2**



**Type 3.1: Unit 05.14 – Bedroom 1**

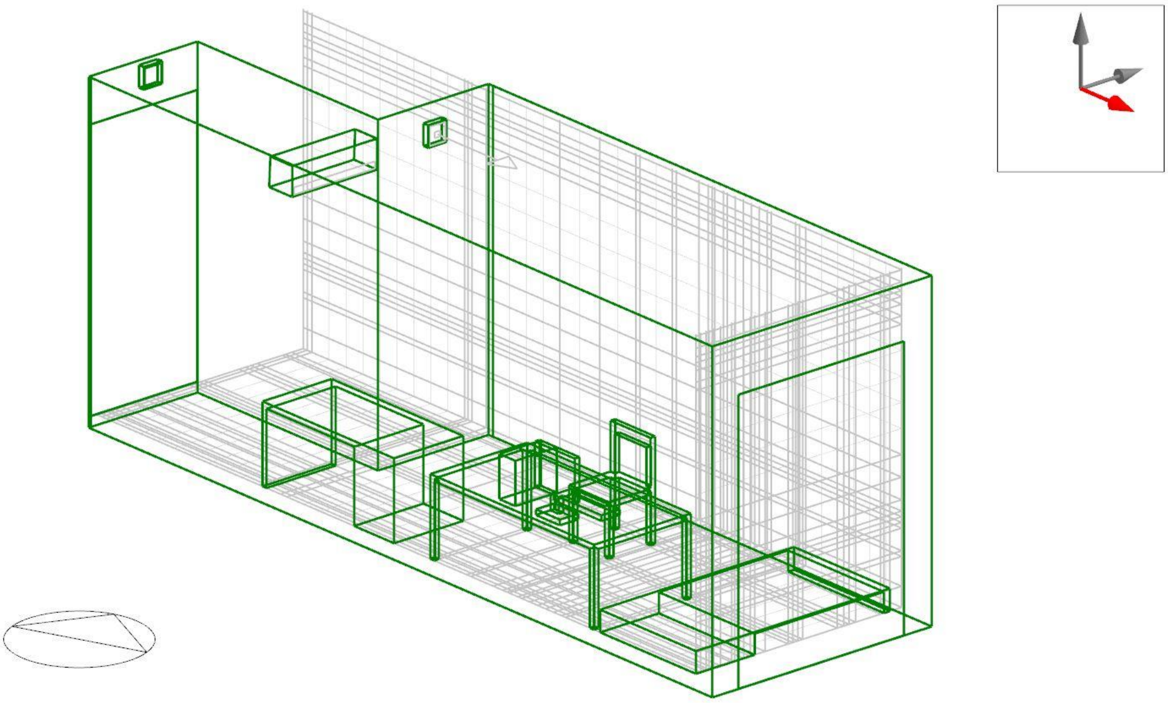


**Type 3.2: Unit 05.14 – Bedroom 2**

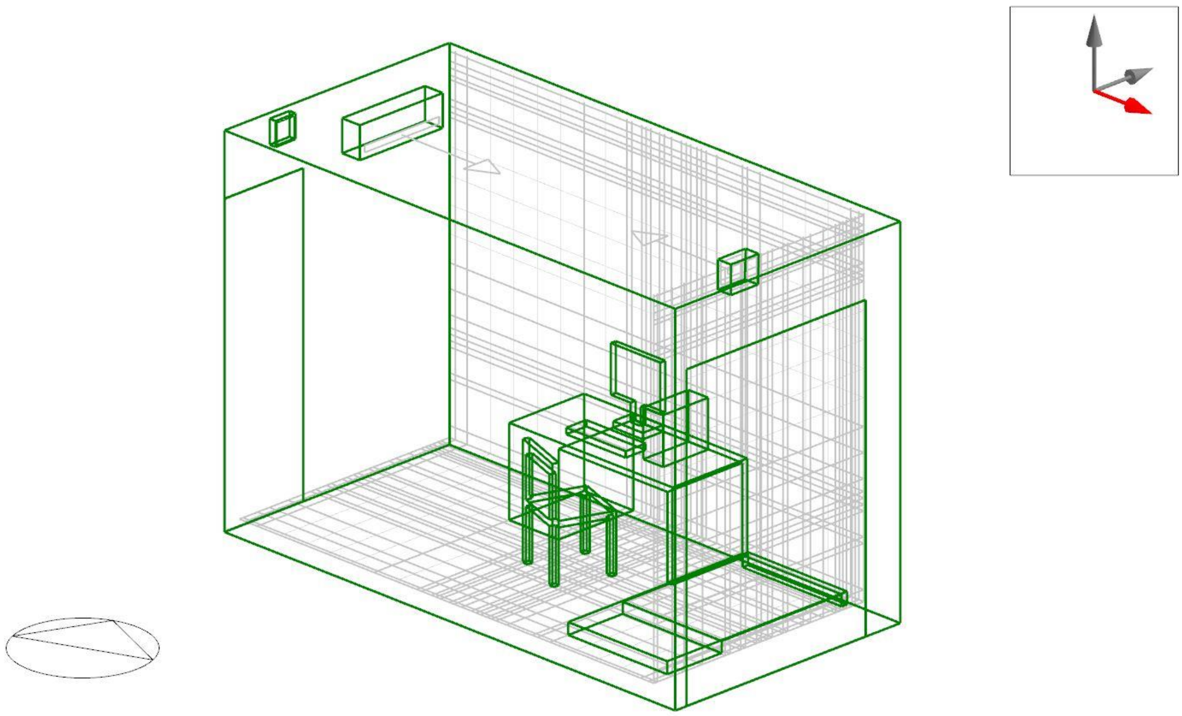


### 3.3.2. Mesh

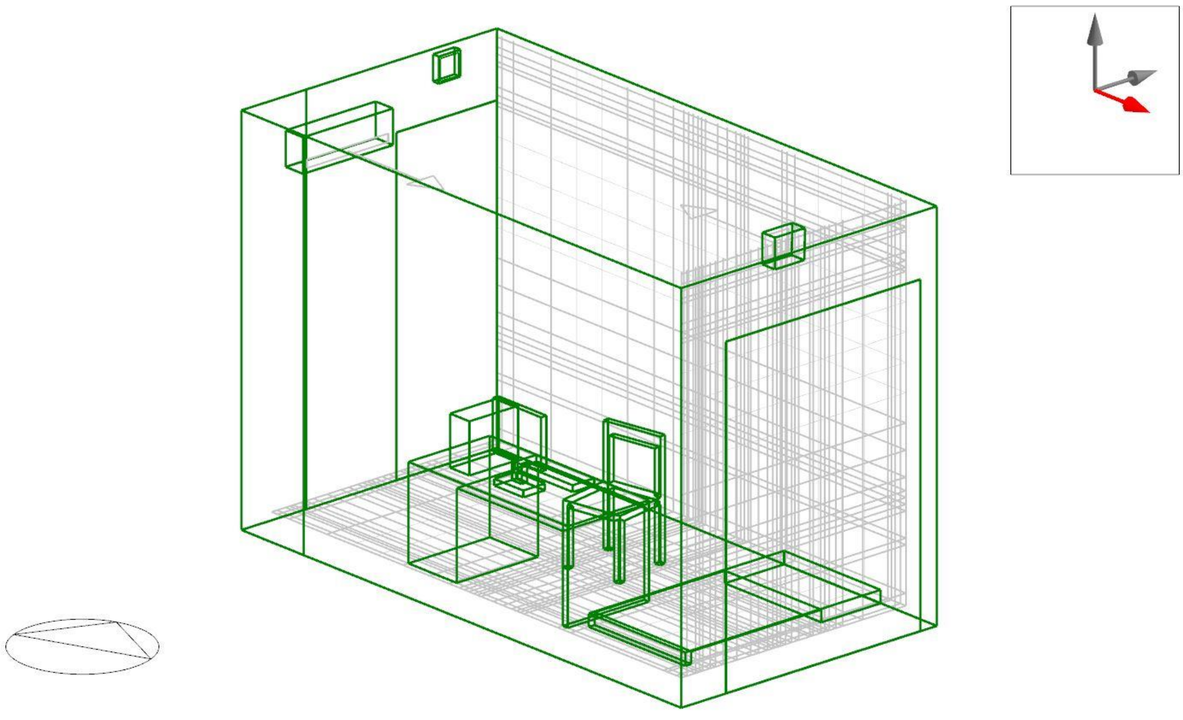
**Type 1: Unit 05.06 - Studio A**



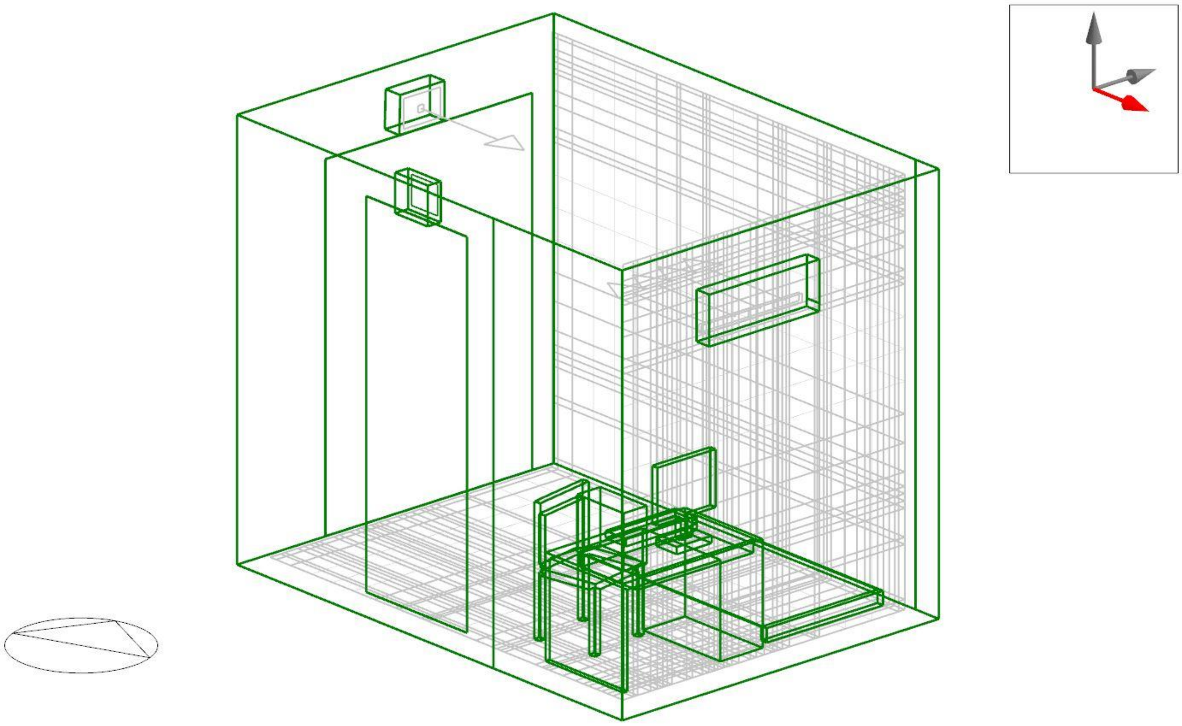
**Type 2.1: Unit 05.01 – Bedroom 1**



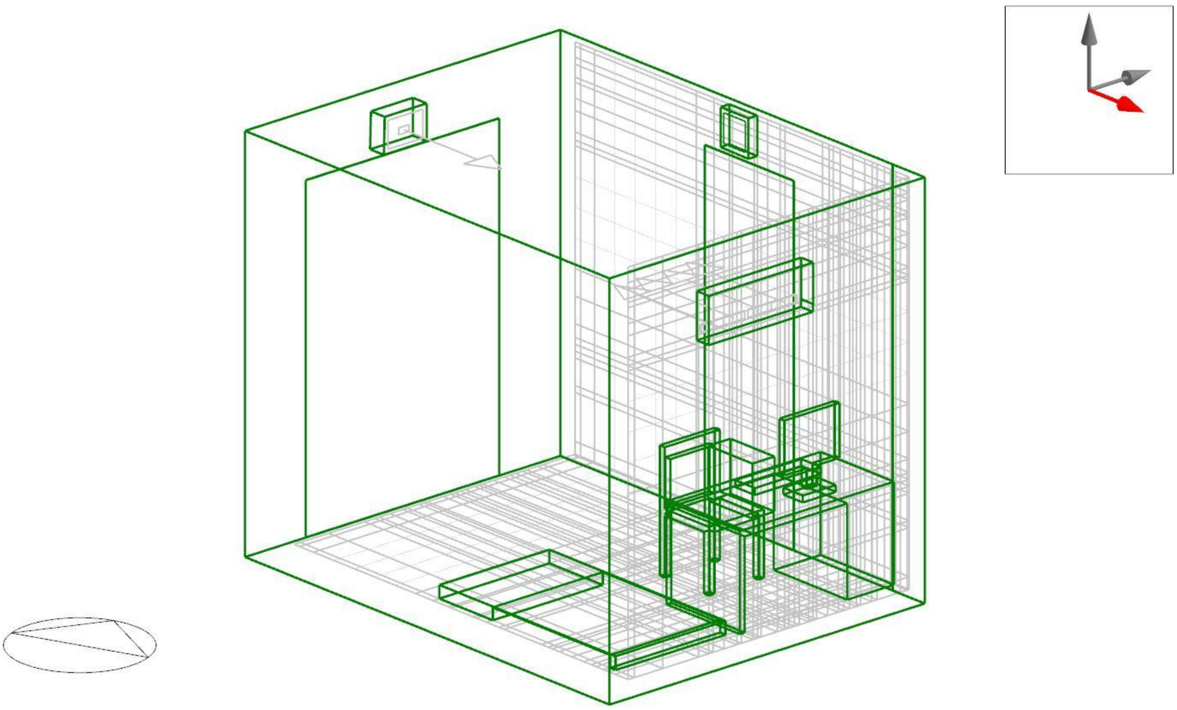
**Type 2.2: Unit 05.01 – Bedroom 2**



**Type 3.1: Unit 05.14 – Bedroom 1**



**Type 3.2: Unit 05.14 – Bedroom 2**



### 3.3.3. Boundary Conditions

The key boundary conditions applied to the model are shown in Figures below.

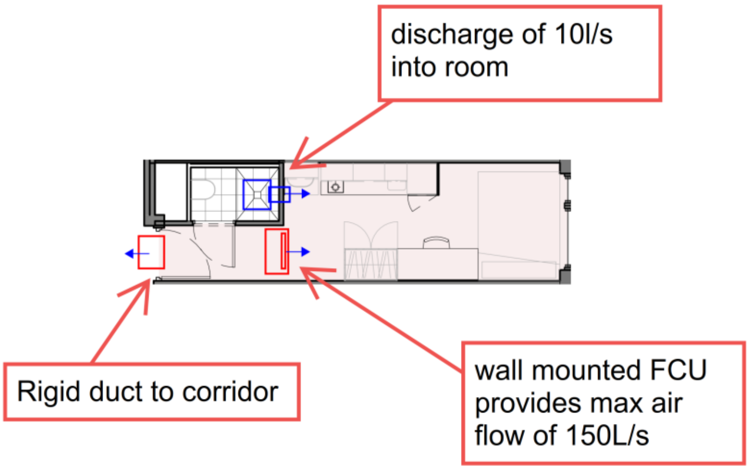



*Figure 4. boundary conditions applied to the model – Unit Type 1.*

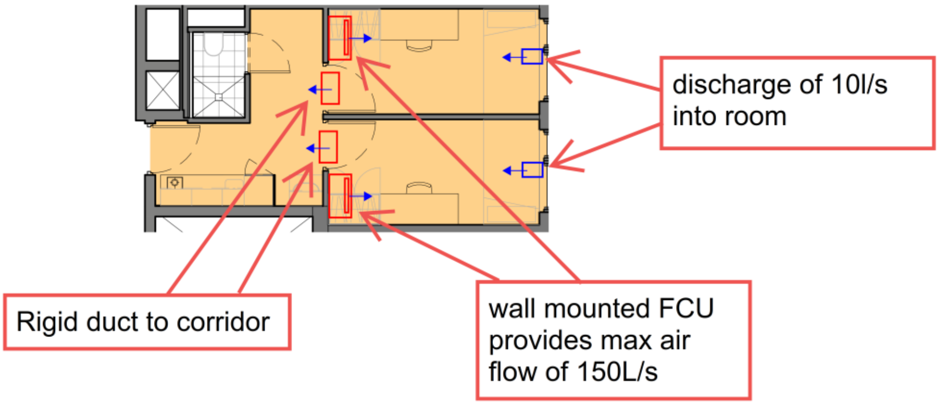



*Figure 5. boundary conditions applied to the model – Units Type 2.*

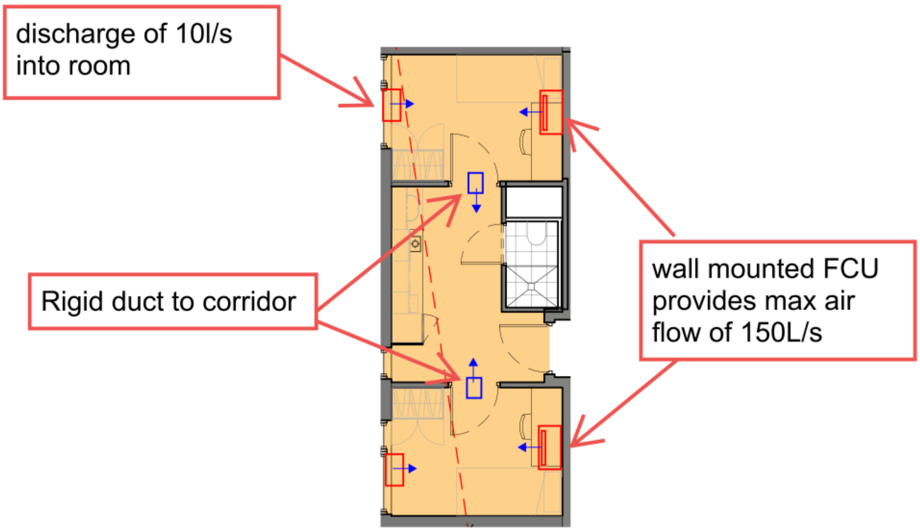
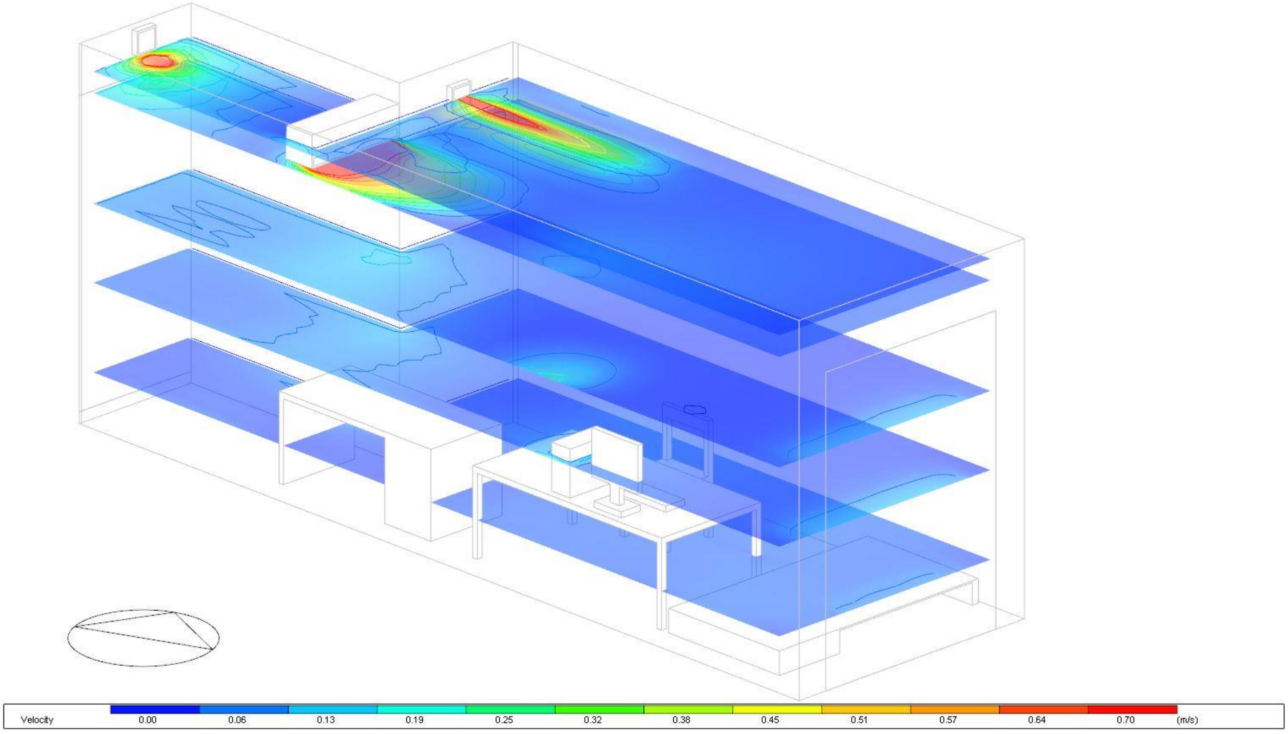


