# IMPLEMENTATION OF LOW ENERGY AFFORDABLE VERTICAL HOUSING TOWARDS NEARLY ZERO ENERGY BUILDING/ NEZB IN INDONESIA


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2024


# BACKGROUND

**8- 16% of plant species are projected to lose half of their habitat.**

**6- 18% of insect species are expected to lose half of their habitat.**

Coral reefs are projected to decrease by 70-99%.

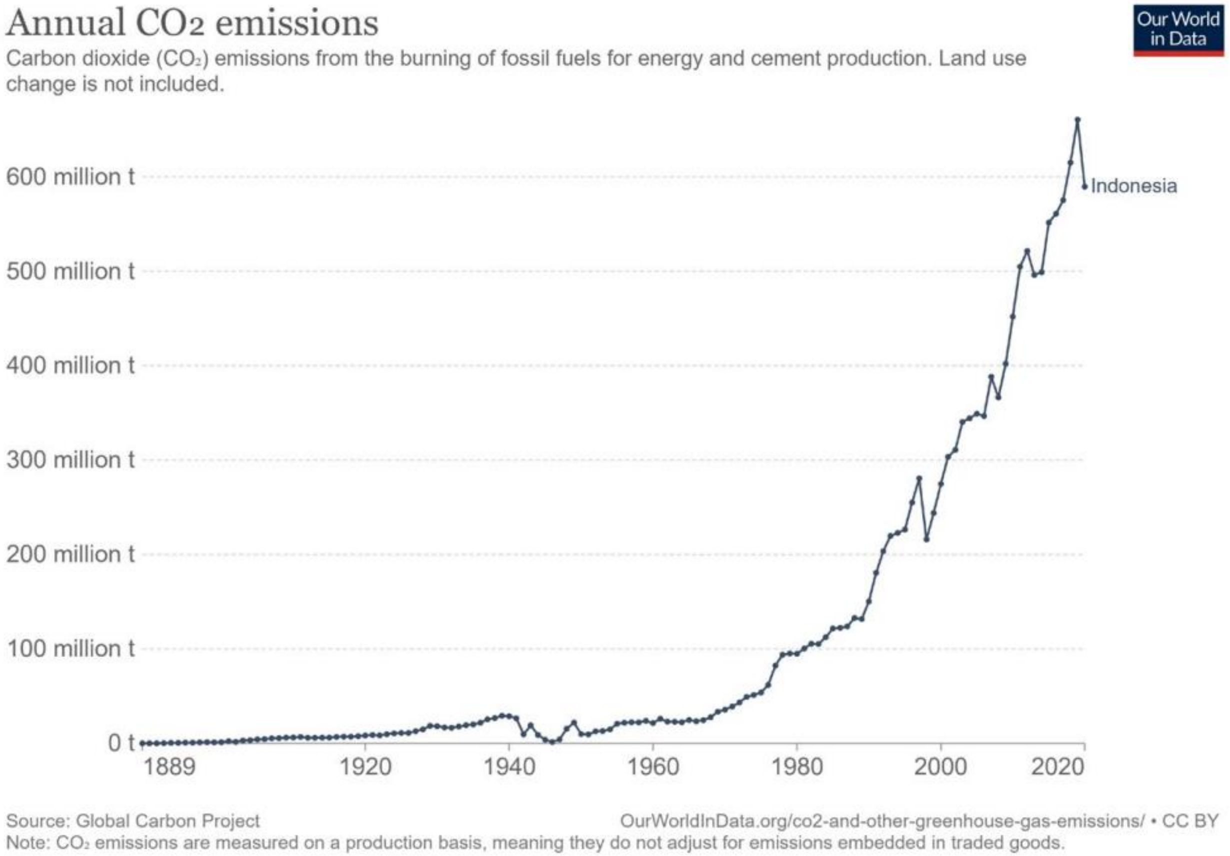
**14- 37% of the global population is projected to be exposed to extreme heat once every five years.**

A summer without the presence of ice in Antarctica is projected to occur once every 100 to 10 years.

**1.5° C**

**66%**

**2° C**





[1] Climatecouncil.org.au https://www.climatecouncil.org.au/resources/impacts- degrees-warming/

[2] Consolidated global temperature datasets for 2023. *WMO*

[3] Agreement, P. (2015, December). Paris agreement. In *report of the conference of the parties to the United Nations f ramework convention on climate change (21st session, 2015: Paris). Retrived December* (Vol. 4, No. 2017, p. 2). Getzville, NY, USA: HeinOnline.

# (LATEST REPORT) BUILDING AND CONSTRUCTION

**37%**

**Carbon Emission**

The Building Sector has recorded a 34% contribution to global energy consumption

**34%**

**Energy Consumption**

The Building Sector has recorded a 34% contribution to global energy consumption

***Present - 2023***

**125%**

**Material Consumption**

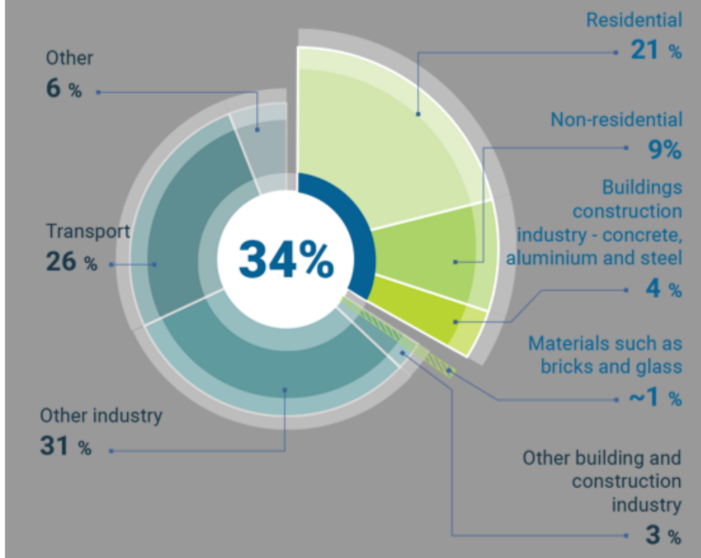
Global material demand is projected to reach 90 billion tones by 2050, representing a 125% increase since 2010

**50%**

**Carbon Emission**

Fifty percent of carbon emissions originate from new buildings

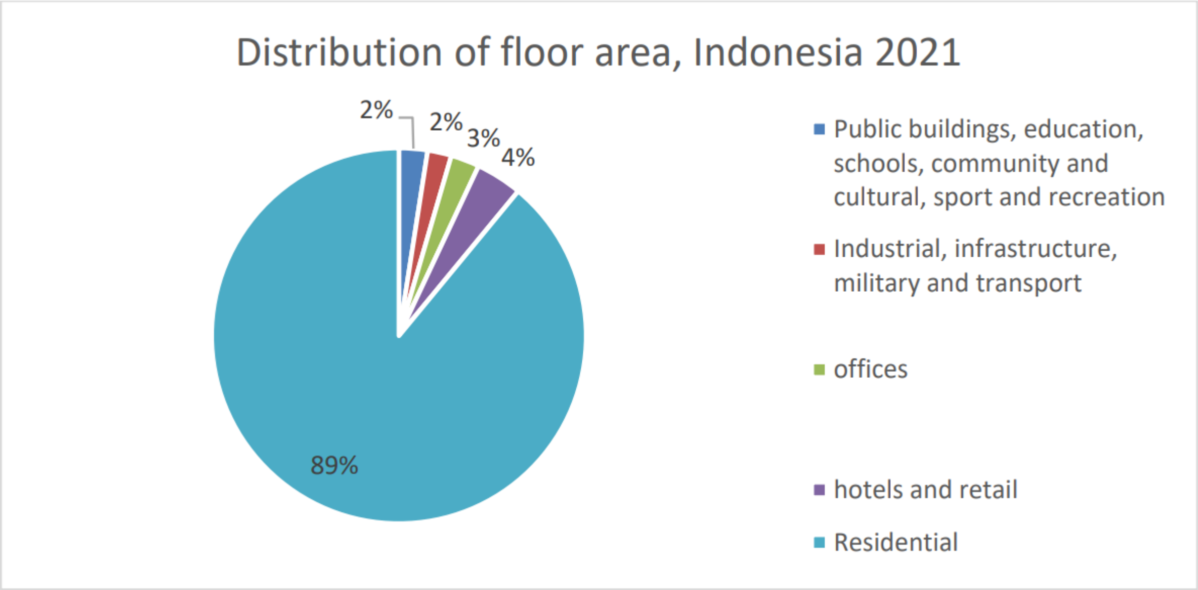
***Future - 2050***

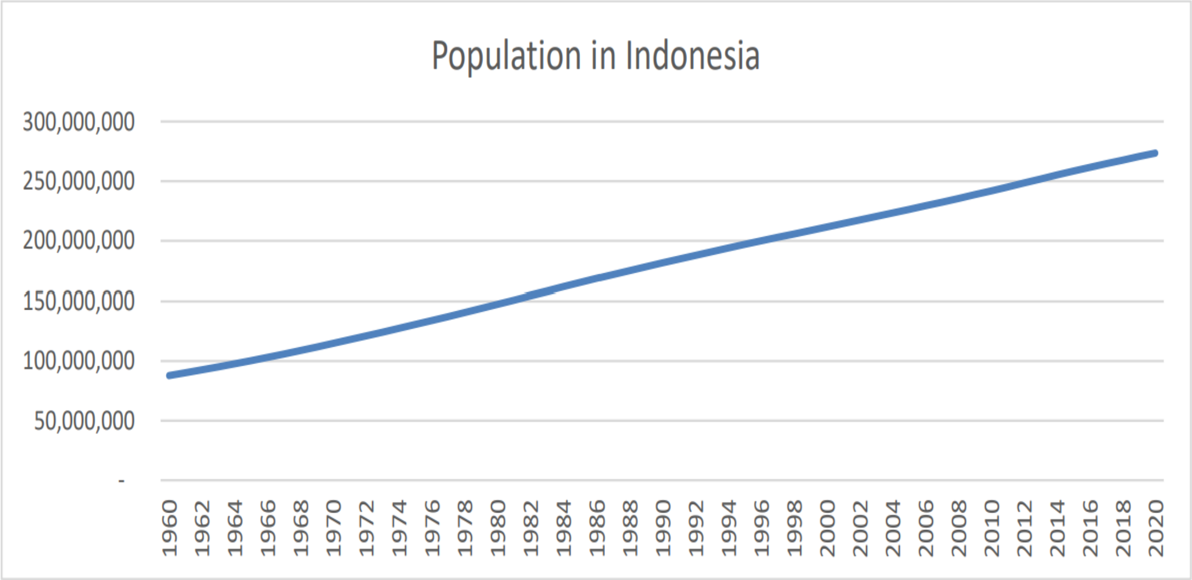



POPULASI GEDUNG KOMERSIAL


B2PTKE, 2020. Benchmarking Specific Energy Consumption di Bangunan Komersial. Laporan Akhir, Kementerian ESDM, Tangerang Selatan.

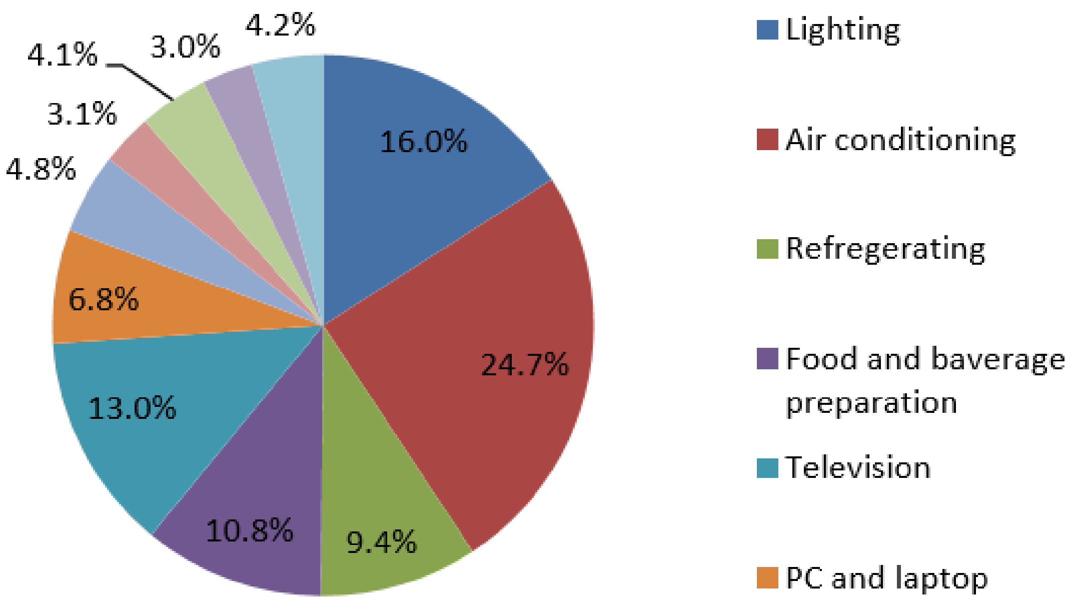
- **BACKGROUND**
  Residential buildings dominates the building area (89%) while the rest (11%) belongs to the commercial sector.
  The residential building sector is expected to have an annual growth of about 3.7%. Single-Family detached buildings are the fastest growing group in the residential sector with an annual growth of 4.2%.
  The demand for energy for households is influenced by the predicted increase in the number of household of about 70.6 million in 2025 and 80 million in 2050.
  Besides that, the urbanization rate also drives the increase of energy demand in the future. Based on Statistics Indonesia projection, the urbanization rate will reach 67% in 2035 from 49.8% in 2010.

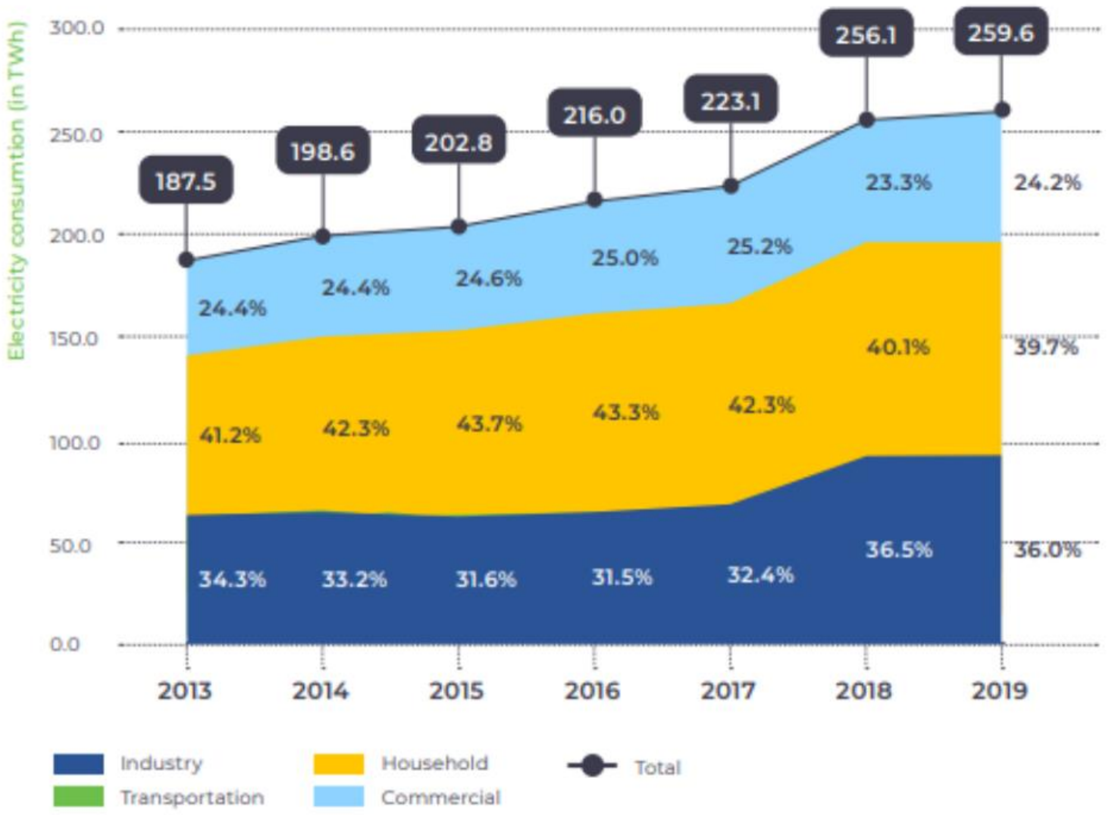


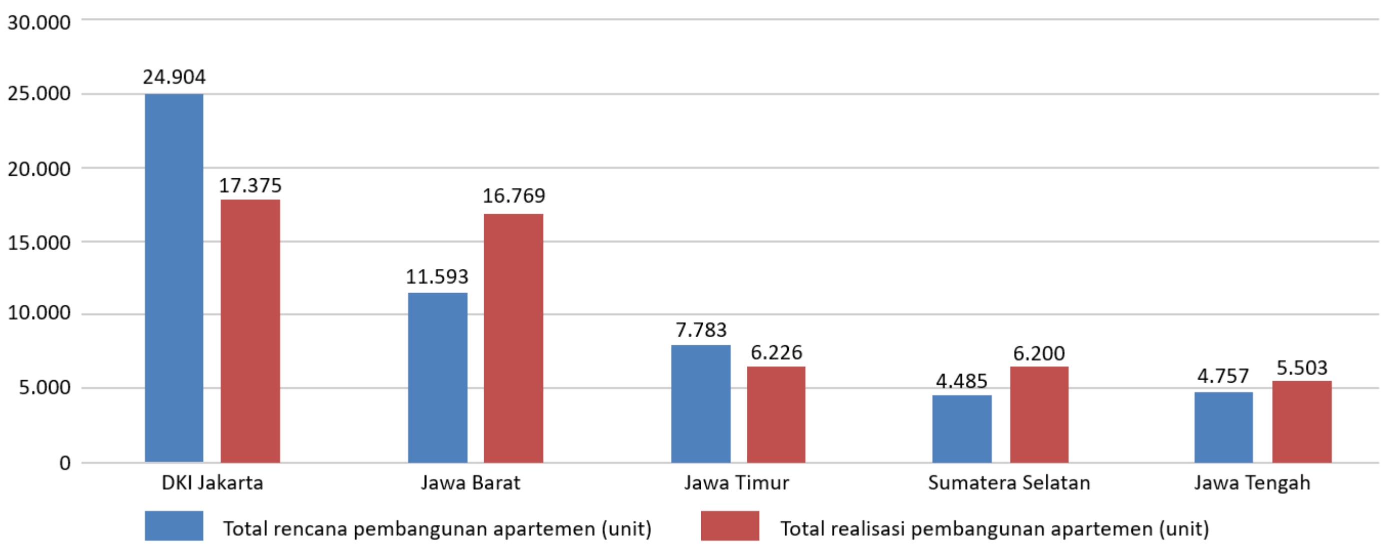
# BACKGROUND

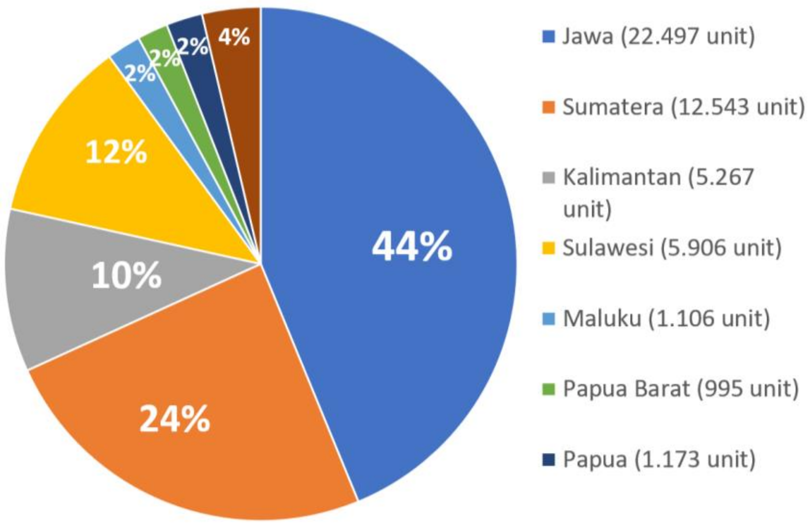
- The total final energy consumption in Indonesia in 2018 was around 114 MTOE derived from 40% transportation, 36% industry, 16% household, 6% commercial sector and 2% other sectors17.
- For electricity consumption, the shares can be seen in fig. 5, where households make up 39,4% and commercial buildings 24,2%.



# Ranking of provinces in the planning and execution of providing apartment units by Perum Perumnas from 2008 to 2018. Source: Central Statistics Agency (2016, 2017, 2018, 2019)



# ROADMAP FOR AN ENERGY EFFICIENT, LOWCARBON BUILDINGS AND CONSTRUCTION SECTOR IN INDONESIA 2022

| | BASELINE (NOW) | SHORT TERM (2025) | MEDIUM TERM (2030) | LONG TERM (2050) |
| --- | --- | --- | --- | --- |
| Urban planning and development | Only little focus on urban planning (urban sprawl) | Plannings for new urban areas is based on sustainability criterias | Requirement for green areas and the walkable city. Plannings for existing urban areas, upgrading areas | All new and existing urban areas are net zero energy |
| New buildings | National building code agreed but not yet implemented | Building code is implemented and updated every 5 year. Green Building Performance Rating is commonly used. | Mandatory building codes for all types of buildings | All new buildings are made according to the codes and are NZEB |
| Building retrofit | Only little focus on energy efficiency in retrofitting | Develop financing methods for retrofitting. Establish knowledge center on retrofitting of buildings | Building codes also mandatory for renovation of buildings. Introduction of labelling of new and existing buildings | Introduce NZEB also for existing building in operation |
| Building operation | Energy management is a requirement in larger buildings | Train building managers in energy management | Require BEMS in public and commercial buildings | All larger buildings have BEMS, appointed and trained energy managers or energy service contract |
| Systems | MEP standards for HVAC exist | Further development of minimum performance standards for appliances | Phase out of old in-efficient appliances | All new and old appliances are high-efficient appliances |
| Materials | No focus on $CO_2$ emission from materials or construction | Registration of the use of building material, develop database with building data | Introduce requirement documentation of emissions from building material | Set requirement for LCA, calculation of emissions and targets for total emissions |
| Resilience | There is a focus on natural disaster in planning | Focus on resilience against power cuts, smoke from wild fires, break down of air conditioning | Requirement for thermal load in buildings in order to store energy if there are powercuts | All new buildings are build taking resilience into account |
| Renewable energy | No requirement to use RE | Encourage the use of rooftop PV | Introduce requirement for rooftop PV | Set minimum requiremetns for the use of RE/NZEB |