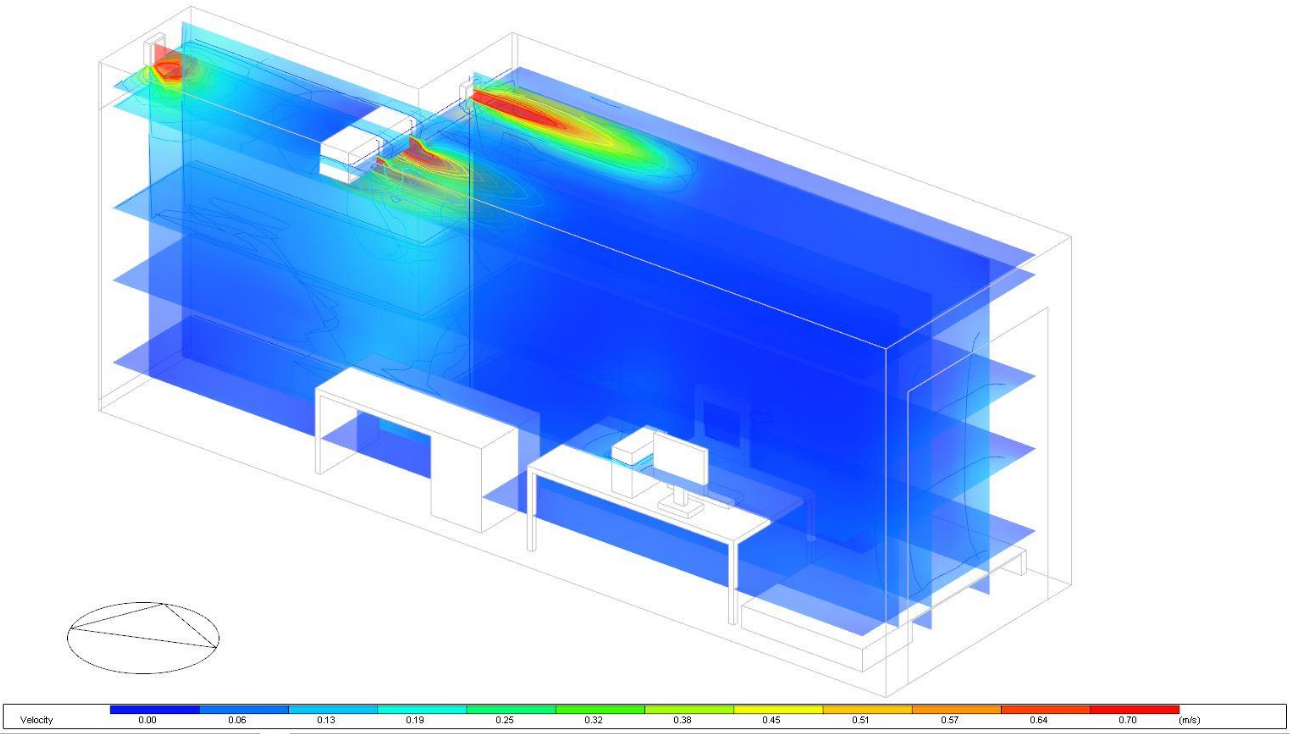

*Figure 6. boundary conditions applied to the model – Units Type 3.*

## 3.4. CFD Modelling Results

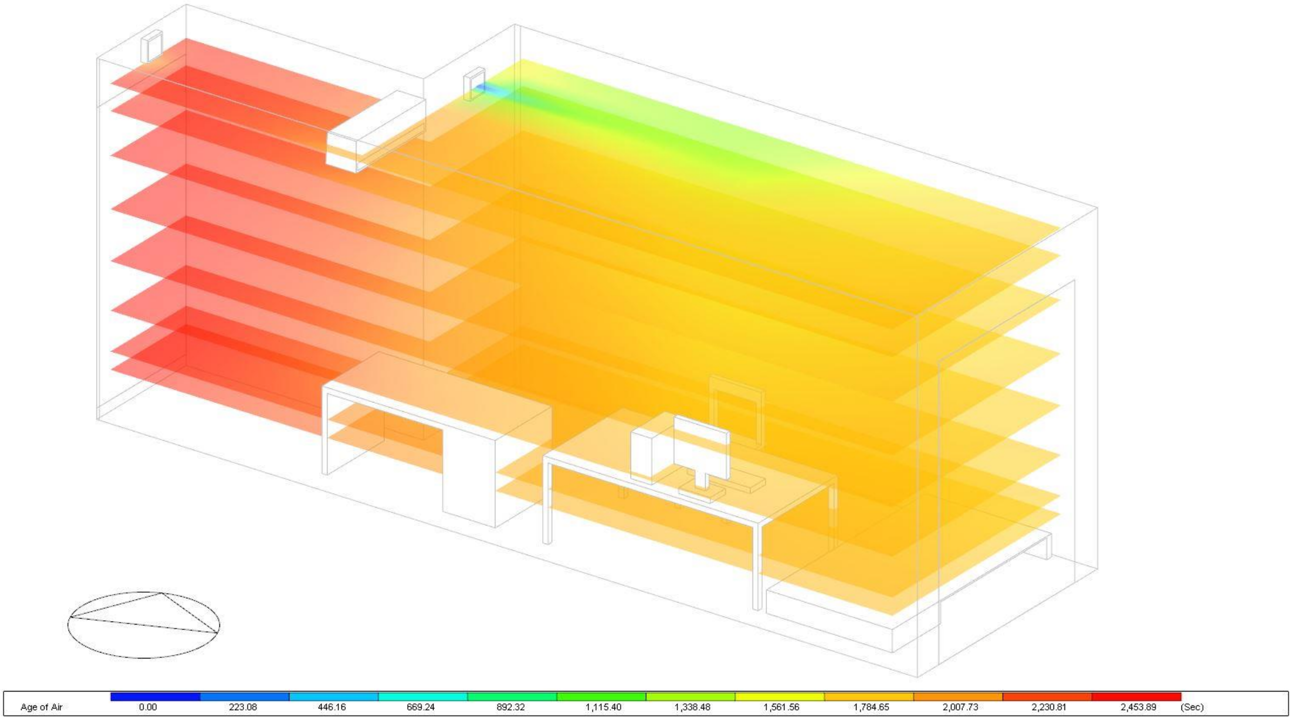
### 3.4.1. Unit Type 1

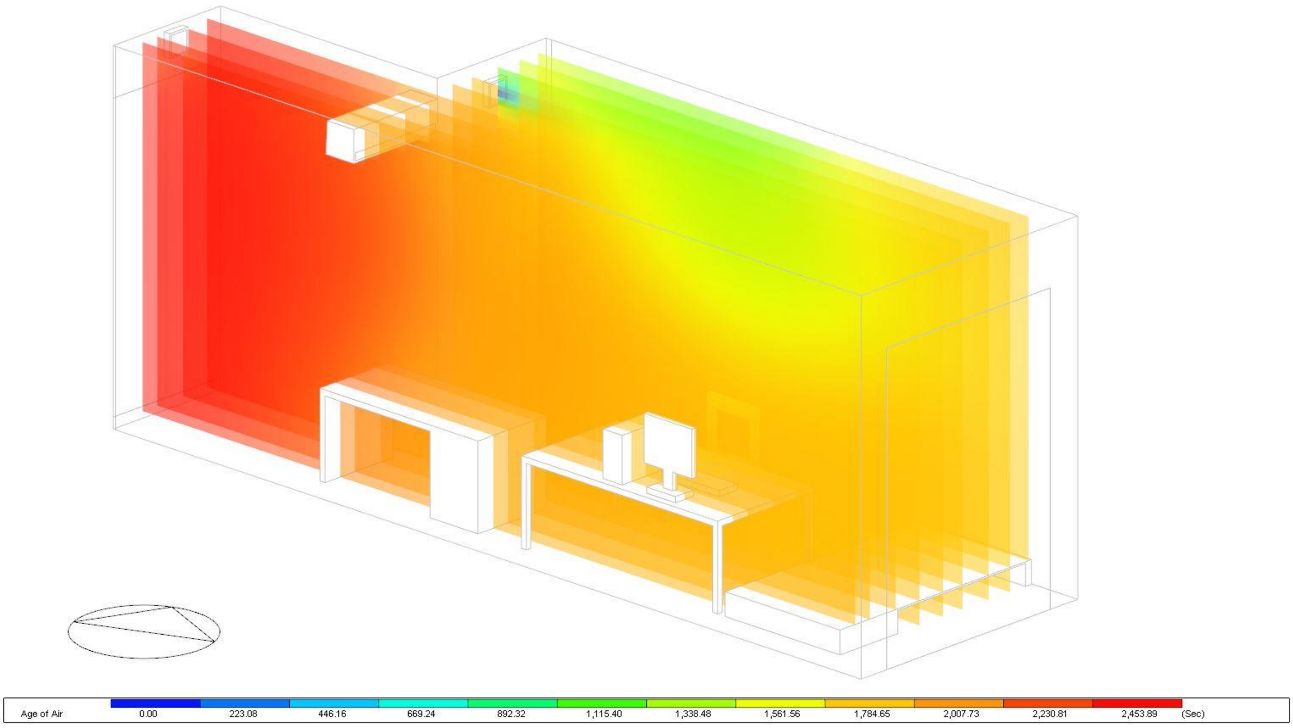
#### 3.4.1.1. Velocity Contours

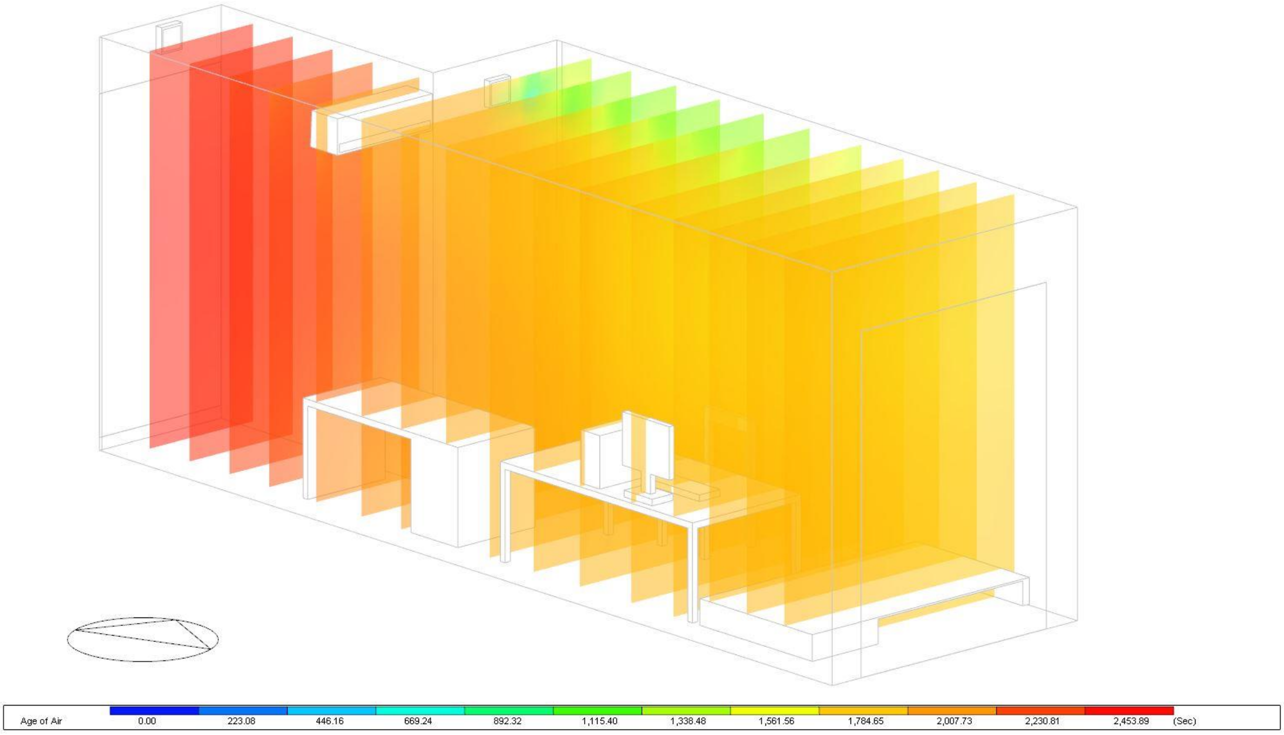


#### 3.4.1.2. Age of Air Contours

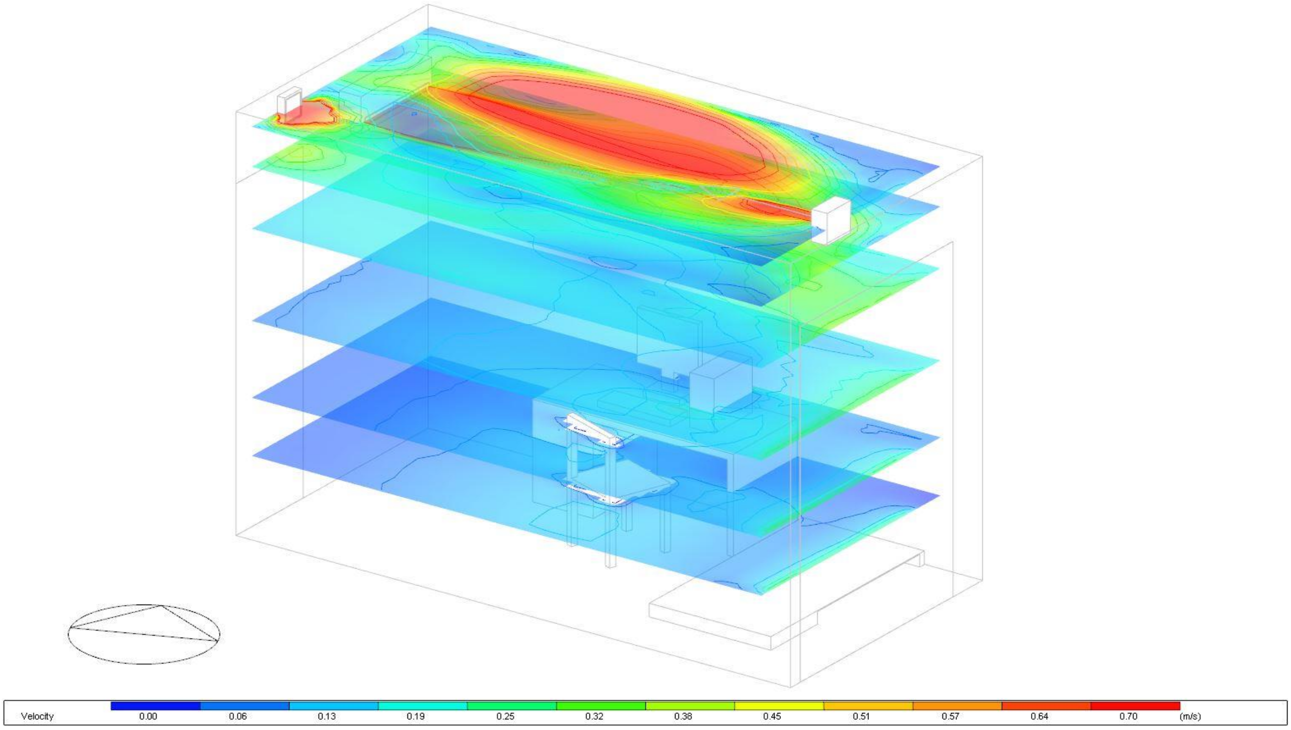


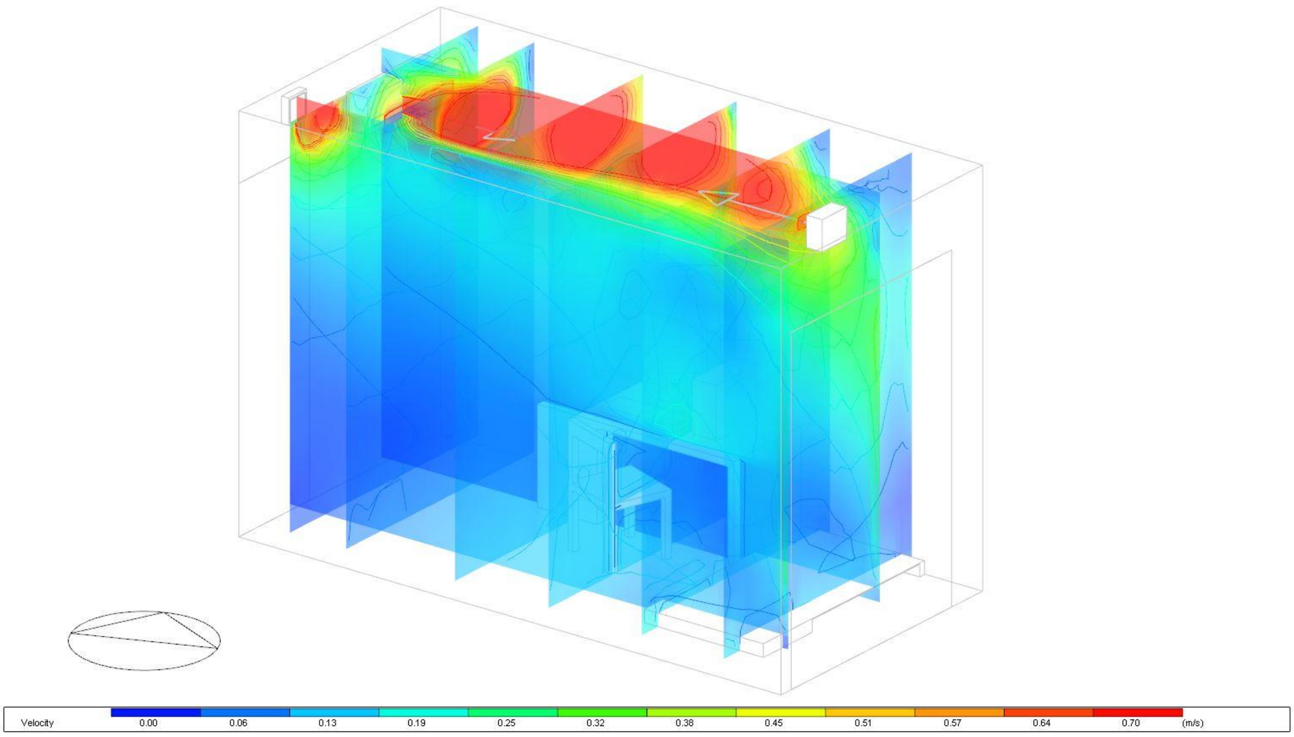




Age of Air
0.00
223.08
446.16
669.24
892.32
1,115.40
1,338.48
1,561.56
1,784.65
2,007.73
2,230.81
2,453.89
(Sec)