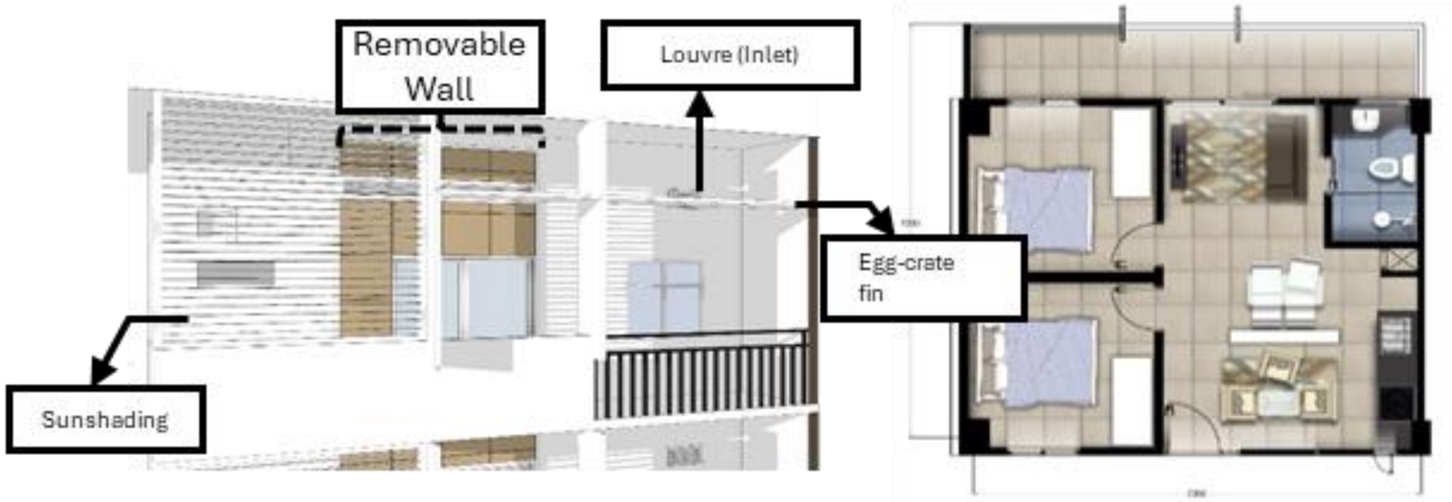
# PROPOSAL OF LOW ENERGY APARTMENT (PROTOTYPE)

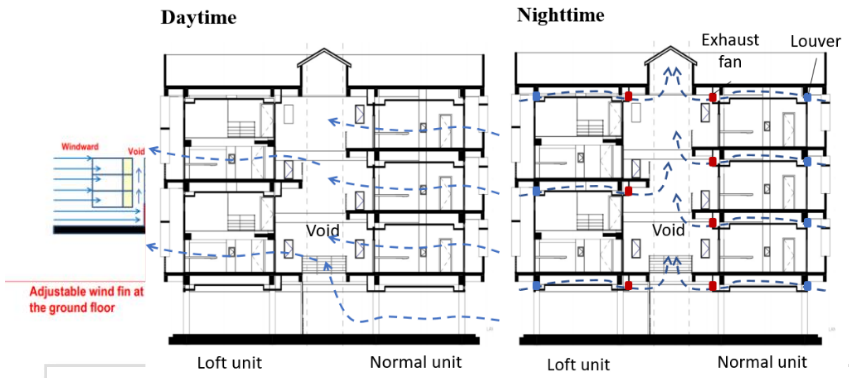
UTILIZE PASSIVE DESIGN STRATEGY

LOW EMBODIED ENERGY (EE) MATERIAL

NEW RENEWABLE ENERGY (NRE) DESIGN STRATEGY

BIM UTILIZATION IN ENERGY EFFICIENCY AND CONSERVATION




# PROTOTYPE LOW ENERGY APARTMENT- 1. PASSIVE DESIGN STRATEGY

- The passive design components that have been previously described will be taken into consideration in evaluating building performance, namely case studies through various applications. Therefore, a low energy apartment building prototype was developed, which in the design process considers passive design with a bioclimatic design approach. Key design considerations of the prototype apartment include:

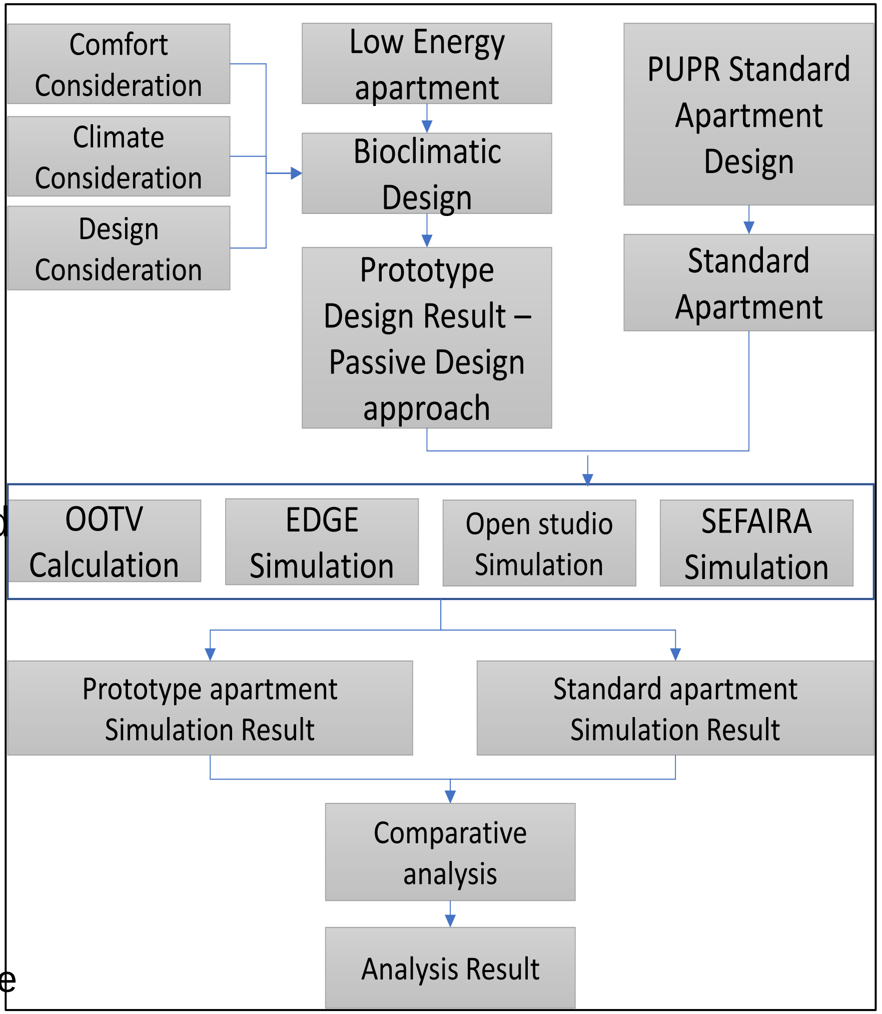
1. Consideration of solar path and wind direction based on climate data from 2007 to 2019, in determining the orientation of the building, with the optimum direction obtained is 22.50 North-East.
2. Simulating the building mass that is related to wind movement so that it can determine the shape and position of the void as well as the size required for the building void.
3. Typology study, based on analysis of 200 built apartments, in determining the shape of building mass, the position of the cores, the position of the bathrooms, number of rooms in the unit, the unit size, and others.
4. Study of passive design components, consisting of the design of openings (such as the position of doors and windows), design of shading devices, insulation, WWR, and others.

# COMPARISON OF THE PROTOTYPE WITH CURRENT APARTMENT DESIGN


**Figure** (a) Prototype Apartment; (b) PUPR Standard Apartment


The analysis is using a comparative method of simulation results that the simulations were carried out through 4 methods:

1. Building energy calculation through EDGE Building. This app calculates the utility savings and reduce carbon footprint against a base case
2. Cooling energy calculation with Open Studio.
3. Building OTTV Calculation. Based on regulation, that allowable accumulated value is a maximum of 35 Watt/m2
4. Simulation of building natural light with SEFAIRA
5. Field observation, such as measuring the temperature of dry air



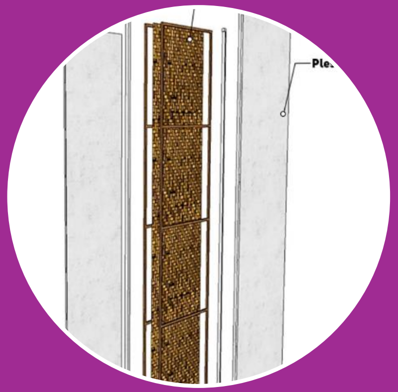
# RESULT

- The simulation results with several applications show that the prototype building can achieve a low-energy building performance compare with standard apartment and the performance higher that national standard regulation.
- The results of dry temperature measurement in the field have also shown significant results, that is in indoor temperature lower 7 to 9 $^{0}$C (average 7,65 $^{0}$C) than the outdoor temperature of prototype building. This result exceeded the target set, which is 3$^{0}$C.
- With this performance, it is hoped that this prototype can be developed as a standard for energy-efficient apartments in Indonesia in the future.

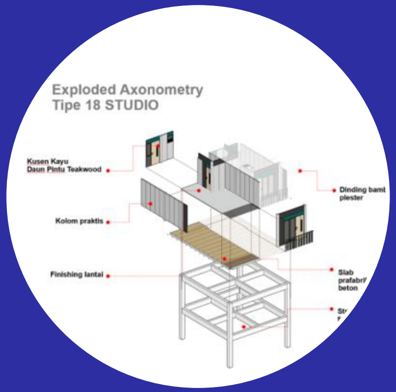
| Simulation method | Average value Prototype apartment | Average value Standard apartment | Note |
|---|---|---|---|
| OTTV Calculation result | 11.8 kwh/m2/year | 18.1 kwh/m2/year | ministerial regulations of PUPR max value 35 kwh/m2/year |
| Energy use building (EDGE Building) | 70 kwh/m2/year | 97.74 kwh/m2/year | UK Green building lower than 75 kwh/m2/year |
| Energy efficiency caused by passive design (EDGE) | 11% | 4.85% | - |
| Cooling Load (Open Studio) | 51.52 MBTu per year | 161.6 MBTu per year | - |
| Energy Use Intensity (Open Studio) | 81,4 kwh/m2/tahun | 98,8 kwh/ m2/ year | - |
| Cooling energy (Open studio) | 66,1 kwh/m2/year | 83 kwh/ m2/ year | - |

# 2. Low EE (Embodied Energy) of Material

- Unfinished Material
- Reuse/ Recycle material
- Low EE Façade Material
- Modular Prefabricated Material
- Biomass Material (Bambu, Kayu Rekayasa, Jamur, Serat Kelapa, dll)