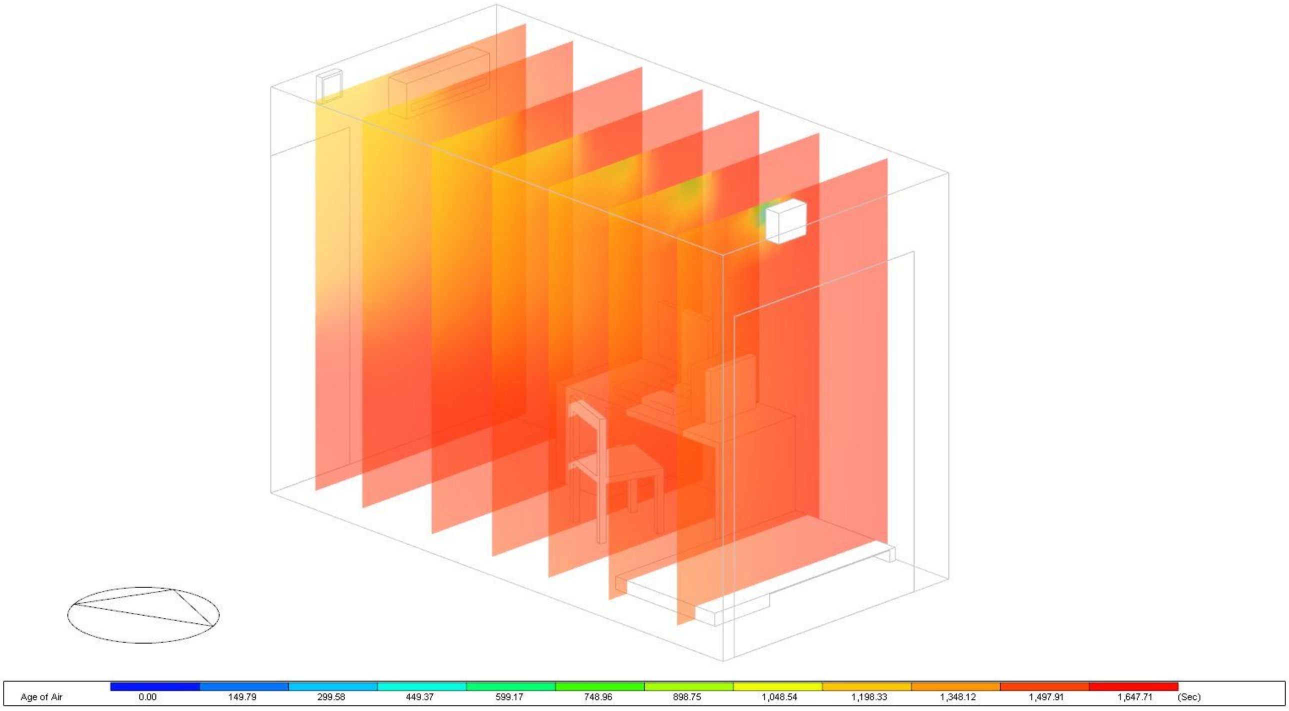
### 3.4.2. Unit Type 2.1

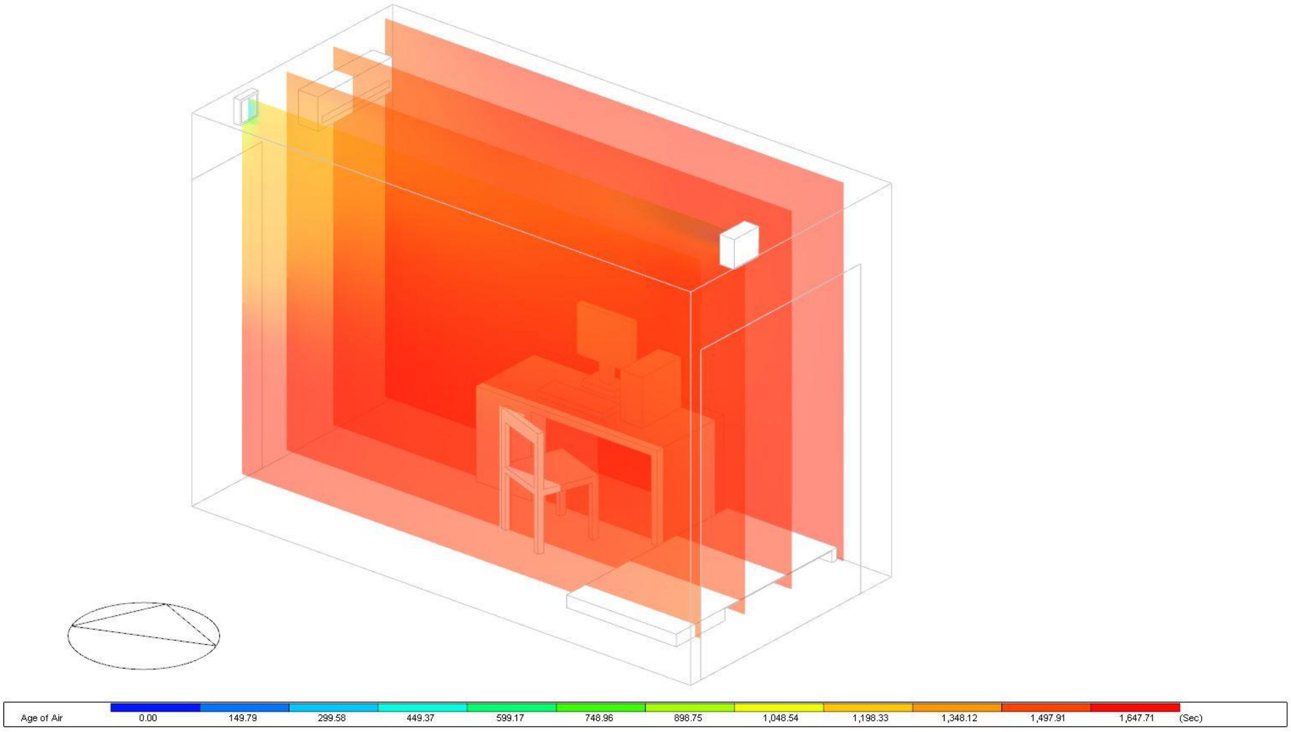
#### 3.4.2.1. Velocity Contours

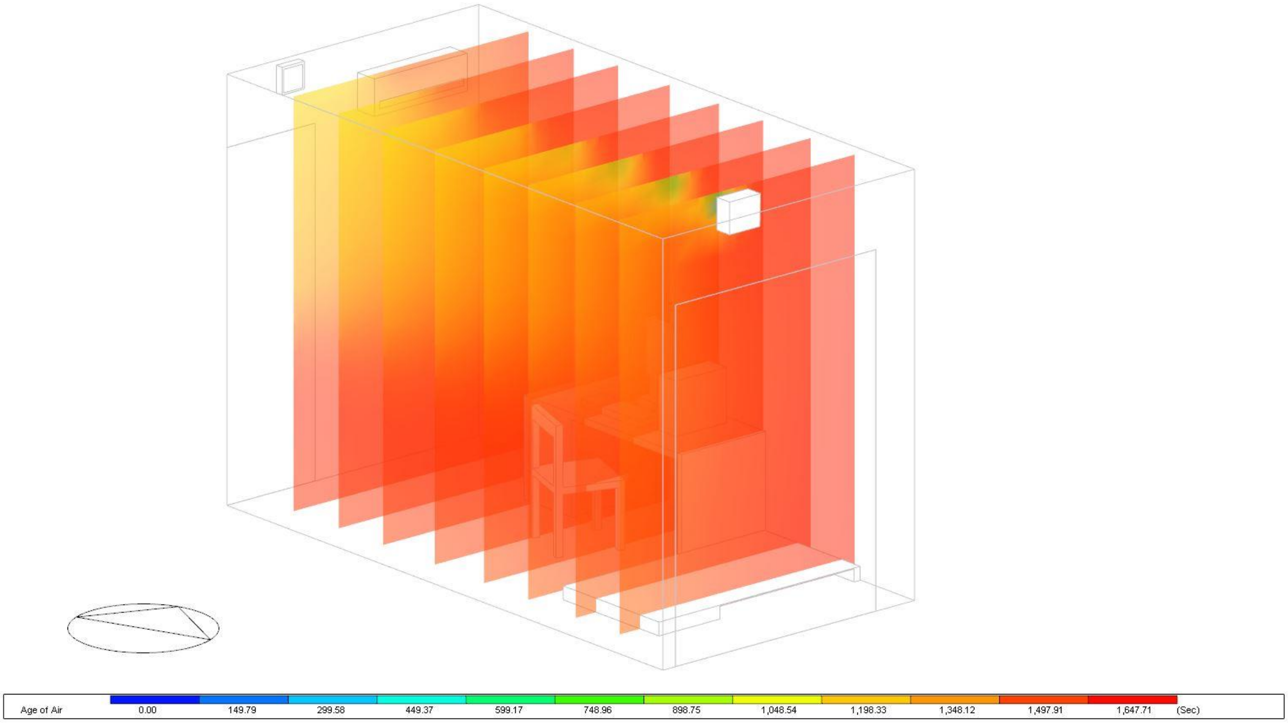


#### 3.4.2.2. Age of Air Contours

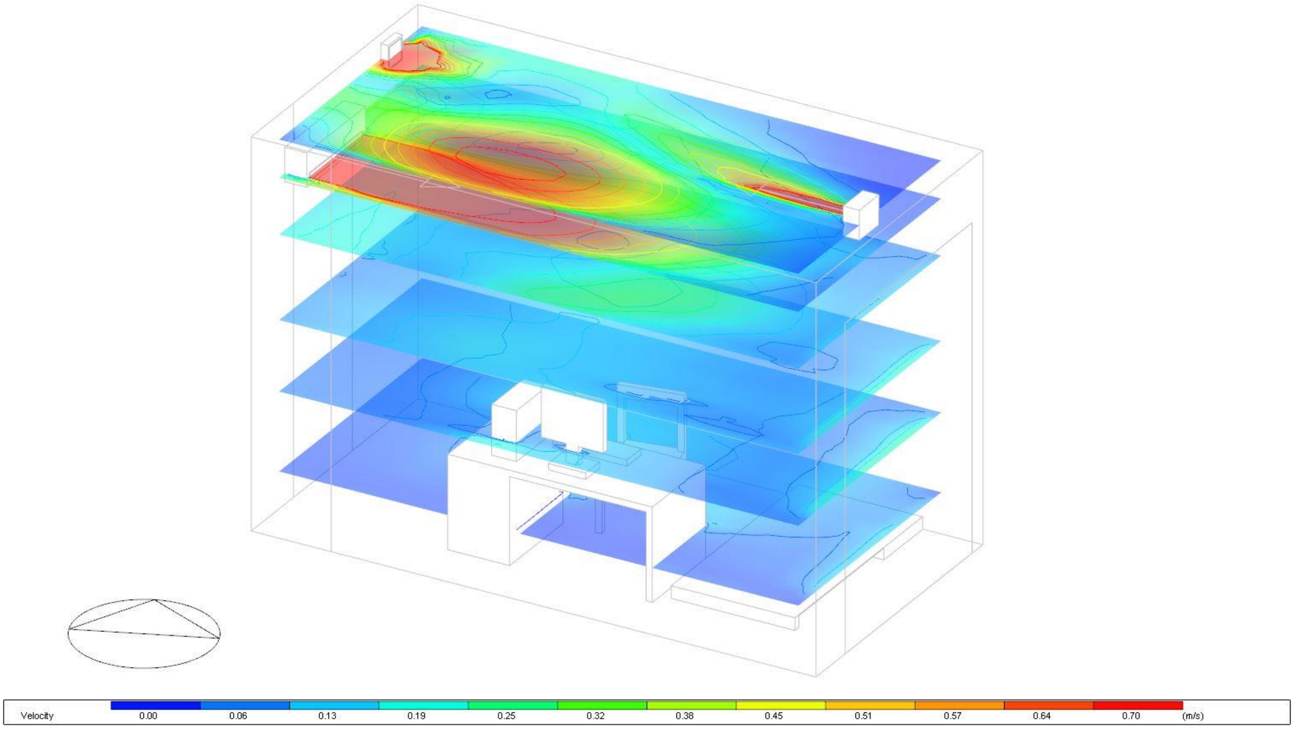


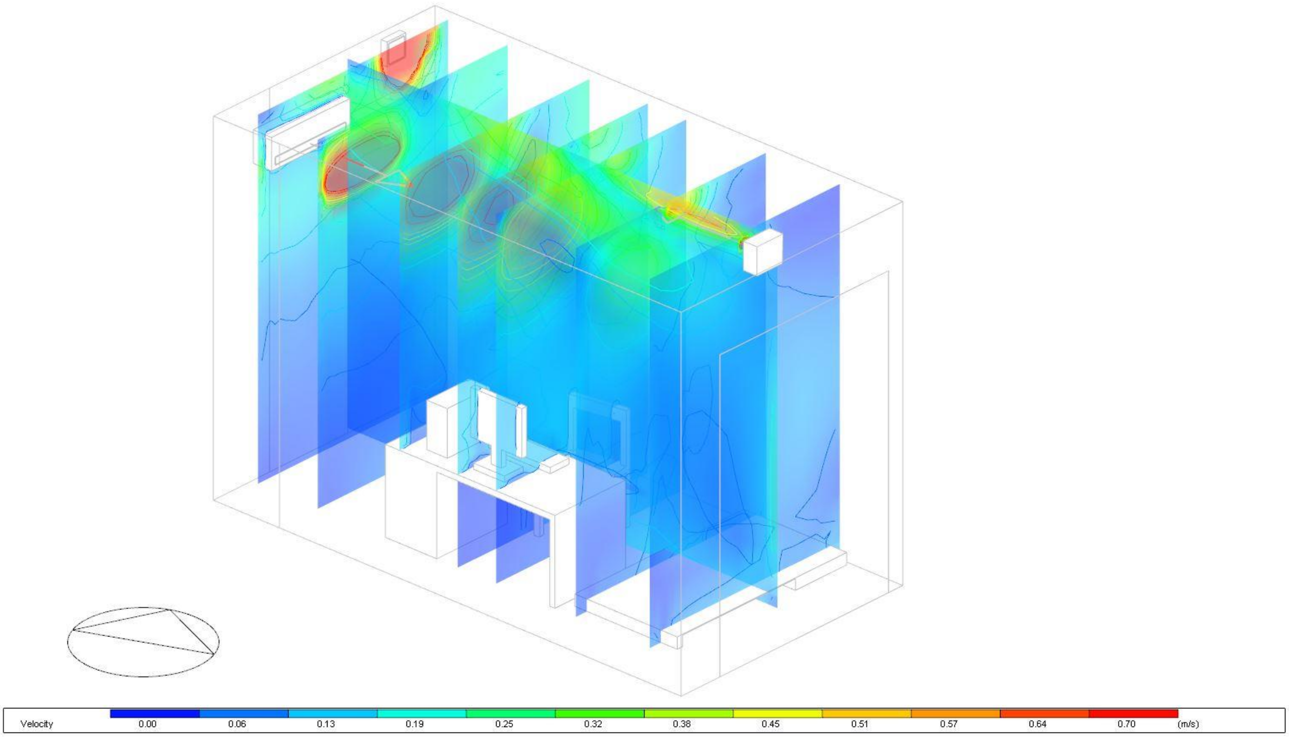




Age of Air
0.00
149.79
299.58
449.37
599.17
748.96
898.75
1,048.54
1,198.33
1,348.12
1,497.91
1,647.71
(Sec)

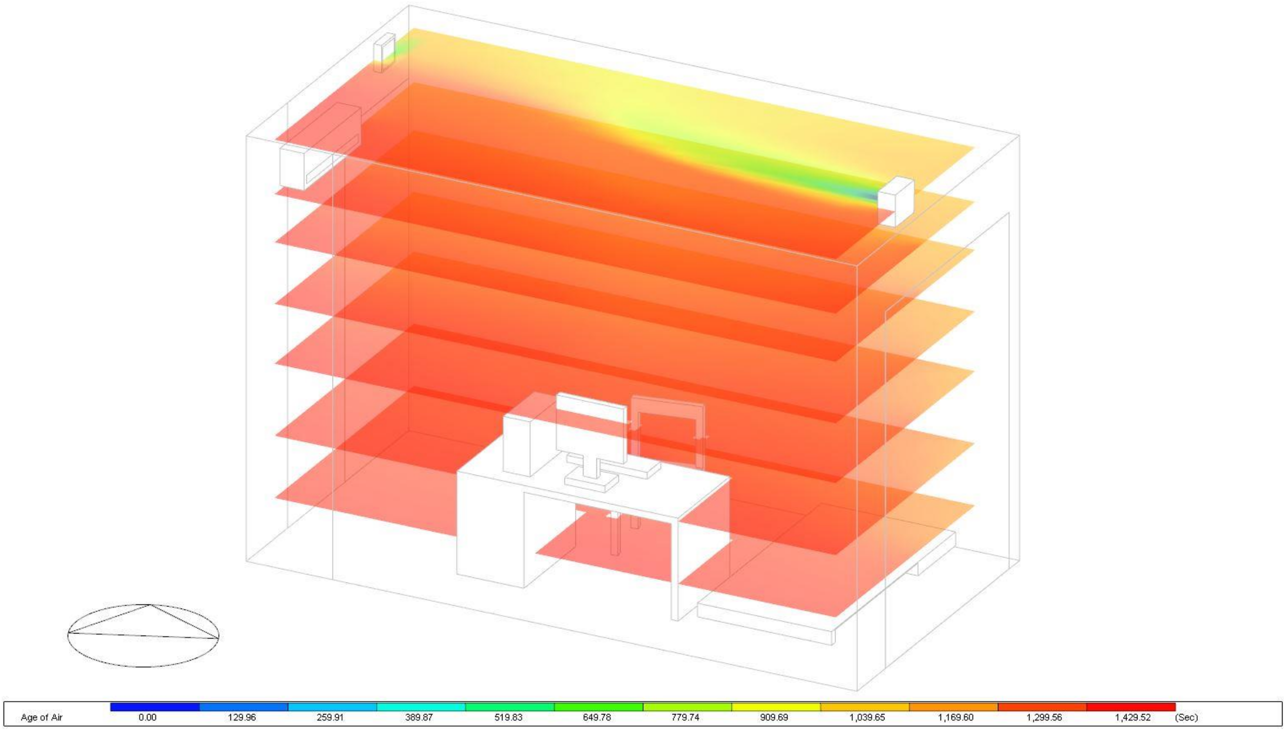
### 3.4.3. Unit Type 2.2

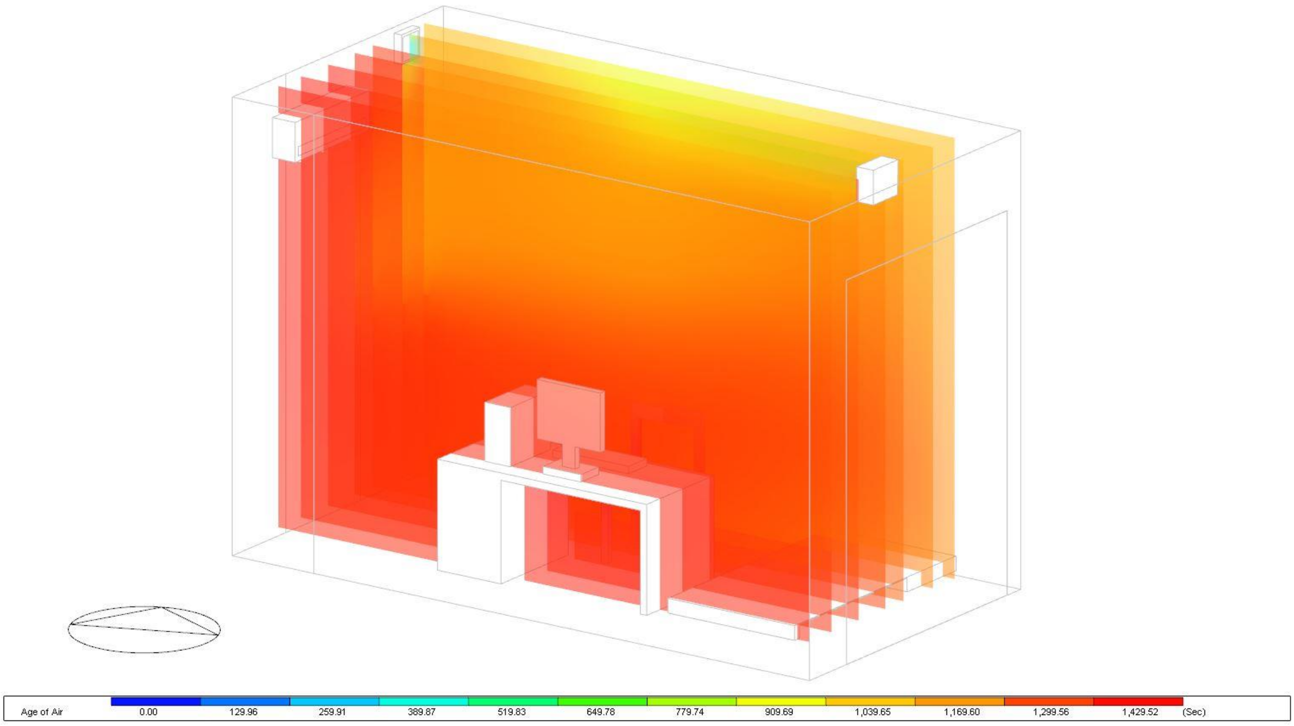
#### 3.4.3.1. Velocity Contours

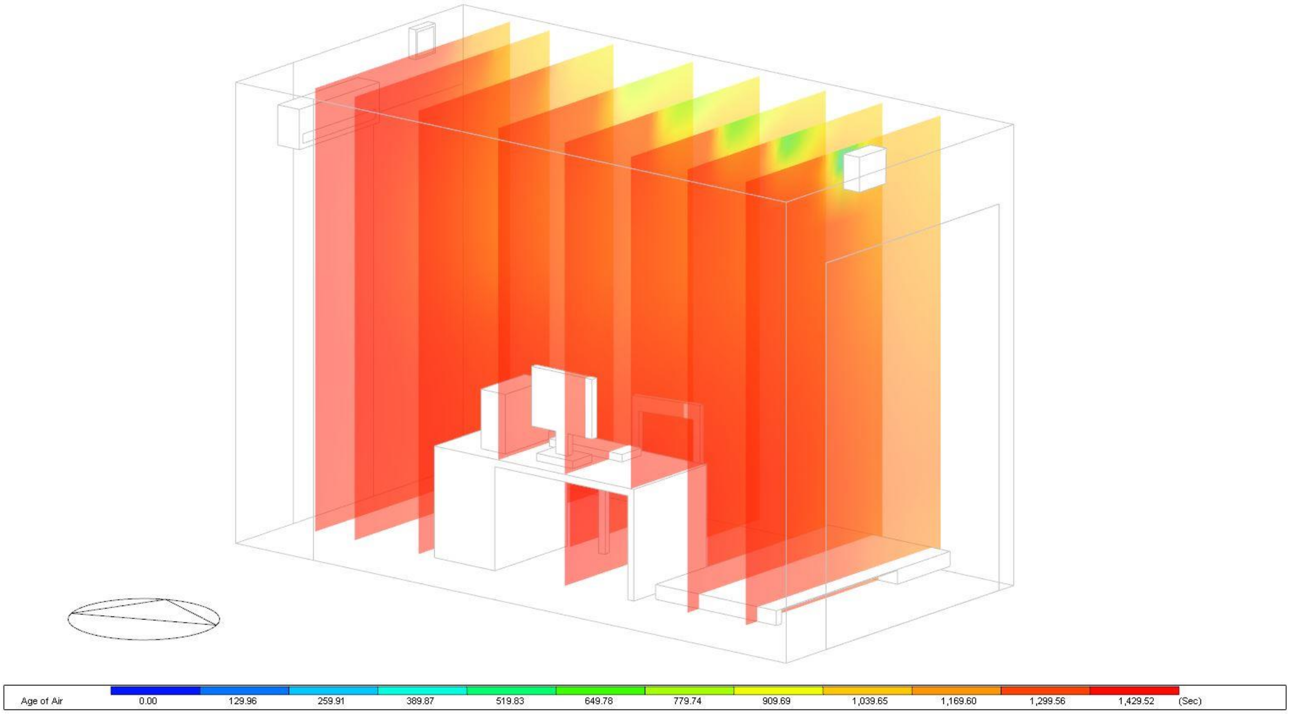


### 3.4.3.2. Age of Air Contours

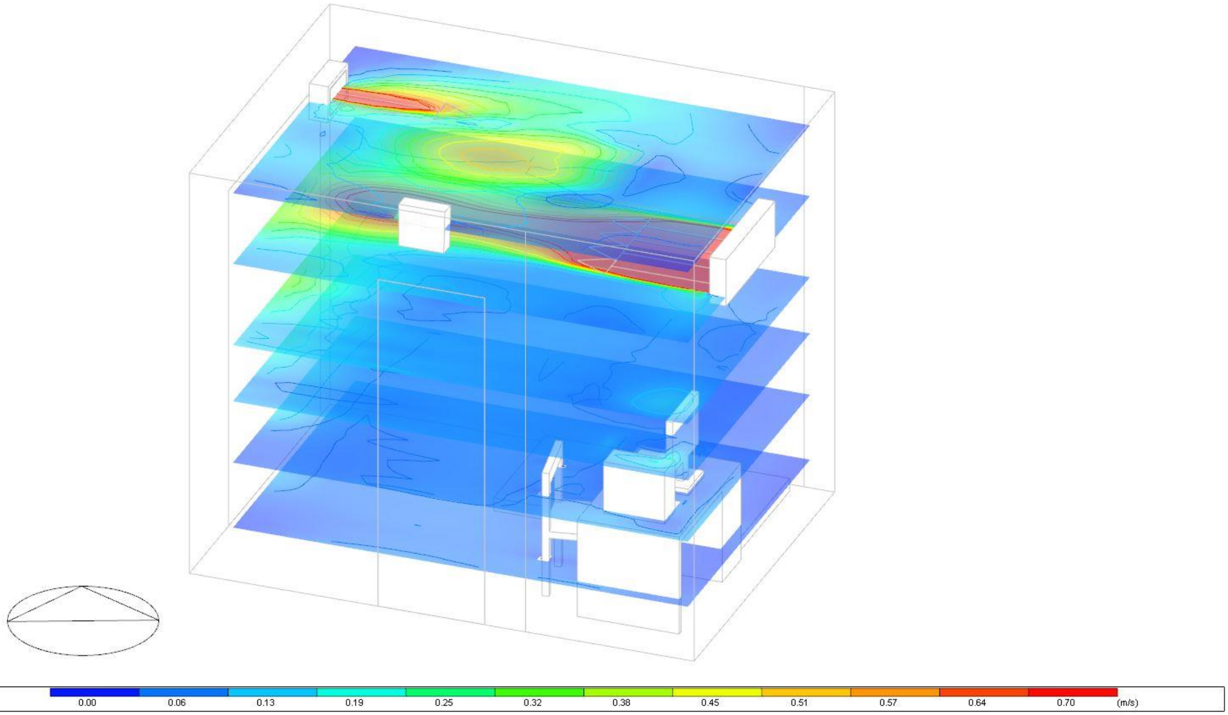


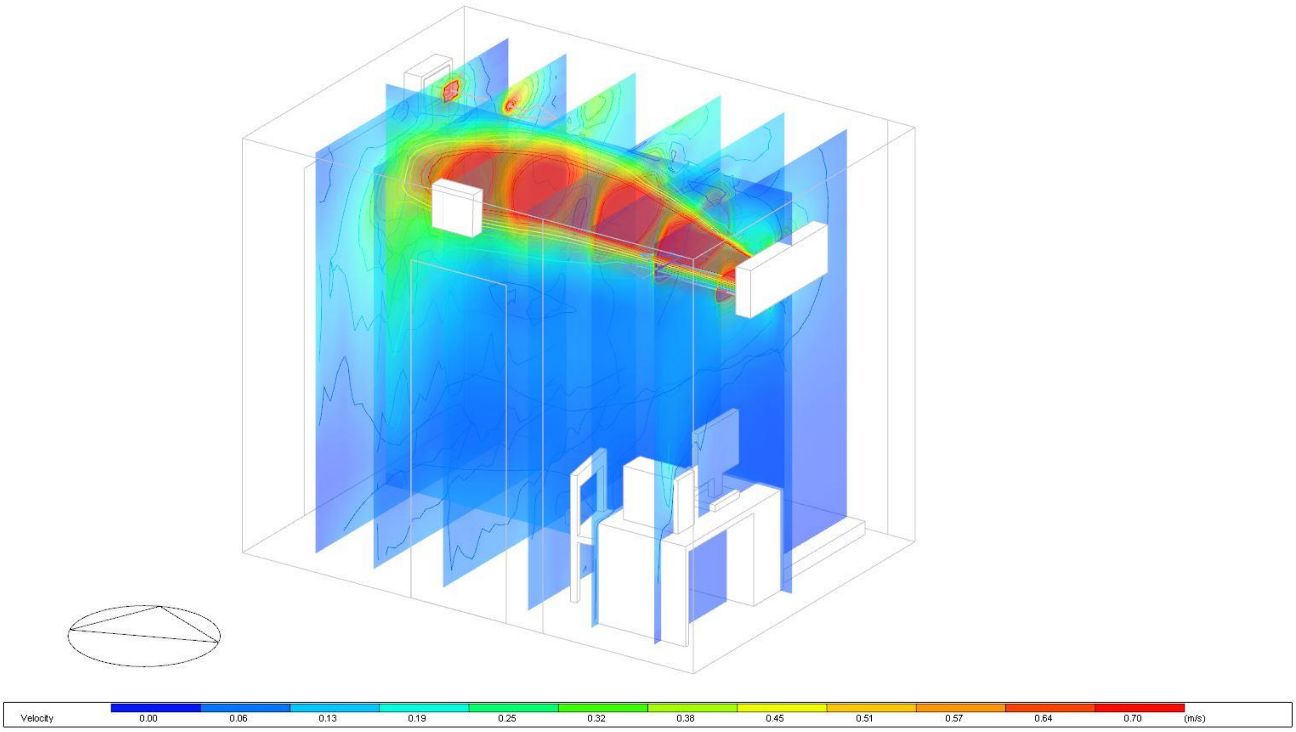




Age of Air
0.00
129.96
259.91
389.87
519.83
649.78
779.74
909.69
1,039.65
1,169.60
1,299.56
1,429.52
(Sec)