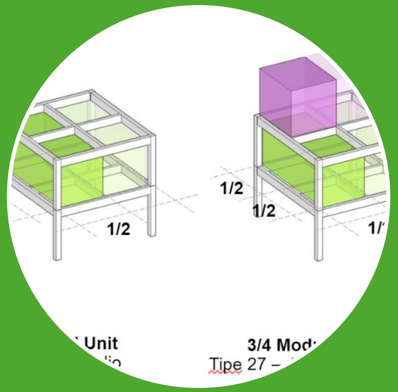


Sandwich system with insulation, low cooling energy load, cool wall system




Light material, earthquake resistant

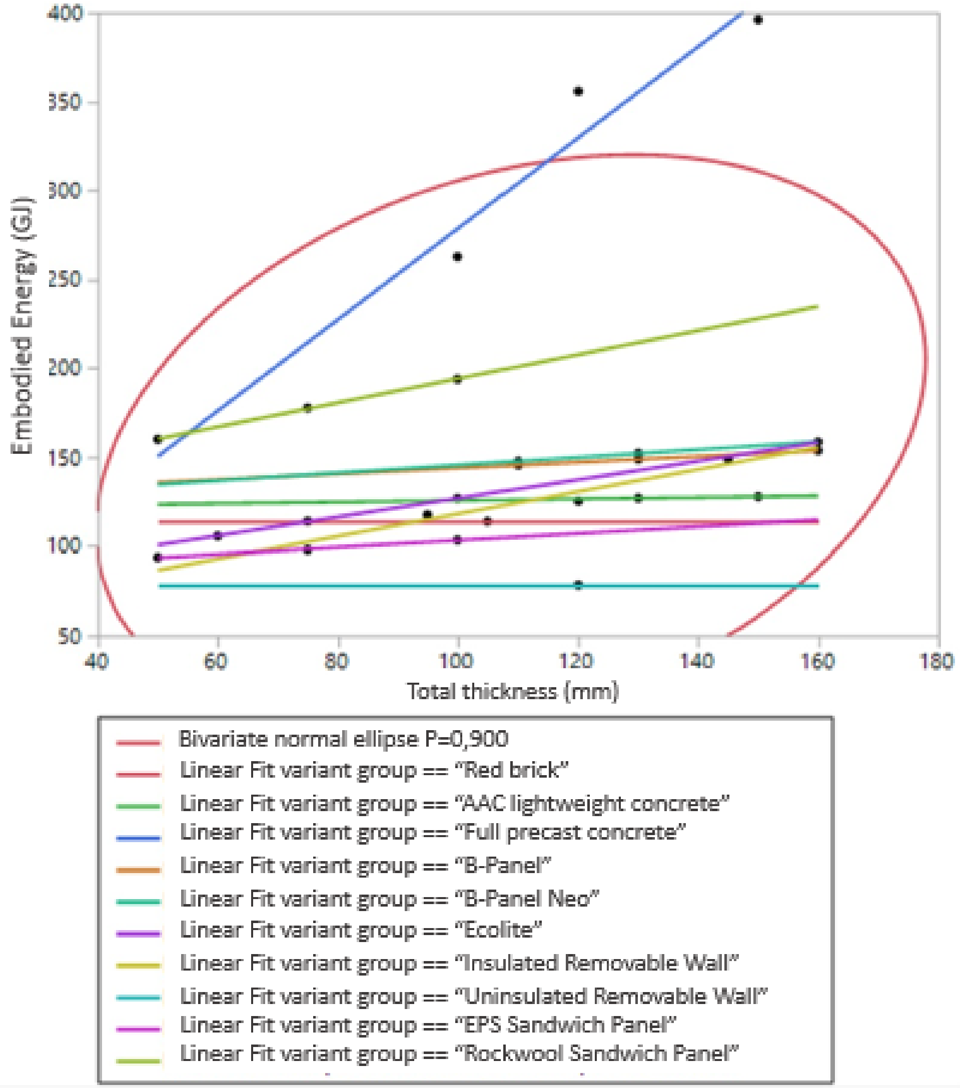
Biomass materials-carbon capture, affordable materials, waste-based materials

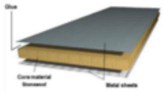
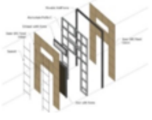
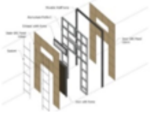
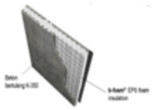
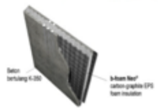


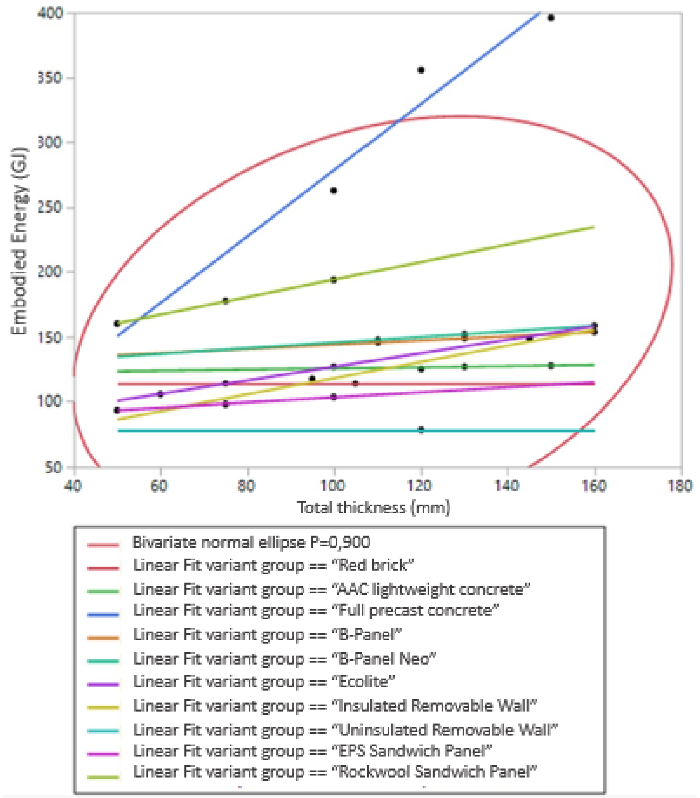
incremental construction, Modular, design for disassembly, fast prefabrication and zero waste

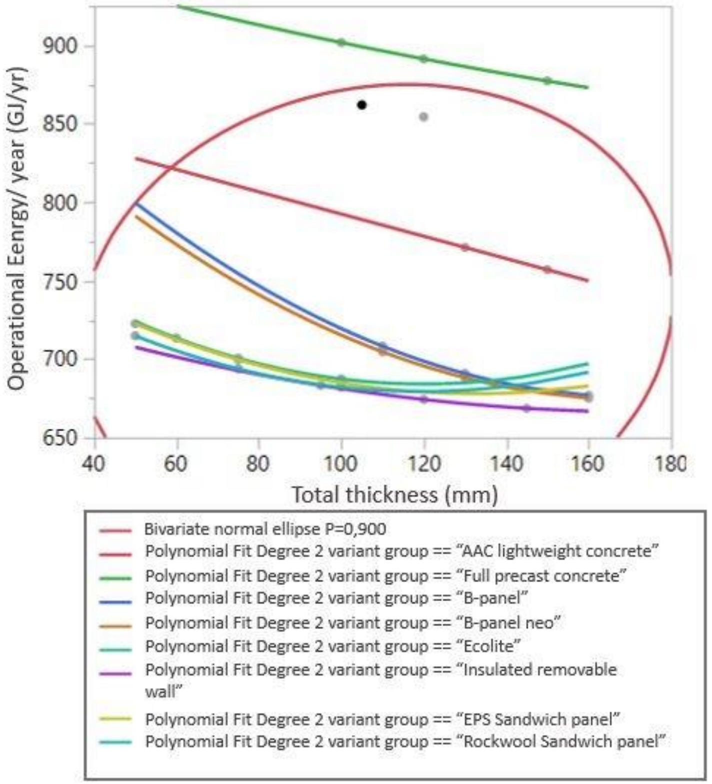
**Integrated Public Housing Design System**

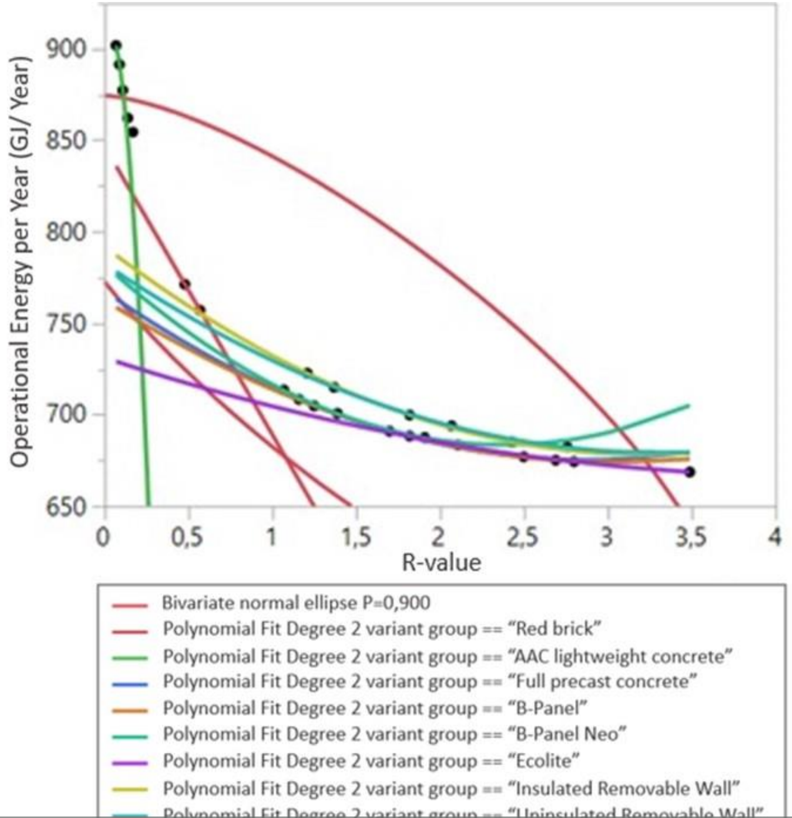
# Utilization of removable sandwich panel




| No | Types of Facades | Material Specification | Insulation Types | Construction Method | Image of Material |
|---|---|---|---|---|---|
| 1 | Eco-lite concrete panel, thickness:<br>• 60 mm<br>• 75 mm<br>• 100 mm | Prefabricated cement fiber board hollow wall panel | Expanded polystyrene (EPS) and cement | Precast |  |
| 2 | Solid precast concrete, thickness:<br>• 100 mm<br>• 120 mm<br>• 150 mm | Prefabricated reinforced concrete with concrete strength of fc 31.2 MPa | Non-insulated | Precast |  |
| 3 | EPS Sandwich panel, thickness:<br>• EPS 50 mm<br>• EPS 75 mm<br>• EPS 100 mm | Galvalume sheet and Expanded polystyrene (EPS) | Expanded polystyrene (EPS) | Precast |  |
| 4 | Rockwool sandwich panel, thickness:<br>• 50 mm<br>• 75 mm<br>• 100 mm | Galvalume sheet and synthetic material | Rockwool | Precast |  |
| 5 | Insulated removeable wall, thickness:<br>• 95 mm<br>• 120 mm<br>• 145 mm | Glass-fiber-reinforced concrete sheet with hollow frame | Rockwool | Precast |  |
| 6 | Uninsulated removeable wall, thickness:<br>• 95 mm<br>• 120 mm<br>• 145 mm | Glass- fiber-reinforced concrete sheet with hollow frame | Non-insulated | Precast |  |
| 7 | Standard concrete panel, thickness:<br>• 100 mm<br>• 120 mm<br>• 150 mm | Prefabricated reinforced concrete + Styrofoam | Expanded polystyrene (EPS) | Precast |  |
| 8 | Neo concrete panel, thickness:<br>• 100 mm<br>• 120 mm<br>• 150 mm | Prefabricated reinforced concrete + Styrofoam | Expanded polystyrene (EPS) with carbon graphite mixture | Precast |  |
| 9 | Lightweight brick, thickness:<br>• 100 mm<br>• 120 mm | Lightweight brick | Non-insulated | Cast in place |  |
| 10 | Red brick 75 mm | Red brick | Non-insulated | Cast in place |  |



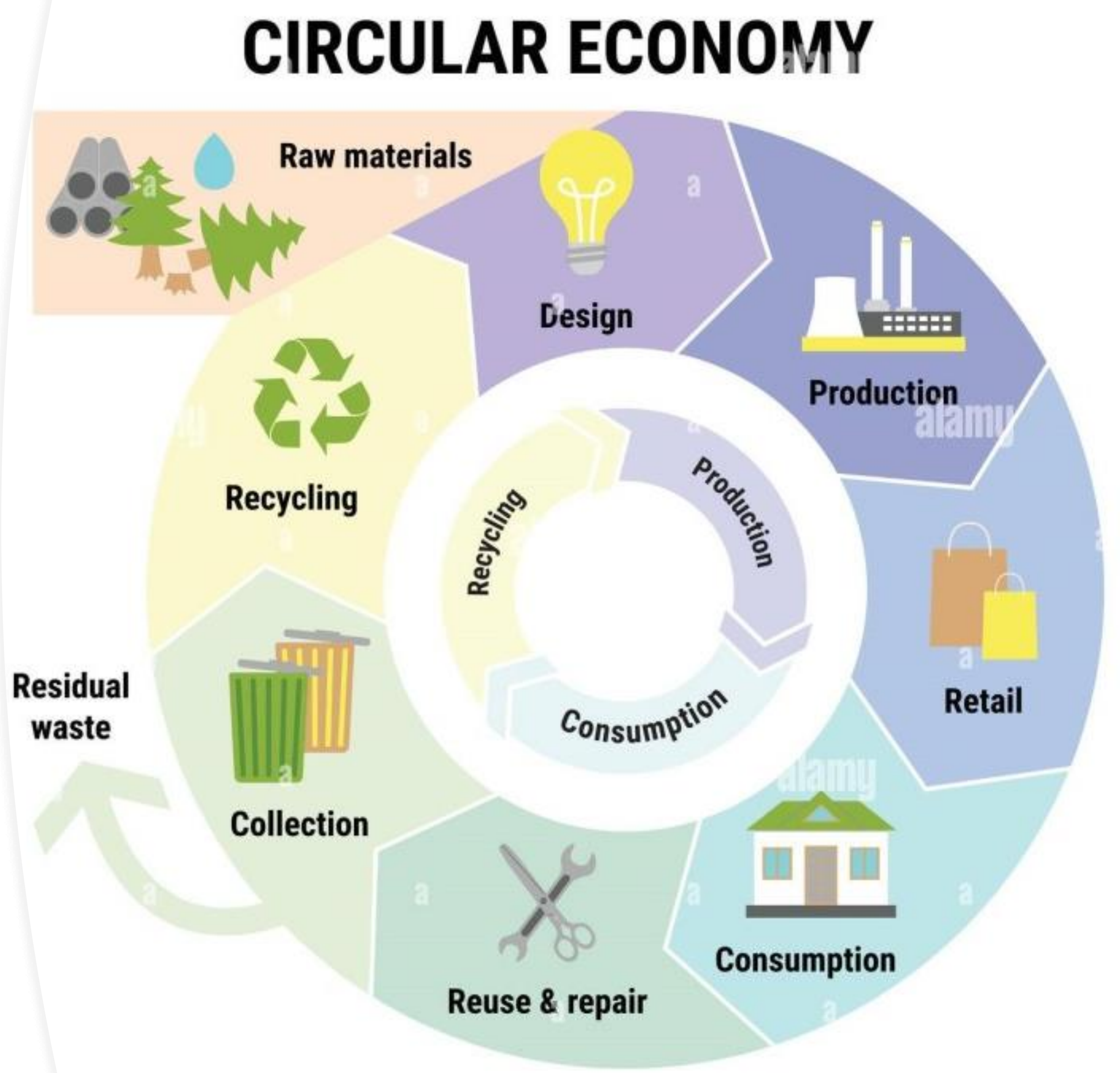




| No | Material Properties | Relation between Embodied Energy and Material | Relation between Operational Energy and Material |
|---|---|---|---|
| 1 | Thickness | Directly proportional/ Linear | Inversely proportional (exponential) |
| 2 | Energy Intensity | Directly proportional (tends to be sloping, not significant) | - |
| 3 | Thermal resistance (r-value) | - | Inversely proportional (exponential but tends to be sloping) |

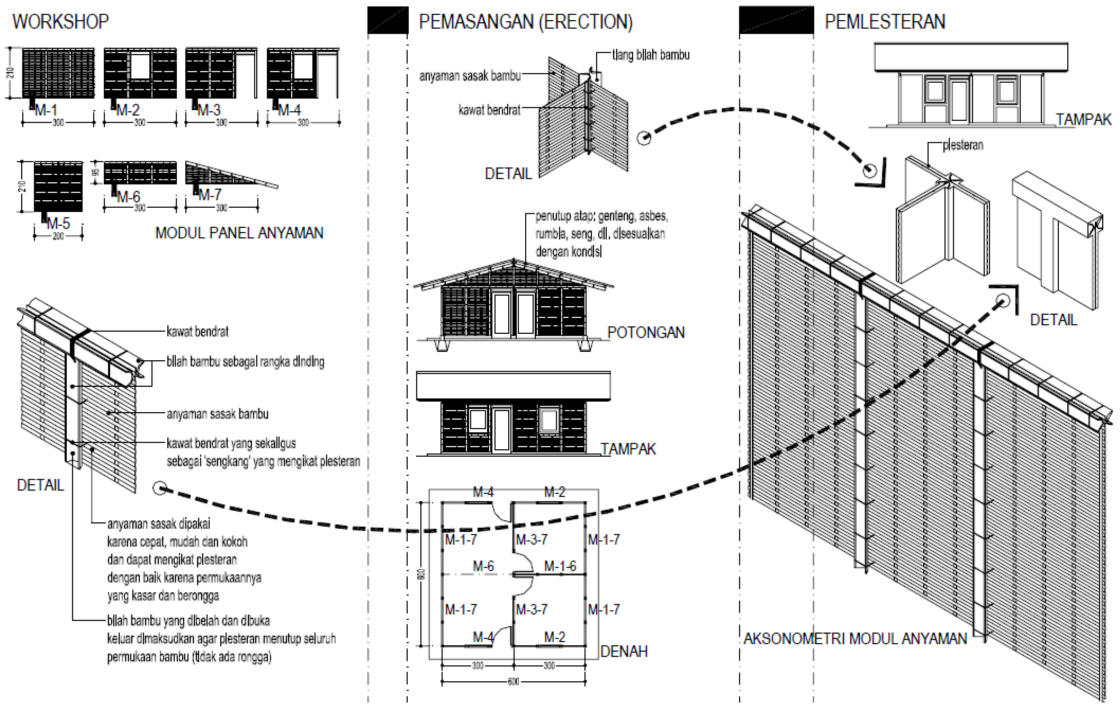
# CIRCULAR ECONOMY

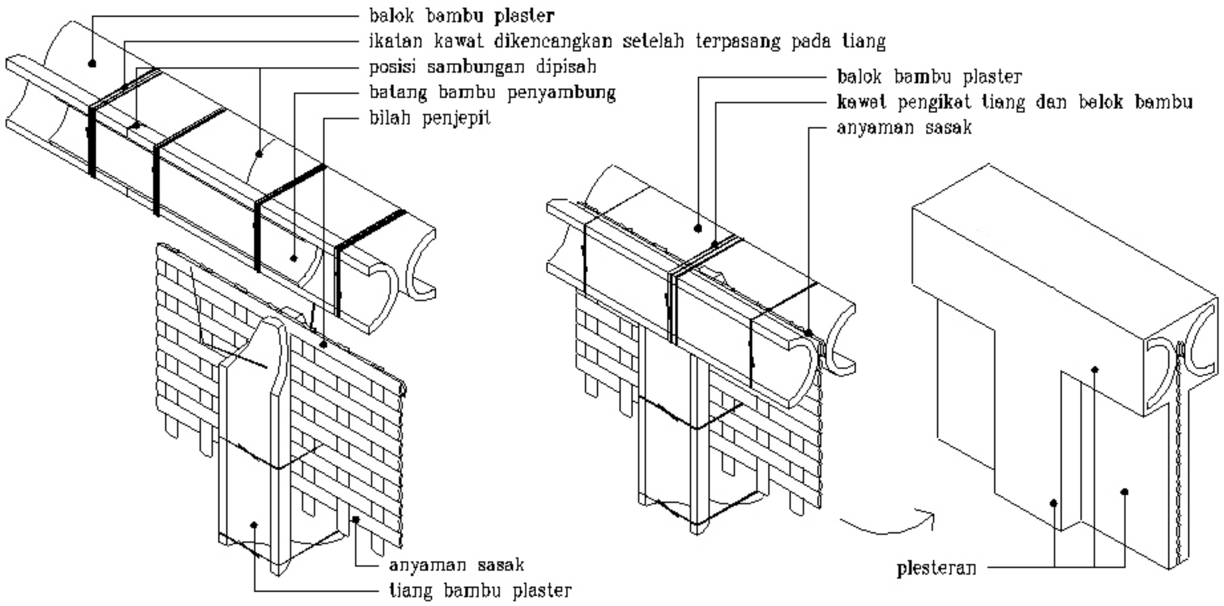
- MODULAR
- PREFABRICATED
- DESIGN FOR DISASEMBLY




LIVING IN VERTICAL CIRCULARITY
ANGELINE SUSANTO
IMPLEMENTING C
WATER CYCLE
FILTRATION
FOOD CYCLE
CONSUMPTION
PROCESSING
MATERIAL CYCLE
REUSE
RECYCLE
RETENTION POND
AQUAPONIC POND
PRODUCE MARKET
PRODUCE CAFE
CIRCULAR FLOW
ENSURING CIRCULARITY WITHIN THE DESIGN
STIMULATING ECONOMIC GROWTH WITH DIVERSITY
IDENTIFICATION OF CIRCULAR DESIGN STRATEGIES
WATER
WATER RECYCLING
OPTIMIZATION OF WATER CONSUMPTION
FOOD
FOOD PRODUCTION
DESIGN FOR DISSASSEMBLY
DESIGN IN LAYERS
SIMPLE AND EFFICIENT STRUCTURAL SYSTEM
REVERSIBLE CONNECTIONS
UNIT + STRUCTURE MODULE
BUILDING COMPONENTS
STRUCTURE (30-100 years)
SKIN (20 years)
SPACE PLAN (3-30 years)
HOLLOW CORE SLAB
STRUCTURAL COMPONENTS
UNIT COMPONENTS

# Prafabrikasi-
# Riset Sebelumnya

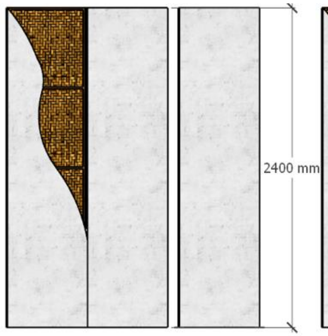


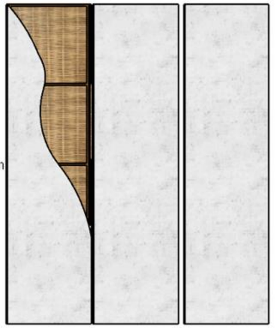

3. Penganyaman panel bambu
4. Pemasangan balok penjepit pada panel
2. Bambu dibelah menjadi bilah-bilah bambu
5. Pemasangan frame jendela/pintu
1. Pemilihan batang bambu
7. Pemlesteran
6. Panel anyaman bambu siap dipasang

# Sandwich Panel+ Joinary
# Modular System

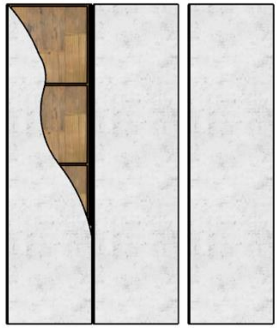
Modul Vertikal + Horisontal
Modul Material
Modul unit
Modul kubikal
Modul massa