### 3.4.4. Unit Type 3.1

#### 3.4.4.1. Velocity Contours



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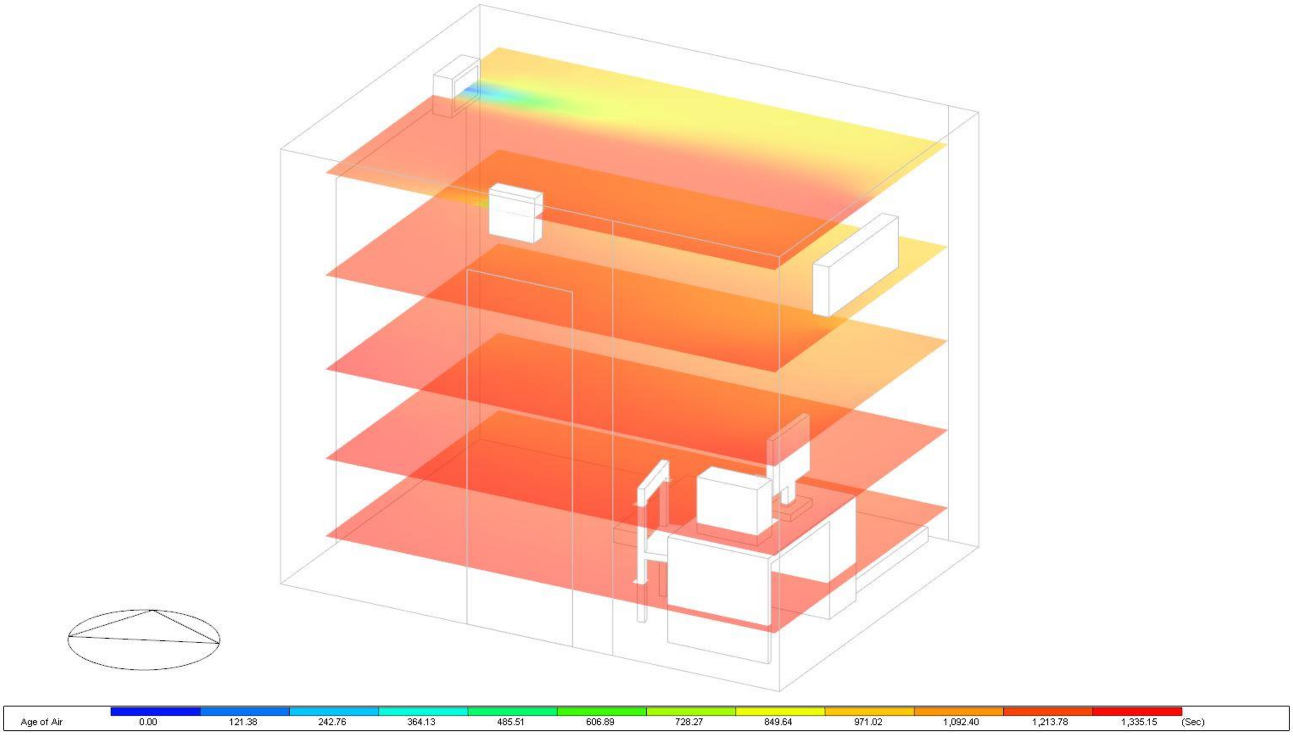
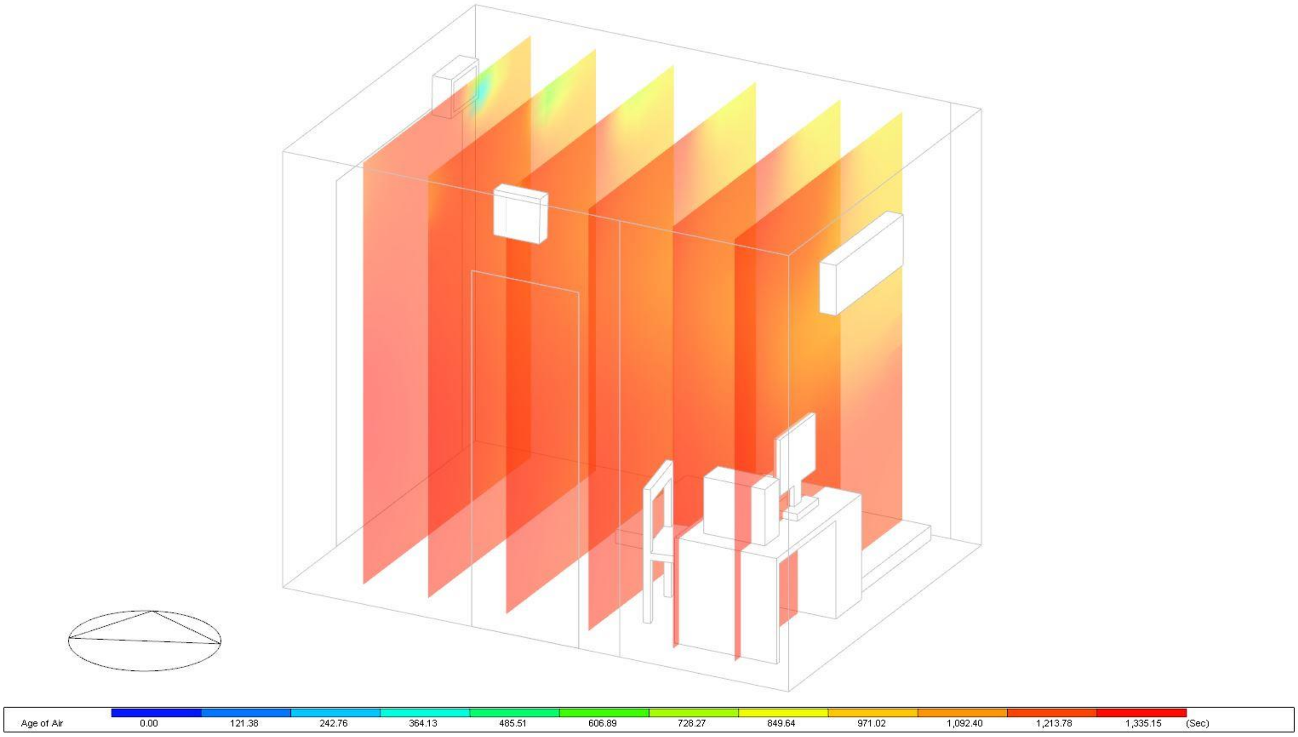
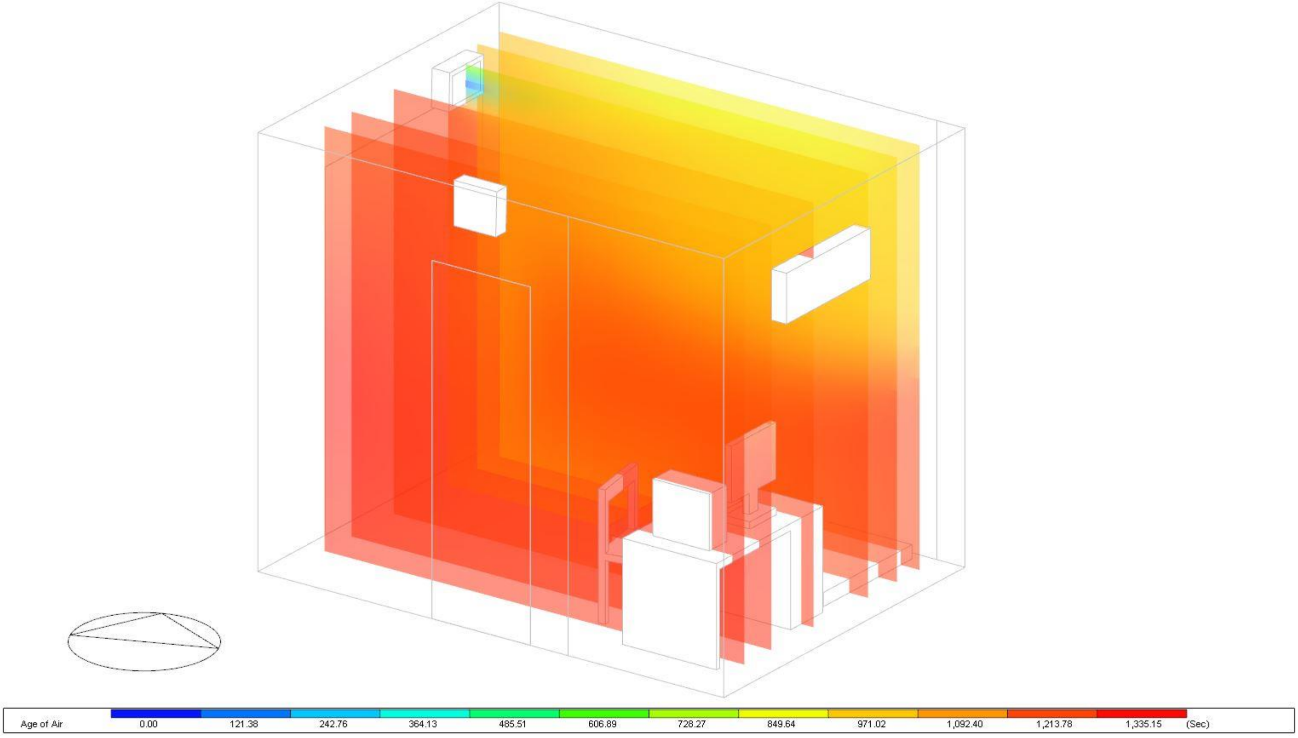
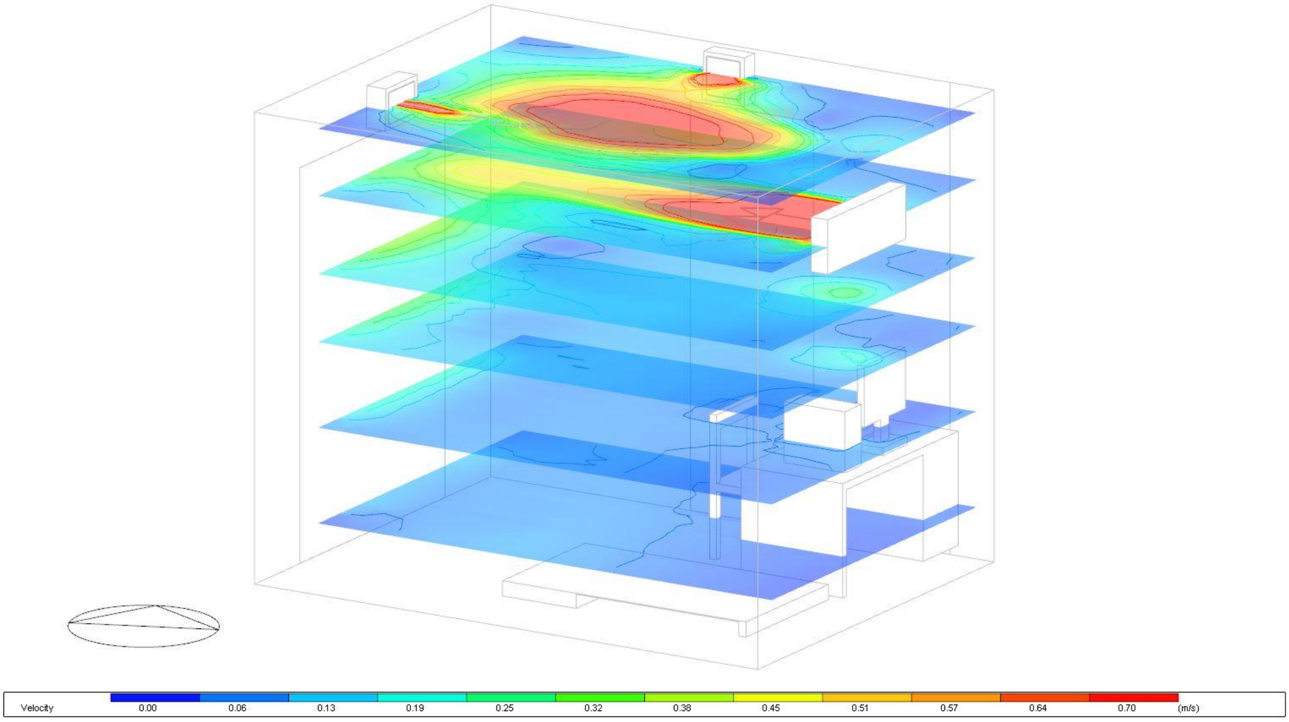


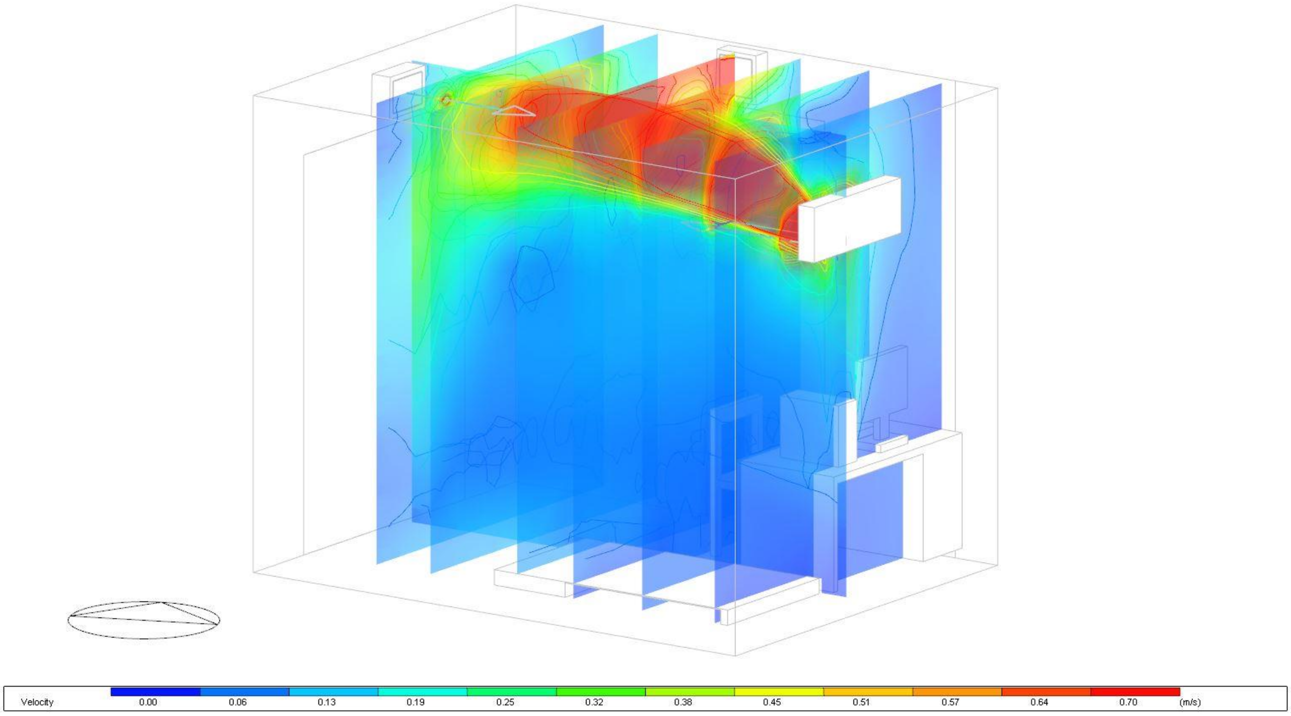




Age of Air
0.00
121.38
242.76
364.13
485.51
606.89
728.27
849.64
971.02
1,092.40
1,213.78
1,335.15
(Sec)