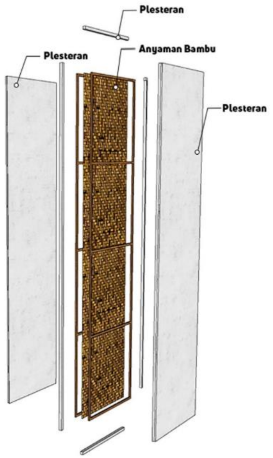

Anyaman 1
(Anyaman Ganda)

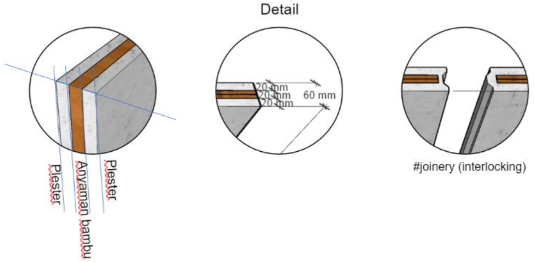


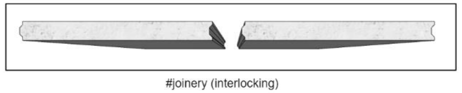
Anyaman 2
(Anyaman Sasak)

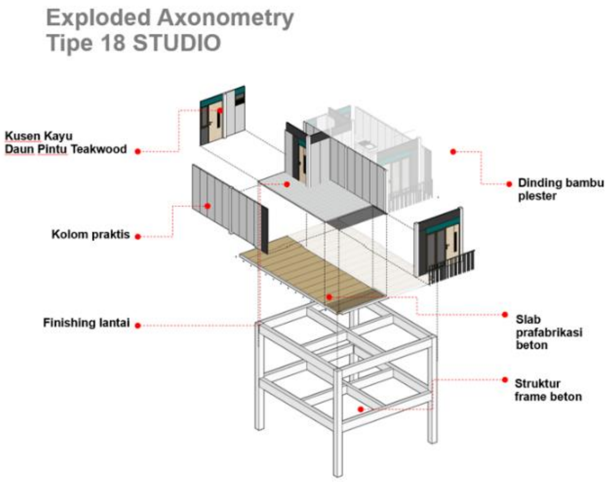


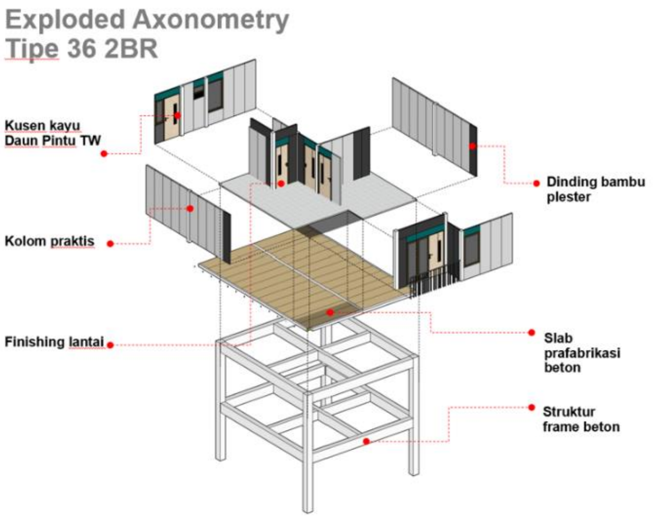
Anyaman 3
(Anyaman "pelupuh bambu")

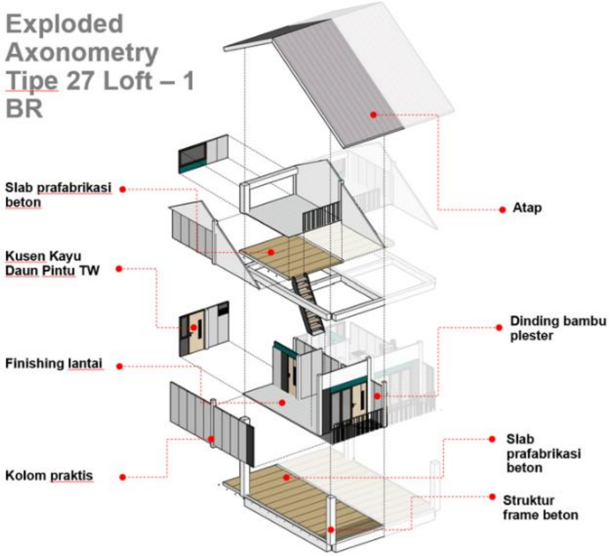


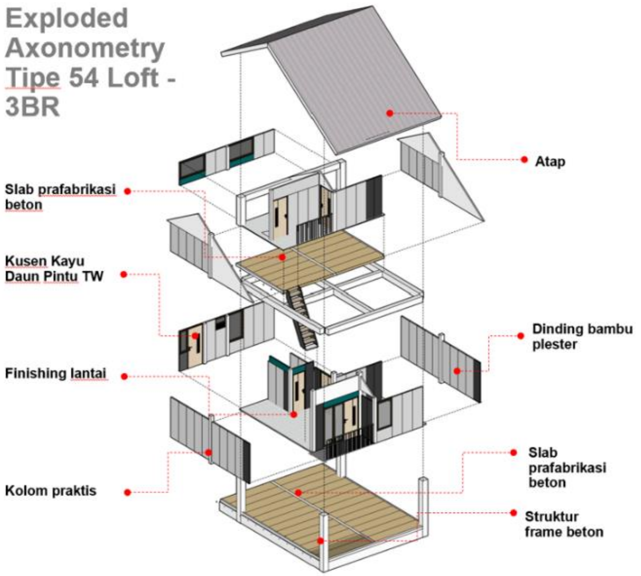



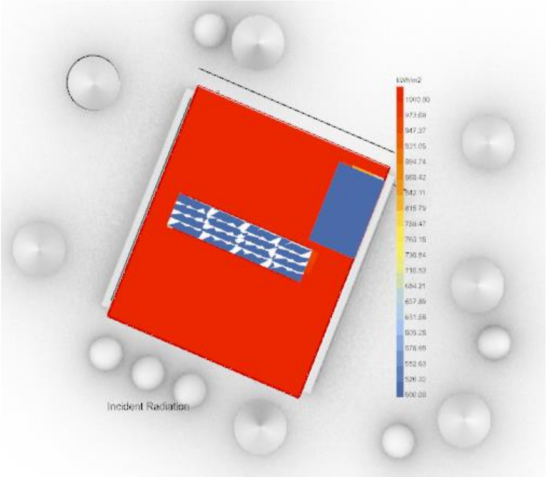



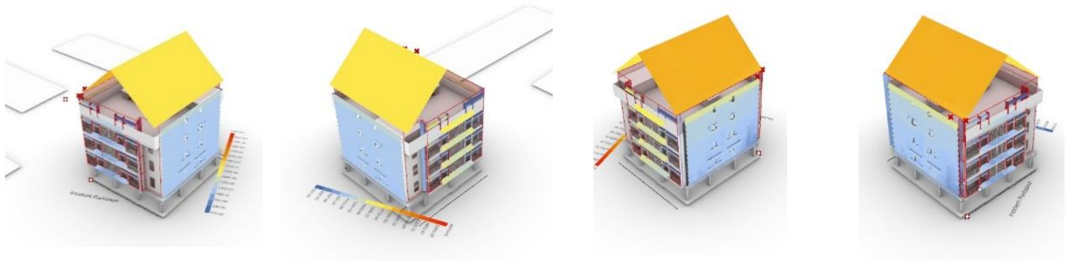



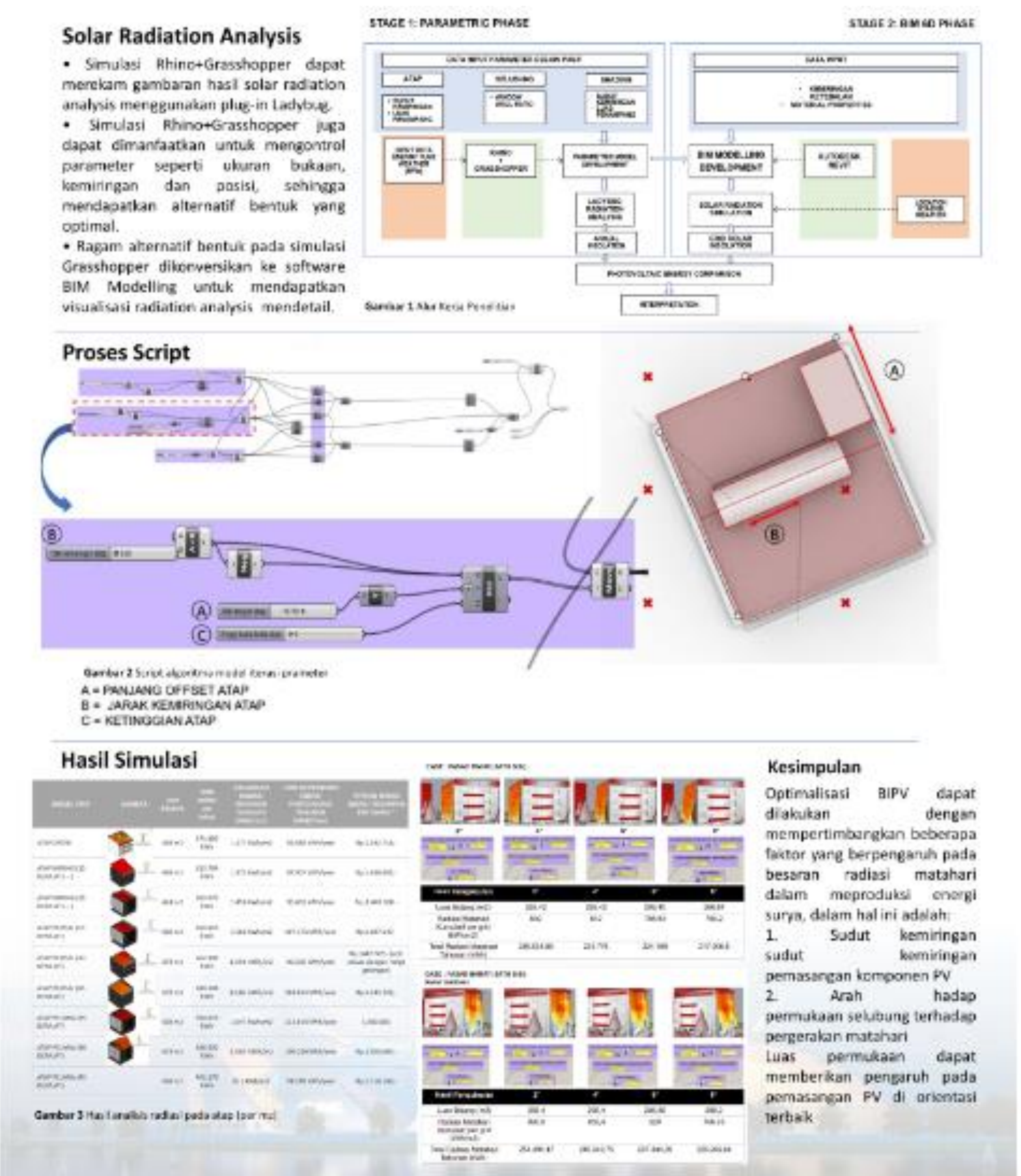
# 3. NEW RENEWABLE ENERGY (NRE) DESIGN STRATEGY