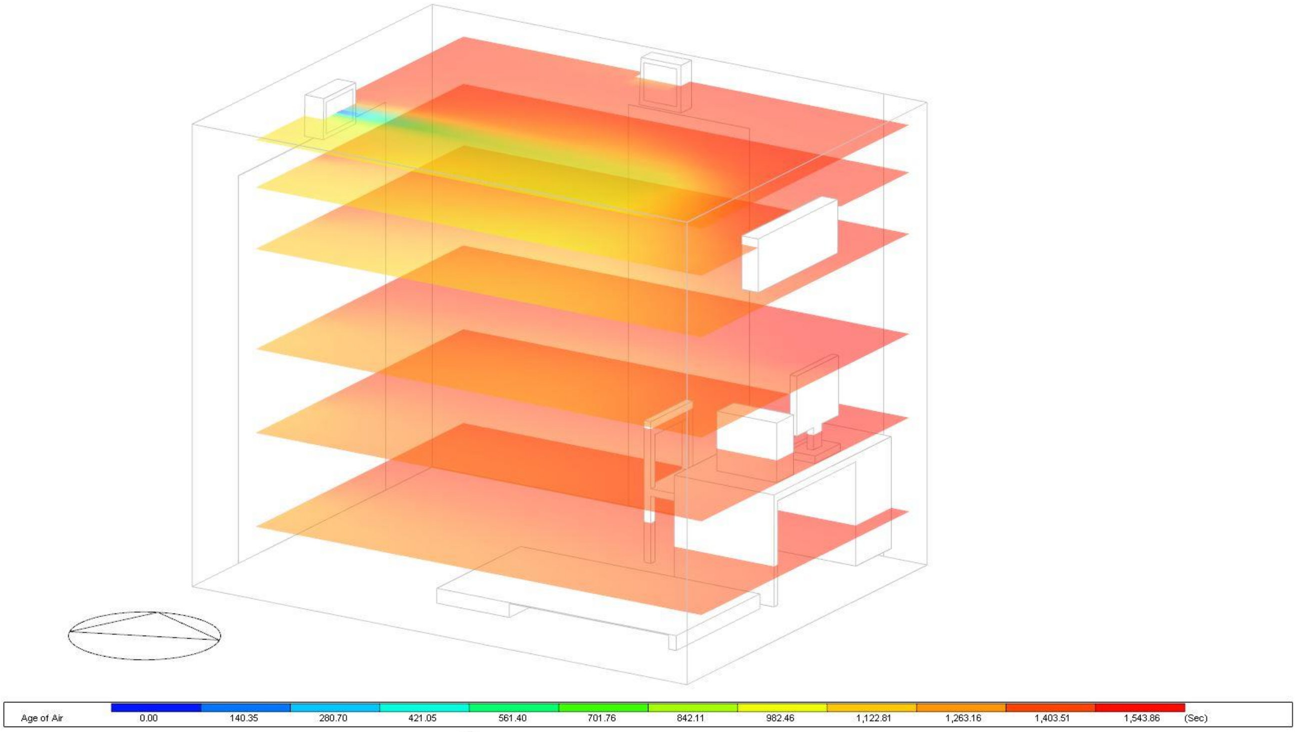
### 3.4.5. Unit Type 2.2

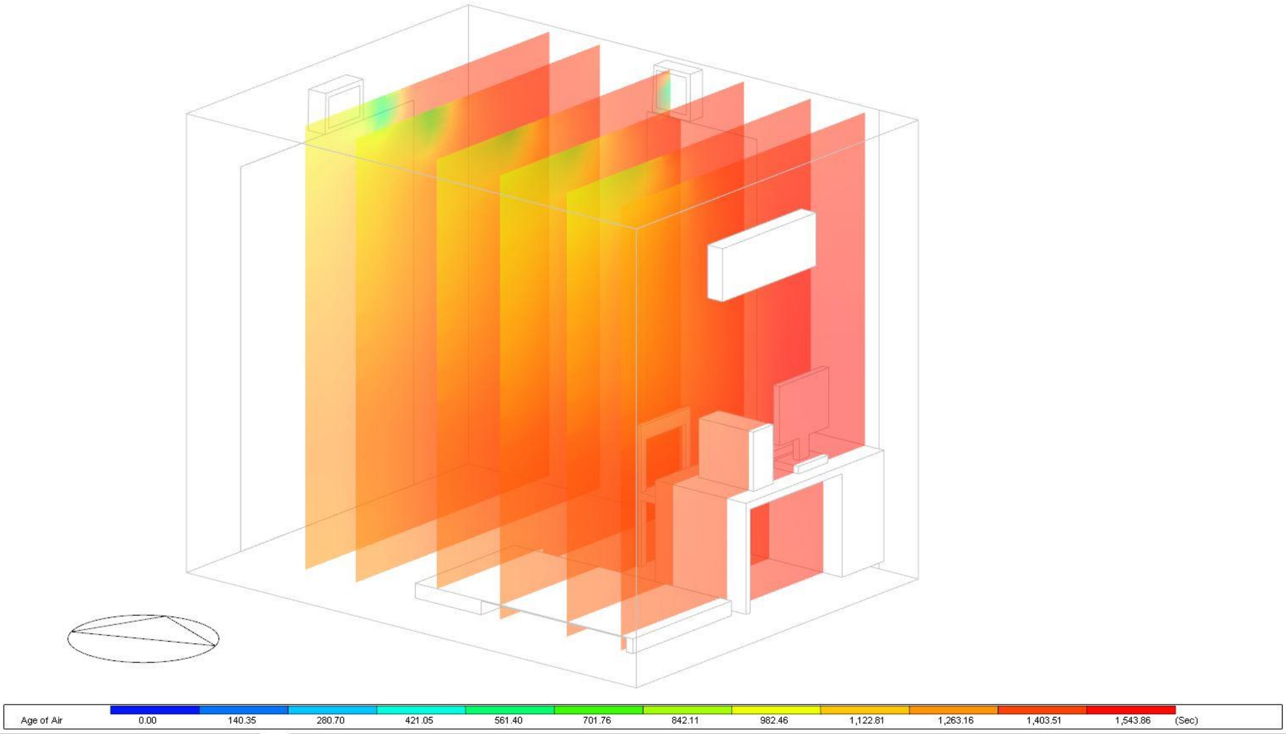
#### 3.4.5.1. Velocity Contours

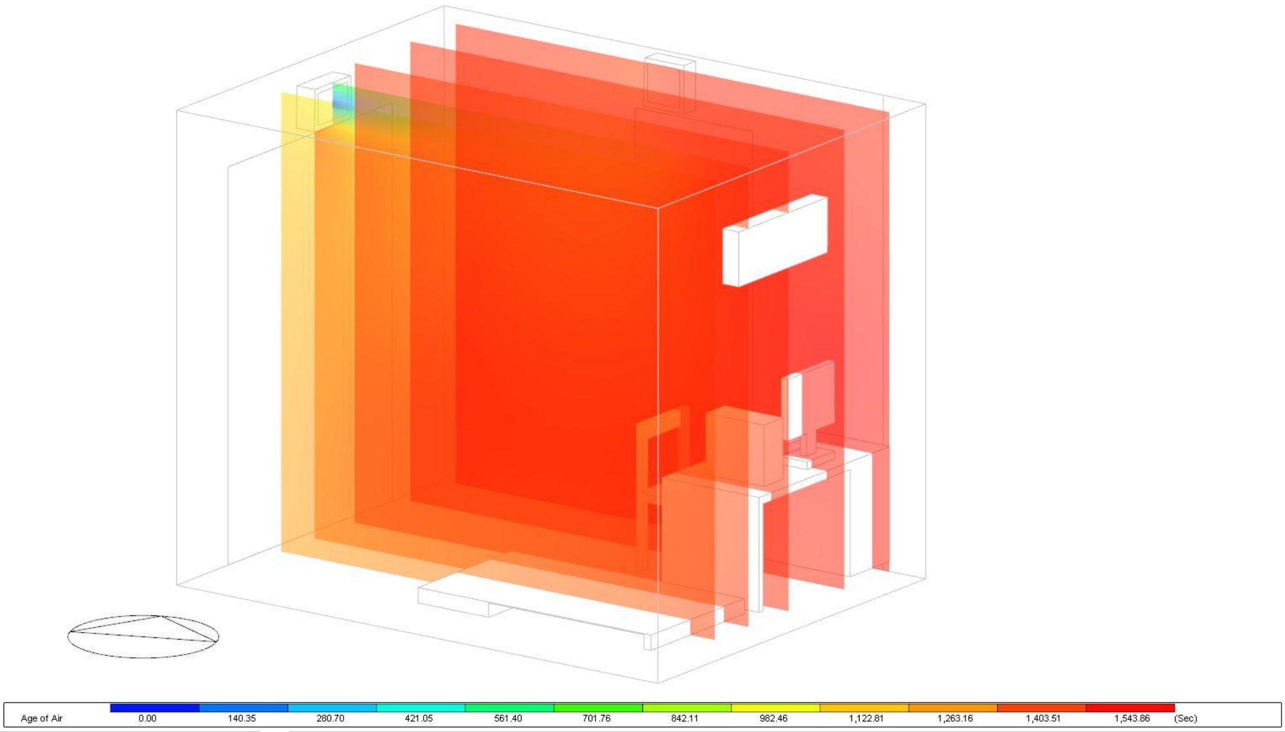


#### 3.4.5.2. Age of Air Contours



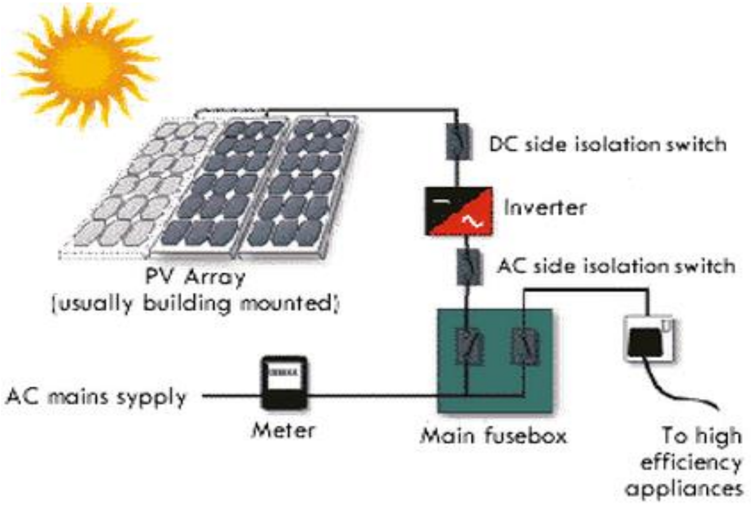

Age of Air
0.00
140.35
280.70
421.05
561.40
701.76
842.11
982.46
1,122.81
1,263.16
1,403.51
1,543.86
(Sec)

# 4 Energy Consumption

## 4.1. Renewable Energy – Solar Photovoltaic (PV) System

Photovoltaic (Solar PV) is a common and widely accepted technology to generate electricity onsite. The generated electricity can be harnessed and used to power any number of devices. It is proposed that the PV panels are mounted on the roof where they will be out of sight and produce the optimum energy output.

PV modules have a very long lifetime with many manufacturers guaranteeing an output of at least 80% of manufactured capacity for 20 years. Another benefit of PV is that it can be installed in various system sizes and the modular design of the systems allows retro-fitting of additional panels if required in the future.




There are generally three types of solar panels available: mono-crystalline (proposed for this development), poly-crystalline and amorphous. Each of these have their advantages and disadvantages and efficiencies range from 6% for amorphous to 19% for mono-crystalline

A 40 kW PV system is currently considered for this development. The exact system sizing, configuration and final design will be completed during the design stage.

The expected renewable energy generation by the system is approx. 60.8 MWh per annum.

**Solar PV - System Components**

The Photovoltaic (PV) system may consist of the following main components or of equal capacity.

| | |
|---|---|
| **Total nominal power:** | **40 kW** |
| **Approx. roof space requirements:** | **280 m²** |
| **Estimated Capital Costs (without battery):** | **$50,000 (Exc GST) after rebates** |
| **Estimated Payback Period:** | **< 4 yrs** |

*Table 6. PV system summery.*

| Components | Brand, Model & Quantity |
|---|---|
| **PV Inverter** | SMA – Quantity: 4 x 10kW |
| **PV Panels** | LG - Neon 330 – capacity: 330W - Quantity: 120 Approx. |
| **Battery storage** | Tesla Powerpack or other similar systems |
| **PV mounting frame and system balance** | Quantity: depending on the requirements and final design |

The exact sizing, configuration and final design will be completed during the design stage. Please refer to Appendices A, B, C & D for technical data sheets of the proposed PV panels (LG), the grid-connected inverter (SMA), solar mounting systems and energy storage options (Tesla).

### 4.1.1. Expected Energy Generation by the Proposed Solar PV

| PVSYST V6.81 | | 25/08/20 | Page 1/1 |
|---|---|---|---|

## Grid system presizing

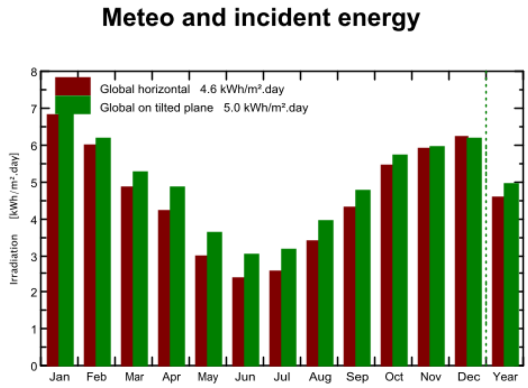
| | | | | | |
|---|---|---|---|---|---|
| **Geographical Site** | **Sydney** | | Country | **Australia** | |
| **Situation** | Latitude | -33.87° S | Longitude | 151.20° E | |
| Time defined as | Legal Time | Time zone UT+10 | Altitude | 42 m | |
| **Collector Plane Orientation** | Tilt | 10° | Azimuth | 0° | |

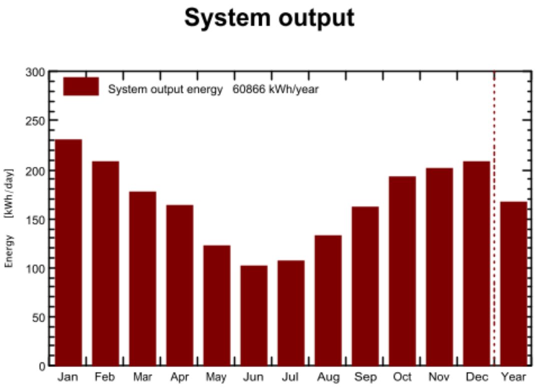
**PV-field installation main features**

| | |
|---|---|
| Module type | Standard |
| Technology | Monocrystalline cells |
| Mounting method | Facade or tilt roof |
| Back ventilation properties | Ventilated |

**System characteristics and pre-sizing evaluation**

| | | | | |
|---|---|---|---|---|
| PV-field nominal power (STC) | Pnom | 40.0 kWp | | |
| Collector area | Acoll | 250 m² | | |
| Annual energy yield | Eyear | 60.9 MWh | Specific yield | 1,522 kWh/kWp |




| | Gl. horiz. kWh/m².day | Coll. Plane kWh/m².day | System output kWh/day | System output kWh |
|---|---|---|---|---|
| **Jan.** | 6.84 | 6.86 | 230.6 | 7149 |
| **Feb.** | 5.99 | 6.19 | 208.2 | 5829 |
| **Mar.** | 4.87 | 5.25 | 176.6 | 5475 |
| **Apr.** | 4.23 | 4.86 | 163.4 | 4902 |
| **May** | 2.99 | 3.64 | 122.2 | 3789 |
| **June** | 2.40 | 3.01 | 101.3 | 3038 |
| **July** | 2.56 | 3.17 | 106.6 | 3304 |
| **Aug.** | 3.38 | 3.94 | 132.5 | 4108 |
| **Sep.** | 4.32 | 4.79 | 160.9 | 4826 |
| **Oct.** | 5.46 | 5.73 | 192.7 | 5973 |
| **Nov.** | 5.89 | 5.97 | 200.7 | 6020 |
| **Dec.** | 6.22 | 6.19 | 208.1 | 6452 |
| **Year** | 4.59 | 4.96 | 166.8 | 60866 |

## 4.2. Expected Energy Consumption by the Mechanical Ventilation System

The expected energy consumption by the mechanical ventilation system can be calculated by the following formula:

$$\mu_f = dp.q / P$$

Where, $\mu_f$ is fan efficiency (values between 0-1), $dp$ is total pressure (Pa), $q$ is air volume delivered by the fan ($m^3$/s), and $P$ is power used by the fan (W, Nm/s).

**Based on the energy simulations, the estimated annual energy consumption of the ventilation fans is 22,037 kWh p.a.**

# 5 Results

Dynamic simulation (using Design Builder software) has been used to determine the percentage of the year in which minimum performance requirements have been met for the habitable rooms provided with alternative means of ventilation due to external noise level conditions.

The proposed mechanical ventilation design has been evaluated using Computational Fluid Dynamic (CFD) simulation to determine the overall impact on the following:

- Energy Efficiency – reduction in the Air-conditioning energy consumption (given the reduced reliance on active air-conditioning),
- Age of the indoor air,
- Thermal Comfort (PMV).

Applicable rooms have been evaluated to demonstrate the following performance requirements are achieved for a minimum 90% of all hours of the year:

- If the habitable area is less than the threshold area: 10 litres/second/person for each apartment, where the number of people equals the number of bedrooms plus 1, OR
- If the habitable area is more than or equal to the threshold area: 0.3 litres/second/m2 for each apartment.

Each habitable room provided with alternative means of natural ventilation has also been assessed for adequate ventilation of 10 litres/second per person.

A tabulated summary of results is presented in Table 7 below. The results demonstrate that the assessed habitable rooms meet the minimum performance requirements for greater than 90% of the all hours of the year. As such, the minimum level of ventilation has been met and adequate ventilation is achieved via the alternative ventilation proposal.

*Table 7. Result Summary.*

| Unit Type | Apartment area (Conditioned area) ($m^2$) | Number of occupants | Required volume flow rate (l/s) | % of year achieved |
|---|---|---|---|---|
| Type 1: Unit 05.06 - Studio A | 13 $m^2$ | 1 | 10 | 100% |
| Type 2.1: Unit 05.01 – Bedroom 1 | 8 $m^2$ | 1 | 10 | 100% |
| Type 2.2: Unit 05.01 – Bedroom 2 | 8 $m^2$ | 1 | 10 | 100% |
| Type 3.1: Unit 05.14 – Bedroom 1 | 8 $m^2$ | 1 | 10 | 100% |
| Type 3.2: Unit 05.14 – Bedroom 2 | 8 $m^2$ | 1 | 10 | 100% |

Furthermore, the simulation has demonstrated that the proposed ventilation design will result in the following improvements:

- Overall Energy Efficiency,
- Thermal Comfort (i.e. PMV),
- Age of air (freshness of the air).

The improvements are listed in Table 8.

*Table 8. Improvements.*

| | Without Ventilation | With Ventilation | Improvement (%) |
|---|---|---|---|
| Heating (KWh p.a. for all tested units) | 87 | 591 | |
| Cooling (KWh p.a. for all tested units) | 1789 | 978 | |
| Total (KWh) | **1876** | **1569** | **16.4%** |
| Energy Per Conditioned Building Area (KWh/m2) | 42 | 35 | 16.4% |
| Fraction Operation Hours between 21-24 degrees (%) | 98.3% | 98.8% | 0.5% |
| Fraction Operation Hours PMV with between -1 and 1 (% Thermal Comfort) | 98.2% | 98.5% | 0.3% |

The simulations demonstrated that the energy generated by the proposed Solar PV system will be sufficient to offset the energy consumption of the proposed mechanical ventilation system (Table 9).

*Table 9. Solar Energy Generation.*

| **Solar Energy Generation vs. Mechanical Ventilation Energy Consumption** | |
|---|---|
| Estimated Annual Energy Consumption for Mechanical Ventilation | **22,037 kWh p.a.** |
| Estimated Annual Solar PV Energy Generation | **60,866 kWh p.a.** |

# 6 Disclaimer

This report is prepared using the information described above and inputs from other consultants. Whilst VIPAC has endeavoured to ensure the information used is accurate, no responsibility or liability to any third party is accepted for any loss or damage arising out of the use of this report by any third party. Any third party wishing to act upon any material contained in this report should first contact VIPAC for detailed advice which will take into account that party's particular requirements.

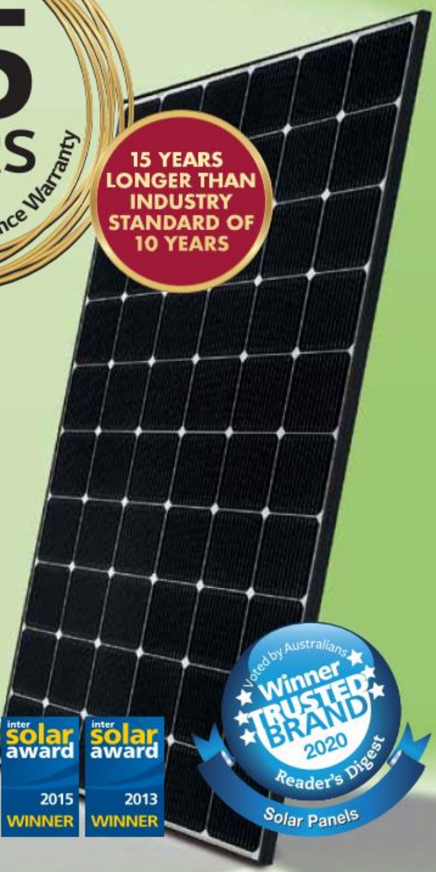
Computer performance assessment provides an estimate of building performance. This estimate is based on a necessarily simplified and idealised version of the building that does not and cannot fully represent all the intricacies of the building once built. As a result, simulation results only represent an interpretation of the potential performance of the building. No guarantee or warrantee of building performance in practice can be based on simulation results alone. VIPAC and its employees and agents shall not be liable for any loss arising because of, any person using or relying on the Report and whether caused by reason or error, negligent act or omission in the report. This draft assessment has been prepared based on the preliminary building services and architectural design with the view to conduct a detailed assessment once the design is further developed.
Performance of the completed building may be significantly affected by the quality of construction; the quality of commissioning, ongoing management of the building, and the way the building is operated, monitored and maintained. Building fabric inputs require verifiable manufacturer data to confirm thermal properties.

# APPENDIX A - TECHNICAL DATASHEET – SIMULATED SOLAR PV PANEL

LG Life's Good

25 YEARS LG Product and Performance Warranty

15 YEARS LONGER THAN INDUSTRY STANDARD OF 10 YEARS




## LG NeON®2

### LG 350/355/360N1C-N5

**THE HIGH PERFORMER**

**UP TO 20.8% MODULE EFFICIENCY**

### Awards Received By LG Solar™


### THE NeON® 2 - THE PANEL OF THE FUTURE AVAILABLE TODAY

The LG NeON® 2 has seen many improvements in the past years, from longer warranties to lower degradation. This panel is ideal for homes seeking a visually pleasing solar panel and for roofs where space is tight or where future system expansions are considered e.g. to incorporate battery storage.

The LG NeON® 2 panels with their double sided cells and CELLO technology absorb light from the front and the back of the cell. This technology sets a new standard for innovation and was recognised with the Photovoltaic Innovation Award at the Intersolar Industry Event in Germany. LG also won the 2016 Intersolar award for our new NeON BiFacial range.

**Great Visual Appearance**

LG NeON® 2 panels have been designed with appearance in mind. Their black cells, black frames and thinner wire busbars give an aesthetically pleasing uniform black appearance. Your home deserves the LG NeON® 2.

**25 Years Product Warranty (Parts & Labour)**

The LG product warranty is many years longer than many competitors standard 10 or 12 years. The Warranty is provided by LG Electronics Australia and New Zealand. The warranty includes replacement, labour and transport.

**More Power per Square Metre**

LG NeON® 2's 360W are a similar physical size to many competing 330W panels. This means with the LG NeON® 2 360W you get 9% more electricity per square metre than a 330W panel. So you can install more kW of solar on your roof with the LG NeON® 2.

**Improved 25 Year Performance Warranty**

The initial degradation of the module has been improved from -3% to -2%, in the 1st year and the annual rate of degradation has fallen from -0.7%/year to -0.33%/ year thereafter. This brings an 90.08% warranted output after 25 years, compared to 80.7% for many competing panels.

**Made in Korea** **Call LG Solar on 1300 152 179** **www.lgenergy.com.au**

LG350N1C-N5 | LG355N1C-N5 | LG360N1C-N5

# LG NeON®2

## ABOUT LG ELECTRONICS

LG Electronics embarked on a solar energy research programme in 1985, using our vast experience in semi-conductors, chemistry and electronics. LG Solar modules are now available in over 50 countries. In 2013, 2015 and 2016 the LG NeON® range won the acclaimed Intersolar Award in Germany, which demonstrates LG Solar's lead in innovation and commitment to the renewable energy industry. Additionally, LG Solar™ won the Australian Top Brand Award in 2016, 2017, 2018, 2019 and 2020. LG Solar has also been voted WINNER Trusted Brands 2020 - SOLAR PANELS by Reader's Digest from over 3,000 Australian consumers surveyed. With many lesser known brand panels selling in Australia, LG Solar panels offer a peace of mind solution, as they are backed by an established global brand with a long local support history.

## KEY ADVANTAGES

### Proven Field Performance

LG has been involved in a number of comparison tests of the LG panels against many other brand panels. LG NeON® 2 models are consistently among the best performing in these tests.

### Low LID

The N-type doping of the NeON® cells results in extremely low Light Induced Degradation (LID) when compared with the standard P-type cells. This means more electricity generation over the life of the panel, as the panel degrades less.

### Additional Certification

LG NeON® 2 panels have received additional certification including for, Salt Mist Corrosion to maximum severity 6. Ammonia Resistance certification and PID Resistance Tests.

### Extensive Testing Programme

LG solar panels are tested at least up to 2 times the International Standards at our in-house testing laboratories, ensuring a very robust and longer lasting solar module.

### Strict Quality Control Reliable for the Future

The quality control of LG world-class solar production is monitored and improved using Six Sigma techniques via 500+ monitoring points to effectively maintain and improve our uncompromising quality.

### Improved High Temperature Performance

Solar panels slowly lose ability to generate power as they get hotter. LG NeON® 2, has an improved temperature co-efficient to standard modules, which means in hot weather LG NeON® 2 panels will deliver higher output.