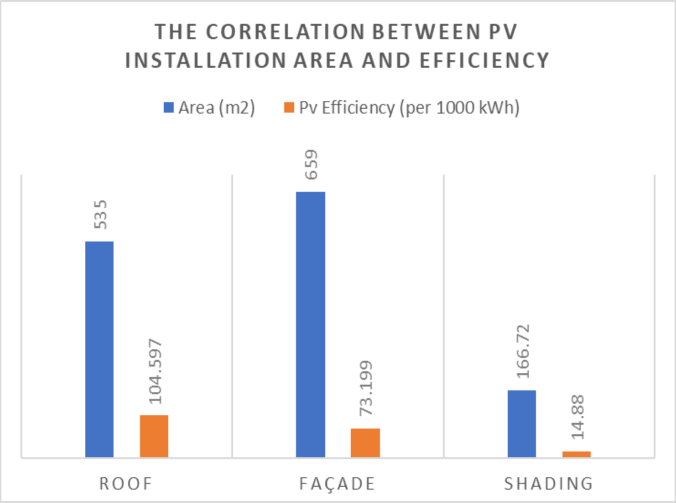

Solar Irradiance Map in Roof Surface

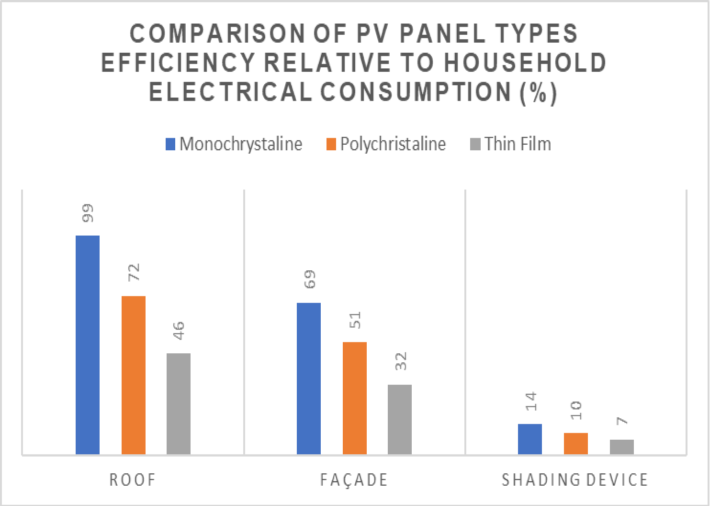


Final Optimization Model in *Low Rise Type*



# Result



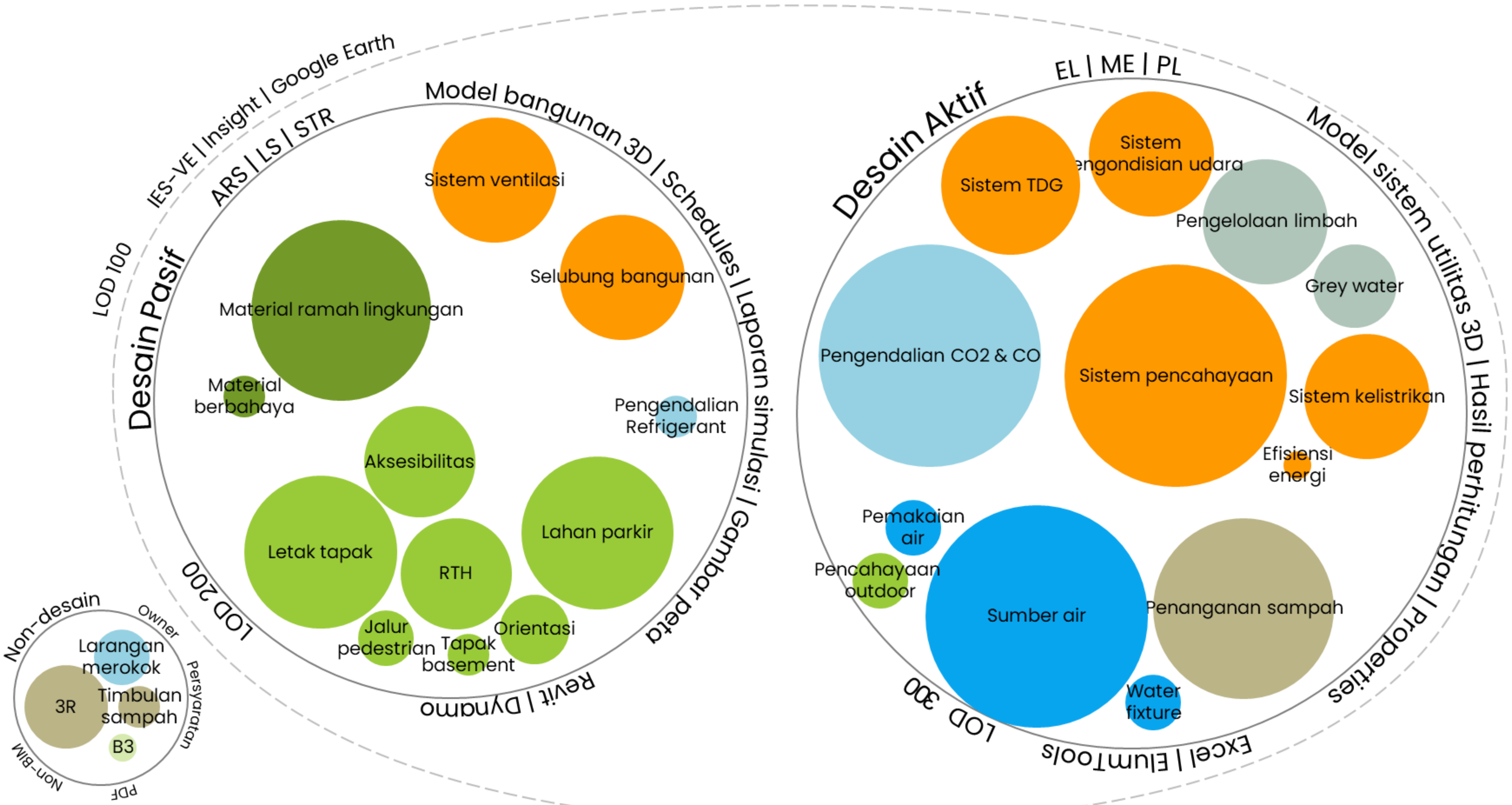

- Roof elements remain the primary choice due to their high efficiency, capable of meeting up to 99% of a building's total electrical energy needs. The facade also provides a significant contribution, covering up to 69% of electrical energy needs. However, elements with shading device concepts only accommodate around 14% of the total electrical energy needs in a 4-story building. Among PV types, Monocrystalline PV exhibits the highest effectiveness ratio, consistent with its superior practical performance. Therefore, integrating Monocrystalline PV on the roof and facade is recommended as the main alternative for 4-story buildings.

| Building Element | PV Surface Area ($m^2$) | Solar Irradiance ($kWh/m^2$) | PV Efficiency (kWh) | Electric Energy Consumption (kWh) | PV Efficiency Generate | |
|---|---|---|---|---|---|---|
| | | | | | **Mono chrystaline** | **Poly chrystaline** |
| **Low Rise (4 Floor)** | | | | | | |
| Roof | 535 $m^2$ | 1737 | 104.597 | 105.937,60 | **99%** | **72%** |
| Façade | 659,2 | 996,09 | 73.199,2 | 105.937,60 | **69%** | **51%** |
| Shading Device | 166,72 | 770,44 | 14.880 | 105.937,60 | **14%** | **10%** |

# 4. BIM UTILIZATION IN ENERGY EFFICIENCY AND CONSERVATION

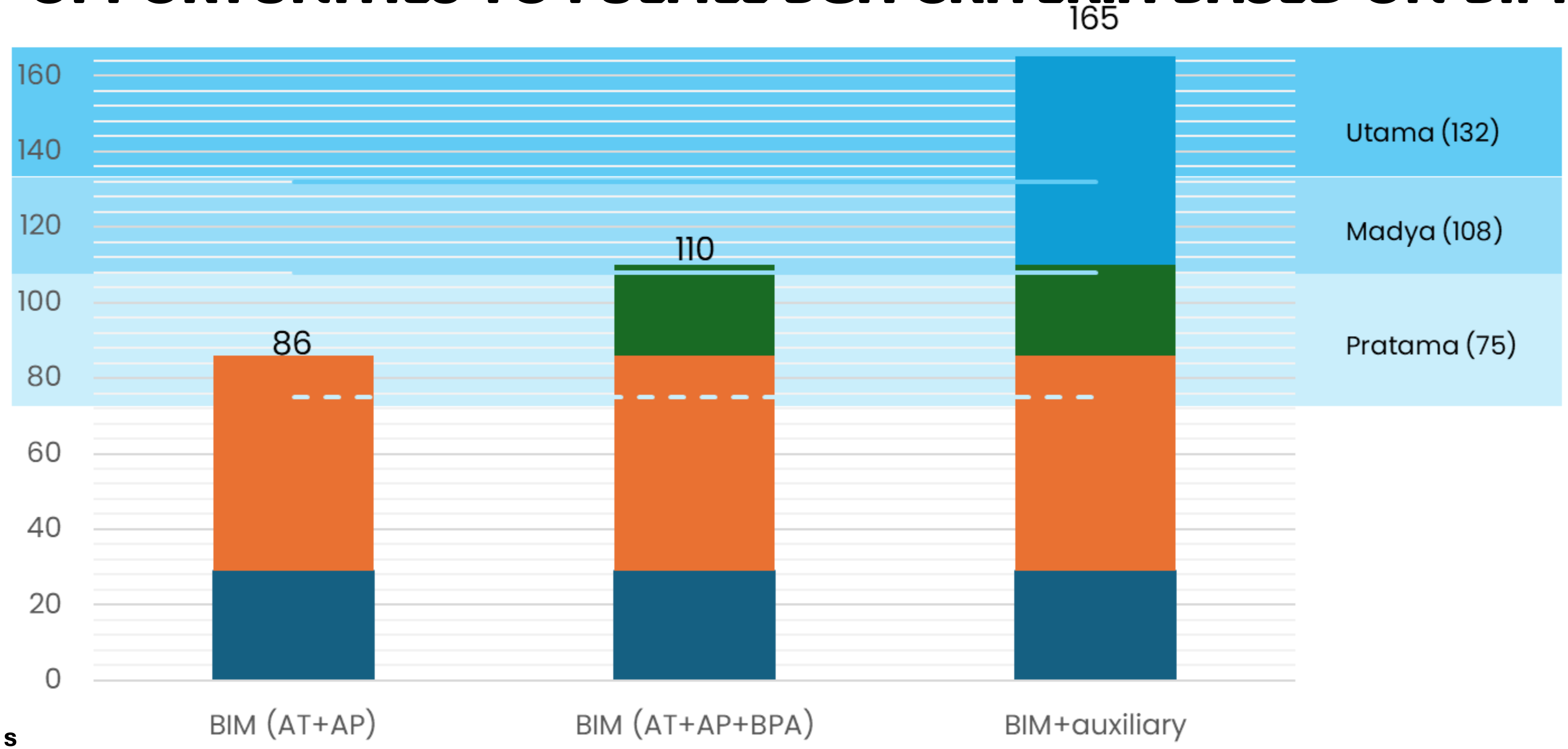
- GREEN BIM
- MODEL BIM PERENCANAAN APARTEMEN RENDAH ENERGI DAN EMISI KARBON
- IPDS (INTEGRATED PROJECT DELIVERY SYSTEM) BIM BASED

# BGH RATING SYSTEM MAP BASED ON DESIGN APPROACH




The size of the bubble indicates the number of documents required to fulfill the criteria.