### Multi Anti-reflective Coatings Increase Output

LG Solar™ is using an anti-reflective coating on the panels glass as well as on the cell surface to ensure more light is absorbed in the panel and not reflected. More absorbed light means more electricity generation.

### Positive Tolerance (0/+3%)

If you buy a 360 Watt panel then the flash test of this panel will show somewhere between 360W and 370W. Some competitor panels have -/+ tolerance, so you could get a flash test result below the rated Watt, meaning you pay for Watts you never get.

### High Wind Load Resistance

LG panels have a strong double walled frame. When it comes to wind forces (rear load) our panel under test withstood a wind load of 4000 Pascals.

### Anti PID Technology for Yield Security

PID (Potential Induced Degradation) affects the long term ability of panels to produce high level electricity output. LG panels have anti PID technology and have been successfully tested by leading third party laboratories regarding PID resistance.

### "CELLO" Technology Increases Power

"CELLO" Multi wire busbar cell technology lowers electrical resistance and increases panel efficiency, giving more power per panel and provides a more uniform look to the panel.

### Automated Production in South Korea

All LG solar panels sold in Australia and New Zealand are manufactured in a custom designed and fully automated production line by LG in Gumi, South Korea ensuring extremely low tolerances. This means great quality and build consistency between panels.

# LG NeON®2

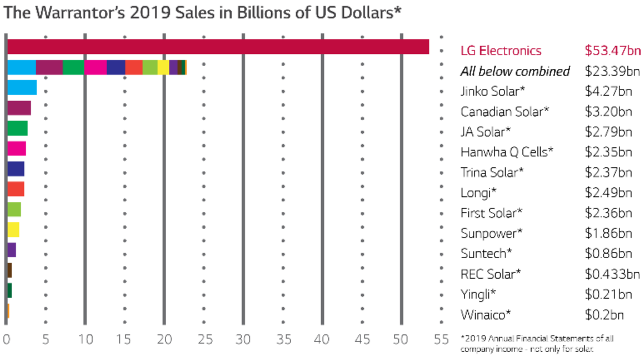
## LG NeON® 2 – ENHANCED. MORE EFFICIENT. ADVANCED.

LG NeON® 2 solar panels now offer even more output. Featuring a classy design and with a total of 60 cells, it can withstand under test a static front panel load of 5400 pascals and rear wind load of 4000 pascals. LG has lengthened its product warranty to 25 years and has improved its linear performance guarantee to 90.08% of nominal output after 25 years. The LG NeON® 2 is an excellent choice for high performing long lasting solar systems.

## LOCAL WARRANTY, GLOBAL STRENGTH

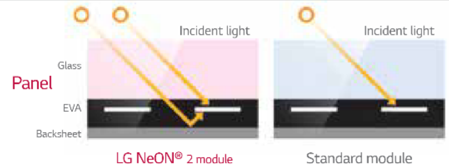
LG Solar™ is part of LG Electronics Inc., a global and financially strong company, with over 50 years of experience in technology.

Good to know: LG Electronics Australia Pty Ltd is the warrantor in Australia and NZ for your solar modules. So LG support, via offices in every Australian mainland state and NZ and through our 80 strong, Australia wide dealer network, is only a phone call away, ph 1300 152 179.



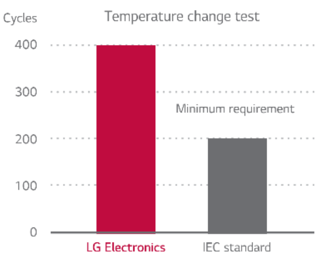

## HIGHER OUTPUT, HIGHER YIELD

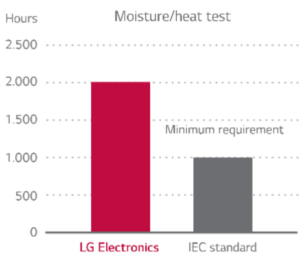
The NeON® Cell produces energy from both the front and the back of the cell. This innovative approach allows the absorption of light from the back of the cell which raises the panel's efficiency and power output. Standard panels only absorb light from the front.




## EXCELLENT QUALITY, THOROUGHLY TESTED

You can rely on LG. We test our products with at least double the intensity specified in the IEC standard. (International Quality Solar Standard).




**Awards Received By LG Solar™**


Our panel range have won a string of Local and International Awards.

## POWERFUL DESIGN, GUARANTEED ROBUST

With reinforced frame design, the LG NeON® 2 can under test withstand a front load of 5400 Pa which is the equivalent of 943 kg over the size of the panel. The rear load/wind load of the panel under test is 4000 Pa.


LG offers a longer 25 year parts and labour warranty than many competitors who provide 10 and 12 year warranties.

LG350N1C-N5 | LG355N1C-N5 | LG360N1C-N5

# LG NeON®2

## Mechanical Properties

| | |
|---|---|
| Cells | 60 Cells (6 x 10) |
| Cell Vendor | LG |
| Cell Type | Monocrystalline / N-type |
| Number of Busbar | 12EA |
| Dimensions (L x W x H) | 1700 x 1016 x 40 mm |
| Front Load (test) | 5400 Pa |
| Rear Load (test) | 4000 Pa |
| Weight | 18 kg |
| Connector Type | Genuine MC4, IP68 (Male: PV-KST4) (Female: PV-KBT4) |
| Junction Box | IP68 with 3 bypass diodes |
| Length of Cables | 2 x 1000 mm |
| Glass (Material) | Tempered Glass with AR Coating |
| Frame | Anodised aluminum with protective matt black coating |

## Certifications and Warranty

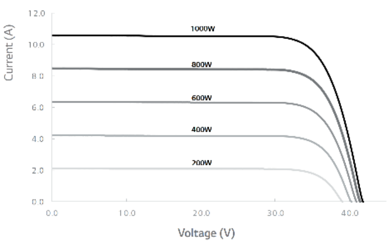
| | |
|---|---|
| Certifications | ISO 9001, ISO 14001, ISO 50001<br>IEC 61215-1/-1-1/2:2016, IEC 61730-1/2:2016<br>OHSAS 18001 |
| Salt Mist Corrosion Test | IEC 61701: 2012 Severity 6 |
| Ammonia Corrosion Test | IEC 62716: 2013 |
| Module Fire Performance | Class C (UL 790) |
| Product Warranty | 25 Years |
| Output Warranty of Pmax (Measurement Tolerance ± 3%) | Linear Warranty[1] |

[1] 1) 1st year: 98%, 2) After 1st year: 0.33% annual degradation, 3) 90.08% for 25 years.

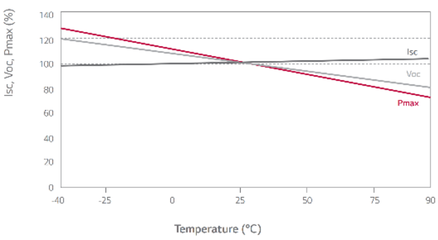
## Temperature Characteristics

| | |
|---|---|
| NMOT | 42 ± 3 °C |
| Pmax | -0.34 %/°C |
| Voc | -0.26 %/°C |
| Isc | 0.03 %/°C |

## Current – Voltage characteristics at various irradiance levels




## Current – Voltage characteristics at various cell temperatures




## Electrical Properties (STC[2])

| Module Type | LG350N1C-N5 | LG355N1C-N5 | LG360N1C-N5 |
|---|---|---|---|
| Maximum Power Pmax (W) | 350 | 355 | 360 |
| MPP Voltage Vmpp (V) | 34.3 | 34.7 | 35.1 |
| MPP Current Impp (A) | 10.22 | 10.25 | 10.28 |
| Open Circuit Voltage Voc (V) | 41.4 | 41.5 | 41.6 |
| Short Circuit Current Isc (A) | 10.76 | 10.80 | 10.84 |
| Module Efficiency (%) | 20.3 | 20.6 | 20.8 |
| Operating Temperature (°C) | -40 ~ +90 | | |
| Maximum System Voltage (V) | 1000 | | |
| Maximum Series Fuse Rating (A) | 20 | | |
| Power Tolerance (%) | 0 ~ +3 | | |

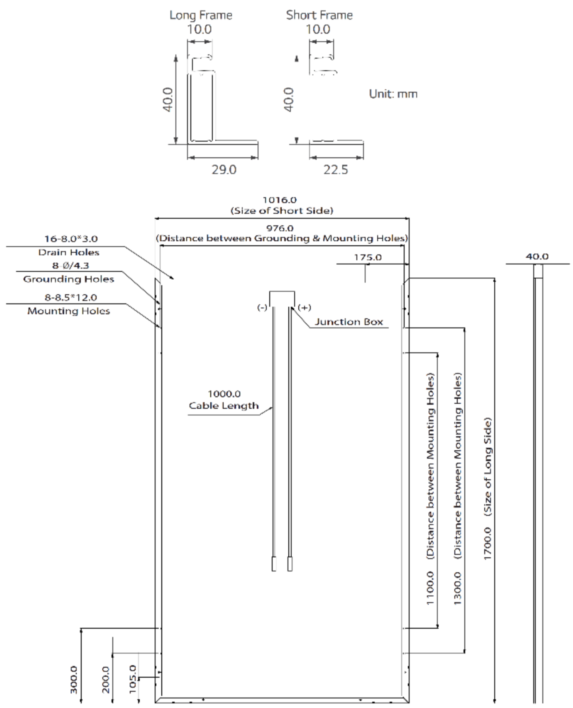
[2] STC (Standard Test Condition): Irradiance 1000 W/m², Module Temperature 25 °C, AM 1.5.
The nameplate power output is measured and determined by LG Electronics at its sole and absolute discretion.

## Electrical Properties (NMOT[3])

| Module Type | LG350N1C-N5 | LG355N1C-N5 | LG360N1C-N5 |
|---|---|---|---|
| Maximum Power Pmax (W) | 262 | 266 | 270 |
| MPP Voltage Vmpp (V) | 32.2 | 32.6 | 33.0 |
| MPP Current Impp (A) | 8.15 | 8.17 | 8.20 |
| Open Circuit Voltage Voc (V) | 39.0 | 39.1 | 39.2 |
| Short Circuit Current Isc (A) | 8.64 | 8.68 | 8.71 |

[3] NMOT (Nominal Module Operating Temperature): Irradiance 800 W/m², ambient temperature 20 °C, wind speed 1 m/s, Spectrum AM 1.5.

## Dimensions (mm)

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Solar Business Group
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LG Electronics Inc.
Solar Business Division
Twin Building, Western Tower, 11F, 128, Yeoui-daero, Yeongdeungpo-gu, Seoul, 07336, Korea
www.lg.com/global/business

Product specifications are subject to change without prior notice.
Date: 08/2020

# APPENDIX B - TECHNICAL DATASHEET – SIMULATED PV INVERTER

SUNNY TRIPOWER
15000TL / 20000TL / 25000TL


**Efficient**
- Maximum efficiency of 98.4%

**Safe**
- DC surge arrester (SPD type II) can be integrated

**Flexible**
- DC input voltage of up to 1000 V
- Multistring capability for optimum system design
- Optional display

**Innovative**
- Cutting-edge grid management functions with Integrated Plant Control
- Reactive power available 24/7 (Q on Demand 24/7)

## SUNNY TRIPOWER 15000TL / 20000TL / 25000TL

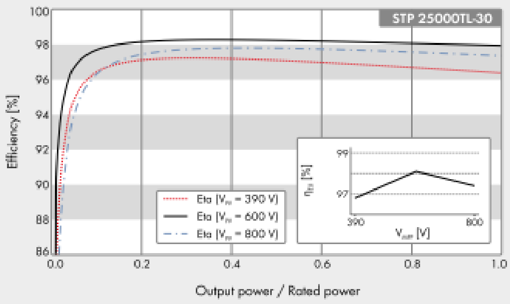
The versatile specialist for large-scale commercial plants and solar power plants

The Sunny Tripower is the ideal inverter for large-scale commercial and industrial plants. Not only does it deliver extraordinary high yields with an efficiency of 98.4%, but it also offers enormous design flexibility and compatibility with many PV modules thanks to its multistring capabilities and wide input voltage range.
The future is now: the Sunny Tripower comes with cutting-edge grid management functions such as Integrated Plant Control, which allows the inverter to regulate reactive power at the point of common coupling. Separate controllers are no longer needed, lowering system costs. Another new feature–reactive power provision on demand (Q on Demand 24/7).

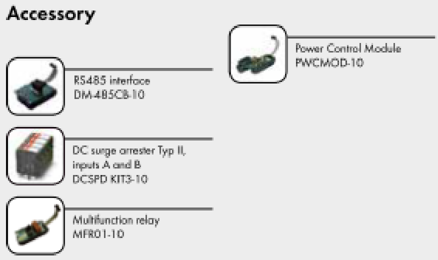
# SUNNY TRIPOWER
# 15000TL / 20000TL / 25000TL

| Technical Data | Sunny Tripower 15000TL |
|---|---|
| **Input (DC)** | |
| Max. generator power | 27000 Wp |
| DC rated power | 15330 W |
| Max. input voltage | 1000 V |
| MPP voltage range / rated input voltage | 240 V to 800 V / 600 V |
| Min. input voltage / start input voltage | 150 V / 188 V |
| Max. input current input A / input B | 33 A / 33 A |
| Number of independent MPP inputs / strings per MPP input | 2 / A:3; B:3 |
| **Output (AC)** | |
| Rated power (at 230 V, 50 Hz) | 15000 W |
| Max. AC apparent power | 15000 VA |
| AC nominal voltage | 3 / N / PE; 230 V / 400 V |
| AC grid frequency / range | 50 Hz / 44 Hz to 55 Hz |
| Rated power frequency / rated grid voltage | 50 Hz / 230 V |
| Max. output current / Rated output current | 29 A / 21.7 A |
| Power factor at rated power / Adjustable displacement power factor | 1 / 0 overexcited to 0 underexcited |
| THD | ≤ 3% |
| Feed-in phases / connection phases | 3 / 3 |
| **Efficiency** | |
| Max. efficiency / European Efficiency | 98.4% / 98.0% |
| **Protective devices** | |
| DC-side disconnection device | ● |
| Ground fault monitoring / grid monitoring | ● / ● |
| DC surge arrester (Type II) can be integrated | ○ |
| DC reverse polarity protection / AC short-circuit current capability / galvanically isolated | ● / ● / – |
| All-pole sensitive residual-current monitoring unit | ● |
| Protection class (according to IEC 62109-1) / overvoltage category (according to IEC 62109-1) | I / AC: III; DC: II |
| **General data** | |
| Dimensions (W / H / D) | 661 / 682 / 264 mm (26.0 / 26.9 / 10.4 inch) |
| Weight | 61 kg (134.48 lb) |
| Operating temperature range | −25 °C to +60 °C (−13 °F to +140 °F) |
| Noise emission (typical) | 51 dB(A) |
| Self-consumption (at night) | 1 W |
| Topology / cooling concept | Transformerless / Opticool |
| Degree of protection (as per IEC 60529) | IP65 |
| Climatic category (according to IEC 60721-3-4) | 4K4H |
| Maximum permissible value for relative humidity (non-condensing) | 100% |
| **Features / function / Accessories** | |
| DC connection / AC connection | SUNCLIX / spring-cage terminal |
| Display | ○ |
| Interface: RS485, Speedwire/Webconnect | ○ / ● |
| Data interface: SMA Modbus / SunSpec Modbus | ● / ● |
| Multifunction relay / Power Control Module | ○ / ○ |
| OptiTrac Global Peak / Integrated Plant Control / Q on Demand 24/7 | ● / ● / ● |
| Off-Grid capable / SMA Fuel Save Controller compatible | ● / ● |
| Guarantee: 5 / 10 / 15 / 20 years | ● / ○ / ○ / ○ |
| Planned certificates and permits<br><br>* Does not apply to all national appendices of EN 50438 | ANRE 30, AS 4777, BDEW 2008, C10/11:2012, CE, CEI 0-16, CEI 0-21, DEWA 2.0, EN 50438:2013*, G59/3, IEC 60068-2-x, IEC 61727, IEC 62109-1/2, IEC 62116, MEA 2013, NBR 16149, NEN EN 50438, NRS 097-2-1, PEA 2013, PPC, RD 1699/413, RD 661/2007, Res. n°7:2013, SI4777, TOR D4, TR 3.2.2, UTE C15-712-1, VDE 0126-1-1, VDE-AR-N 4105, VFR 2014 |
| | |
| Type designation | STP 15000TL-30 |

**Efficiency Curve**




**Accessory**




● Standard features ○ Optional features – Not available
Data at nominal conditions
Status: October 2017

| **Technical Data** | **Sunny Tripower 20000TL** | **Sunny Tripower 25000TL** |
|---|---|---|
| **Input (DC)** | | |
| Max. generator power | 36000 Wp | 45000 Wp |
| DC rated power | 20440 W | 25550 W |
| Max. input voltage | 1000 V | 1000 V |
| MPP voltage range / rated input voltage | 320 V to 800 V / 600 V | 390 V to 800 V / 600 V |
| Min. input voltage / start input voltage | 150 V / 188 V | 150 V / 188 V |
| Max. input current input A / input B | 33 A / 33 A | 33 A / 33 A |
| Number of independent MPP inputs / strings per MPP input | 2 / A:3; B:3 | 2 / A:3; B:3 |
| **Output (AC)** | | |
| Rated power (at 230 V, 50 Hz) | 20000 W | 25000 W |
| Max. AC apparent power | 20000 VA | 25000 VA |
| AC nominal voltage | 3 / N / PE; 230 V / 400 V | |
| AC grid frequency / range | 50 Hz / 44 Hz to 55 Hz | |
| Rated power frequency / rated grid voltage | 50 Hz / 230 V | |
| Max. output current / Rated output current | 29 A / 29 A | 36.2 A / 36.2 A |
| Power factor at rated power / Adjustable displacement power factor | 1 / 0 overexcited to 0 underexcited | |
| THD | ≤ 3% | |
| Feed-in phases / connection phases | 3 / 3 | |
| **Efficiency** | | |
| Max. efficiency / European Efficiency | 98.4% / 98.0% | 98.3% / 98.1% |
| **Protective devices** | | |
| DC-side disconnection device | ● | |
| Ground fault monitoring / grid monitoring | ● / ● | |
| DC surge arrester (Type II) can be integrated | ○ | |
| DC reverse polarity protection / AC short-circuit current capability / galvanically isolated | ● / ● / – | |
| All-pole sensitive residual-current monitoring unit | ● | |
| Protection class (according to IEC 62109-1) / overvoltage category (according to IEC 62109-1) | I / AC: III; DC: II | |
| **General data** | | |
| Dimensions (W / H / D) | 661 / 682 / 264 mm (26.0 / 26.9 / 10.4 inch) | |
| Weight | 61 kg (134.48 lb) | |
| Operating temperature range | −25 °C to +60 °C (−13 °F to +140 °F) | |
| Noise emission (typical) | 51 dB(A) | |
| Self-consumption (at night) | 1 W | |
| Topology / cooling concept | Transformerless / Opticool | |
| Degree of protection (as per IEC 60529) | IP65 | |
| Climatic category (according to IEC 60721-3-4) | 4K4H | |
| Maximum permissible value for relative humidity (non-condensing) | 100% | |
| **Features / function / Accessories** | | |
| DC connection / AC connection | SUNCLIX / spring-cage terminal | |
| Display | ○ | |
| Interface: RS485, Speedwire/Webconnect | ○ / ● | |
| Data interface: SMA Modbus / SunSpec Modbus | ● / ● | |
| Multifunction relay / Power Control Module | ○ / ○ | |
| OptiTrac Global Peak / Integrated Plant Control / Q on Demand 24/7 | ● / ● / ● | |
| Off-Grid capable / SMA Fuel Save Controller compatible | ● / ● | |
| Guarantee: 5 / 10 / 15 / 20 years | ● / ○ / ○ / ○ | |
| Certificates and permits (more available on request)<br>* Does not apply to all national appendices of EN 50438 | ANRE 30, AS 4777, BDEW 2008, C10/11:2012, CE, CEI 0-16, CEI 0-21, DEWA 2.0, EN 50438:2013*, G59/3, IEC 60068-2-x, IEC 61727, IEC 62109-1/2, IEC 62116, MEA 2013, NBR 16149, NEN EN 50438, NRS 097-2-1, PEA 2013, PPC, RD 1699/413, RD 661/2007, Res. n°7:2013, SI4777, TOR D4, TR 3.2.2, UTE C15-712-1, VDE 0126-1-1, VDE-AR-N 4105, VFR 2014 | |
| | | |
| Type designation | STP 20000TL-30 | STP 25000TL-30 |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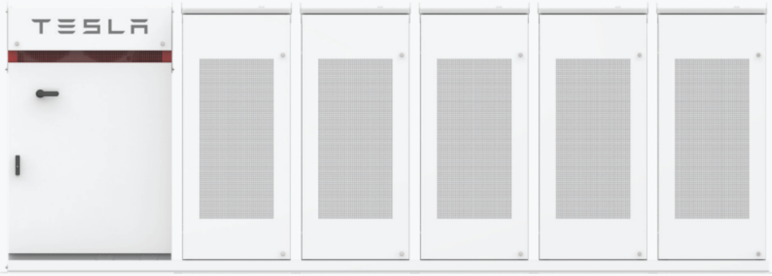
# APPENDIX C - TECHNICAL DATASHEET FOR TESLA POWERPACK (Sample Storage system)

## POWERPACK 2.5 SYSTEM

Tesla has been building integrated battery systems in cars for over 10 years. The same degree of expertise, quality control, and technological innovation has informed our process of developing high-performance energy storage systems.

The Powerpack System scales to the space, power and energy requirements of any site from 100 kWh+ to 100 MWh+.

Tesla offers a 10-year warranty at no additional cost. Extensions are also available under certain conditions.




Powerpack System includes an Inverter and DC Battery Packs

### FULLY INTEGRATED SYSTEM

A complete energy storage system including DC batteries, bi-directional inverter, and a Powerpack Controller with intelligent software. This turnkey system is designed to maximize savings and prolong battery life.

### OPTIMIZATION SOFTWARE

Powerpack Systems have the most advanced battery technology and dispatch optimization software to quickly learn and predict a facility's energy patterns. Tesla's proprietary storage dispatch software can charge and discharge autonomously to maximize customer value.

### ENHANCED SYSTEM SAFETY

Powerpack's battery architecture consists of a low voltage battery with a DC/DC converter for added electrical isolation and safety. It also has an integrated liquid cooling and heating system for thermal safety and enhanced performance and reliability.

### APPLICATIONS

**PEAK SHAVING**
Discharge at times of peak demand to reduce expensive demand charges

**EMERGENCY BACKUP**
Powers a facility when the grid goes down

**CAPACITY FIRMING**
Smooth out the intermittency of renewables by storing and dispatching when needed

**LOAD SHIFTING**
Shift energy consumption from one point in time to another

**MICROGRID**
Build a localized grid that can disconnect from the main power grid

**TRANSMISSION AND DISTRIBUTION SUPPORT**
Supply power at a distributed location to defer the need to upgrade aging infrastructure

**DEMAND RESPONSE**
Discharge or charge in response to signals from a demand response administrator

**ANCILLARY SERVICES**
Provide service to the grid in response to signals sent

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## POWERPACK 2.5 SPECIFICATIONS

- One Powerpack includes 16 battery Pods
- Each Pod has an isolated DC/DC converter and sensors to monitor cell level performance in real time
- Standard configurations:
  - 1.2-hour discharge duration (Frequency Regulation)
  - 1.6-hour discharge duration
  - 2-hour discharge duration
  - 4-hour discharge duration


### INVERTER RATINGS

| | |
|---|---|
| **AC Voltage** | 380–480 VAC 3-phase |
| **Nominal Frequency** | 50 or 60 Hz |
| **Inverter Size (at 480 V)** | Scalable up to 700 kVA |

### POWERPACK RATINGS

| Configuration | Power/Energy[1] | Roundtrip[1] System Efficiency |
|---|---|---|
| 1.2 hr: | 130 kW / 160 kWh | 84.5% [2] |
| 1.6 hr | 109 kW / 174 kWh | 86% |
| 2 hr | 108 kW / 215 kWh | 86.5% |
| 4 hr | 57 kW / 228 kWh | 90% |

[1] Net energy delivered at 25°C (77°F) including thermal control
[2] Frequency regulation and peak power options, available under certain conditions

### MECHANICAL AND MOUNTING

| | |
|---|---|
| **Enclosure** | IP67 (Pod)<br>NEMA 3R / IP35 (Powerpack)<br>NEMA 4 / IP66 (Inverter) |
| **Powerpack Unit Dimensions** | L: 1308 mm (51.5 in)<br>W: 822 mm (32.4 in)<br>H: 2235 mm (88 in) |
| **Powerpack Unit Max Shipped Weight** | 2199 kg (4847 lbs) |
| **Inverter Dimensions** | L: 1014 mm (39.9 in)<br>W: 1254 mm (49.4 in)<br>H: 2242 mm (88.3 in) |
| **Inverter Max Shipped Weight** | 1120 kg (2470 lbs) |
| **Operating Ambient Temperature** | –30°C to 50°C (–22°F to 122°F) |

### COMMUNICATIONS

| | |
|---|---|
| **Protocol** | Modbus TCP<br>DNP3<br>Rest API |

### REGULATORY

| | |
|---|---|
| **Lithium-Ion Cells** | NRTL listed to UL 1642 |
| **System** | NRTL listed to UL 1973, 9540, 1741 SA<br>IEEE 1547<br>Compliant to grid codes and safety standards of all major markets. Full list provided upon request. |

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# POWERPACK

MICROGRID SYSTEM


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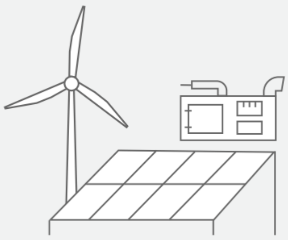
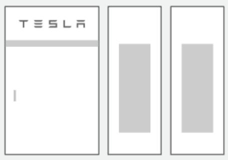
# TESLA MICROGRID SOLUTION

Microgrids and off-grid power systems consisting of a range of conventional and renewable generation sources, battery storage and grid connections present unique challenges that require robust solutions to maintain stable and sustainable power supply. Tesla's microgrid solution leverages existing unit-level controllers and a robust, frequency-based load sharing scheme to solve these challenges. The end result is a solution that delivers savings and stable, reliable power to a wide range of customers—from remote communities, commercial and industrial facilities to utility substations, military bases and mining operations.



GENERATION



STORAGE

LOAD

Tesla's microgrid solution revolves around the Tesla Powerpack energy storage technology and includes software, controls and services to effectively manage power and energy flow, while balancing demand needs and maximizing economic benefit over the life of the microgrid. This document details Tesla's comprehensive solution.

> System Overview
> Distributed Energy Resource Management
> Islanding and Grid-Connected Control
> Monitoring and Reporting
> Networking and IT

Tesla offers industry-leading performance, reliability and value to implement microgrids that meet and exceed our customers expectations and requirements. For additional information please visit www.tesla.com/powerpack.

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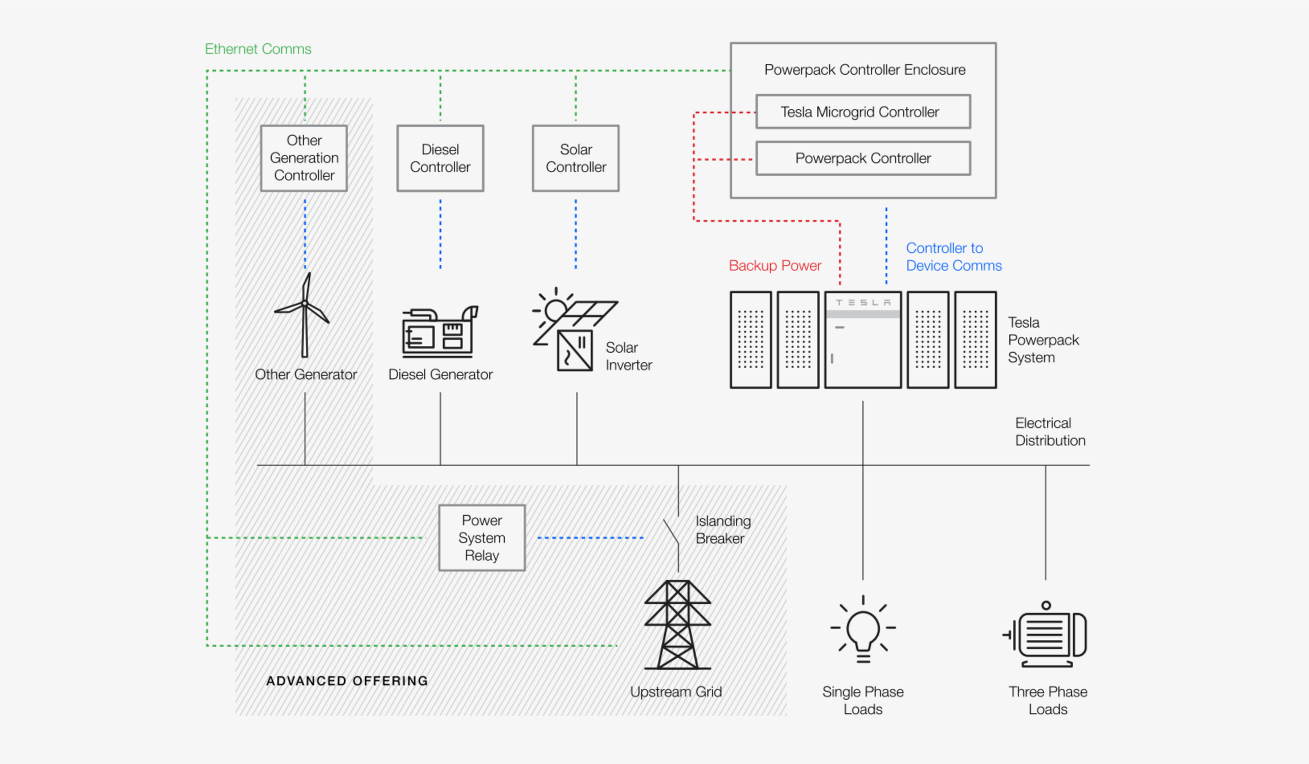
# SYSTEM OVERVIEW




Tesla's Microgrid Controller manages the various Distributed Energy Resources (DERs), such as the Tesla Powerpack system, diesel generators and solar PV to ensure reliable, low cost supply to the system loads.

The Microgrid Controller hardware is contained within the Tesla Powerpack Controller enclosure and includes a redundant, dual-feed DC power supply fed from within the Tesla Powerpack system. The controller utilizes a cost-based optimization algorithm that considers the priority and schedule of all DERs, dispatching generation and allocating power to loads dynamically. The controller easily allows generation sources to be made unavailable without interruption, and can island the microgrid from the upstream grid, and likewise controls the re-synchronization to the grid without interruption.

FEATURES

> User configurable Priority List for all loads and generators
> Cost-based optimization algorithm that utilizes the Priority Lists to dispatch or curtail generators and shed or reconnect loads in order to maintain system operation most cost-effectively
> Management of power buffers (also known as spinning reserves) and energy buffers to account for fluctuations in load and non-dispatachable generation
> System blackstart after a fault and safe system shutdown for maintenance
> Forecasting electric demand and renewable generation in order to optimize schedule decision making*

*Advanced offering

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## DISTRIBUTED ENERGY RESOURCE MANAGEMENT

The Microgrid Controller manages DERs, such as Tesla Powerpack systems, generators and PV systems listed on Tesla's Approved Vendor List (AVL) through interfacing with OEM controllers. DERs may be added to the Approved Vendor List for an additional fee subject to Tesla approval. Generally, the management of DERs include:

> Automatic start and stop of the DER
> Management of real and reactive power sharing between DERs
> DER Priority List and availability and management
> Alarm management and monitoring


### POWERPACK SYSTEMS

The Microgrid Controller manages Tesla Powerpack battery systems by interfacing with the Powerpack Controller. Management of Tesla Powerpack systems includes:

> High State of Energy (SOE) management by curtailing generation
> Low SOE management by increasing dispatachable generation output

TRADITIONAL GENERATION

The Microgrid Controller manages generators by interfacing to the OEM generator controllers listed in the Approved Vendor List. Generator Management includes:

> Maintenance of the minimum run rate during steady-state operation and startup management
> Time-of-use management
> Generator loading optimization
> Minimization of total operating cost*

LOADS

The Microgrid Controller manages generators by interfacing with the OEM load breakers and controllers listed in the Approved Equipment List. Load Management includes:

> Automatic shedding and Automatic re-connection of load feeders*

*Advanced offering

SOLAR PV

The Microgrid Controller manages PV systems by interfacing with the OEM PV controllers listed in the Approved Vendor List.

Magement of PV systems includes:

> Maximization of renewable consumption
> Curtailment to manage battery SOE, Powerpack inverter loading and non-export
> “Wait for Energy” mode whereby in extreme low-energy situations the system will perform a safe shutdown with an energy buffer in order to wait for the next solar day*

# ISLANDED AND GRID-CONNECTED CONTROL

A single connection to an external grid can be managed by the Microgrid Controller, which seamlessly transitions the microgrid between islanded (off grid) and grid-connected configurations using a power system protection relay to manage the islanding breaker/contactor.

Features:

> Transitions the microgrid between islanded and grid-connected configurations by managing the Microgrid generation

> Automatic islanding in the event that a grid excursion is detected

> Automatic re-synchronization when the grid returns or when initiated by customer

> Intentional islanding may be requested by customer

> When on grid, Tesla's vast on-grid experience using Opticaster can be used for tariff optimization or providing grid services, such as demand response, frequency response, or non-export

> "Fast Backup" also available, contact Tesla for details*

*Advanced offering

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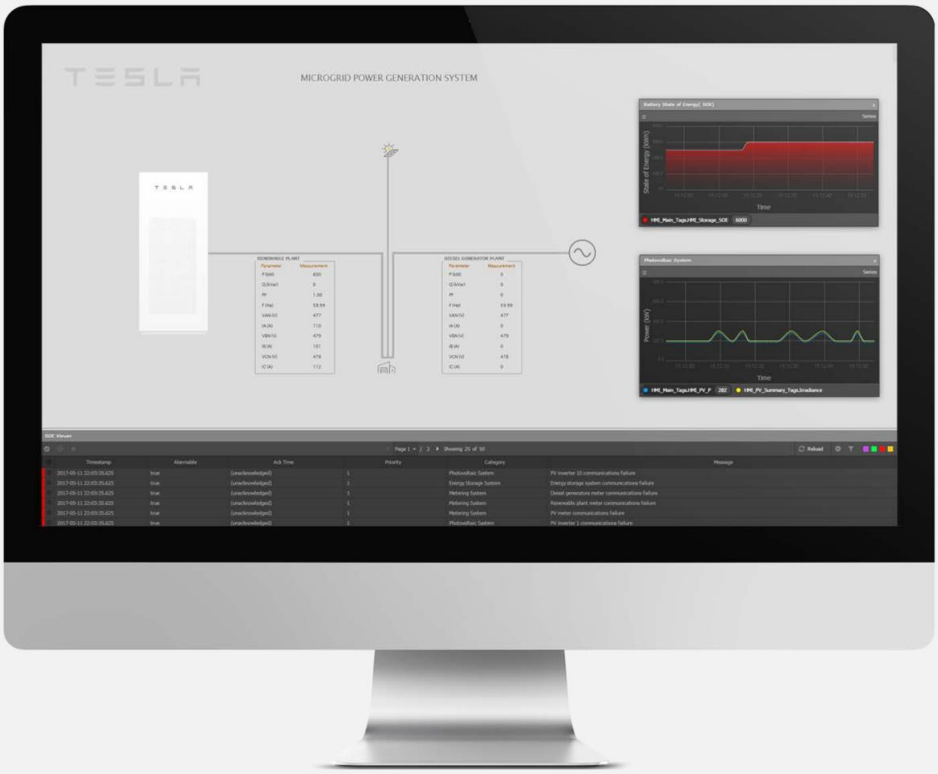
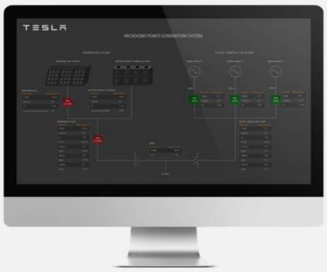
# MONITORING AND REPORTING



The Microgrid Controller includes monitoring and historian functionalities that allow for system values and parameters to be viewed and exported from the system. The monitoring and historian functionalities are available through the web-based HMI, which is hosted as a HTTP page on the local network.

> Data logged to Tesla servers for remote service and support
> Local control (HTTP based)
> HMI accessible via HTML5 browser to provide control and monitoring flexibility
> Comprehensive HMI offering, includes site specific cusomization*

*Advanced offering

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## NETWORKING / IT

The Microgrid Controller relies on customer supplied Ethernet networking infrastructure. The Microgrid Controller communicates to the DERs via Ethernet-based communications (e.g. MODBUS TCP/IP). DER's communicate via OEM communications to the individual components. For components that require non-Ethernet communications (e.g. MODBUS Serial RTU) converters are required to allow these DERs to connect to the Ethernet network.

> Ethernet-based communications
> Redundant ring network recommended
> Internet connection required to allow for, monitoring and historian functionality
> Reporting of the system status and variables to upstream SCADA systems.


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