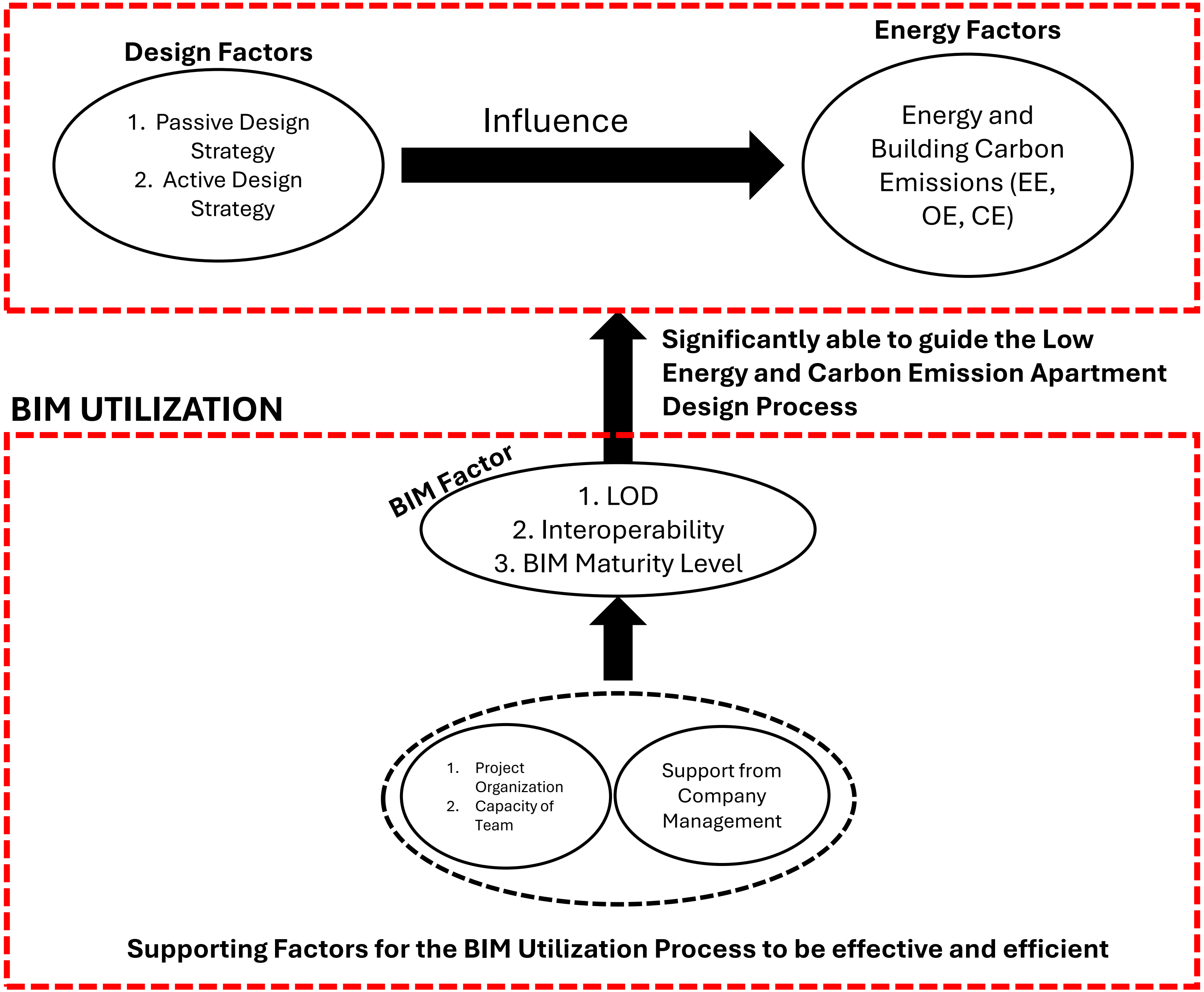
# OPPORTUNITIES TO FULFILL BGH CRITERIA BASED ON BIM



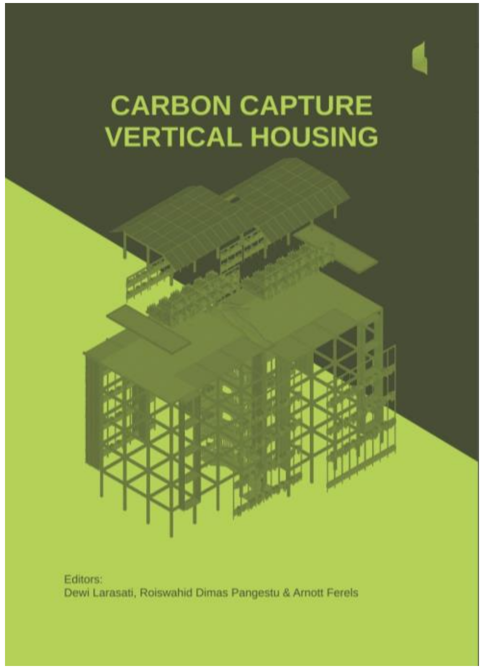

**Findings**

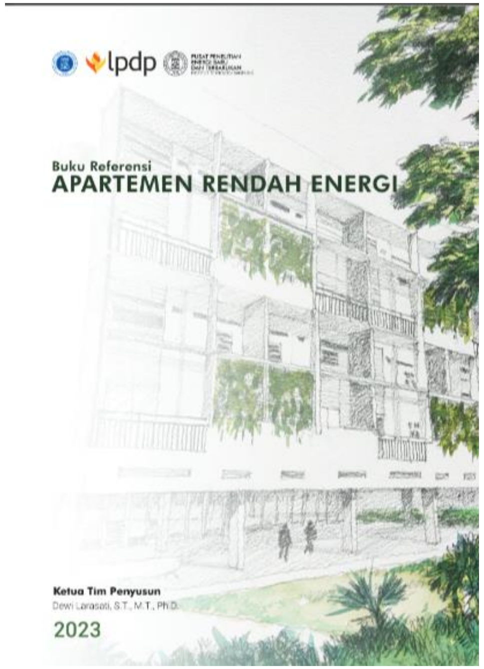
1. The use of BIM as a producer of evidentiary documents presents the opportunity to achieve an intermediate certification rating.
2. Utilizing the BIM authoring tool (AT) Revit, in conjunction with algorithmic programming (AP) Dynamo, can achieve a primary score of 86.
3. Incorporating BIM PA (performance analysis) can increase the score to 110, reaching an intermediate level.
4. Leveraging BIM as a document compiler allows for the attainment of a maximum score of 165 by inputting evidentiary documents produced by auxiliary tools in PDF/image format into Sheets.

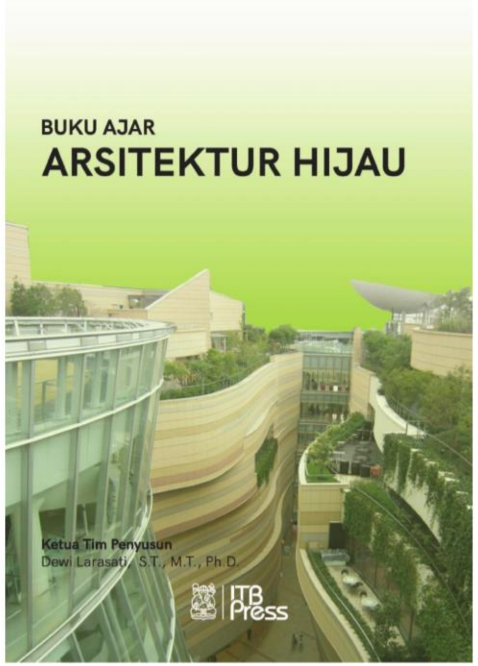
# UTILIZATION OF BIM IN LOW ENERGY AND CARBON EMISSION VERTICAL HOUSING DESIGN

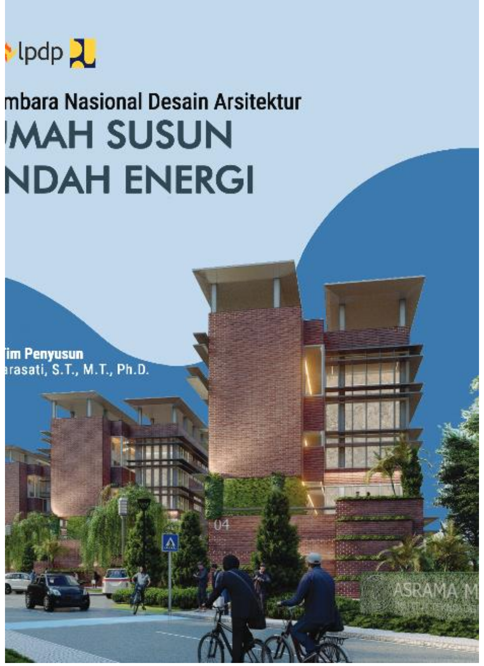


# BOOK PUBLISHED



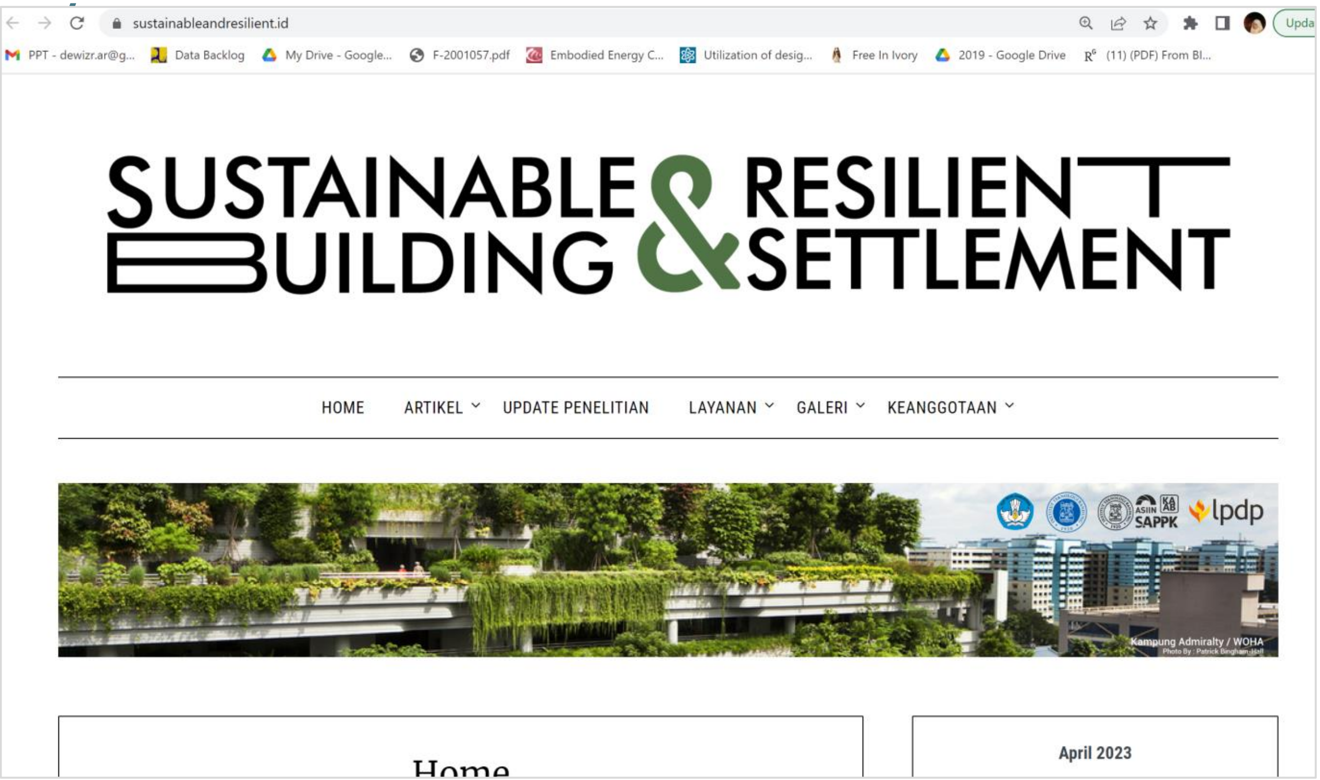



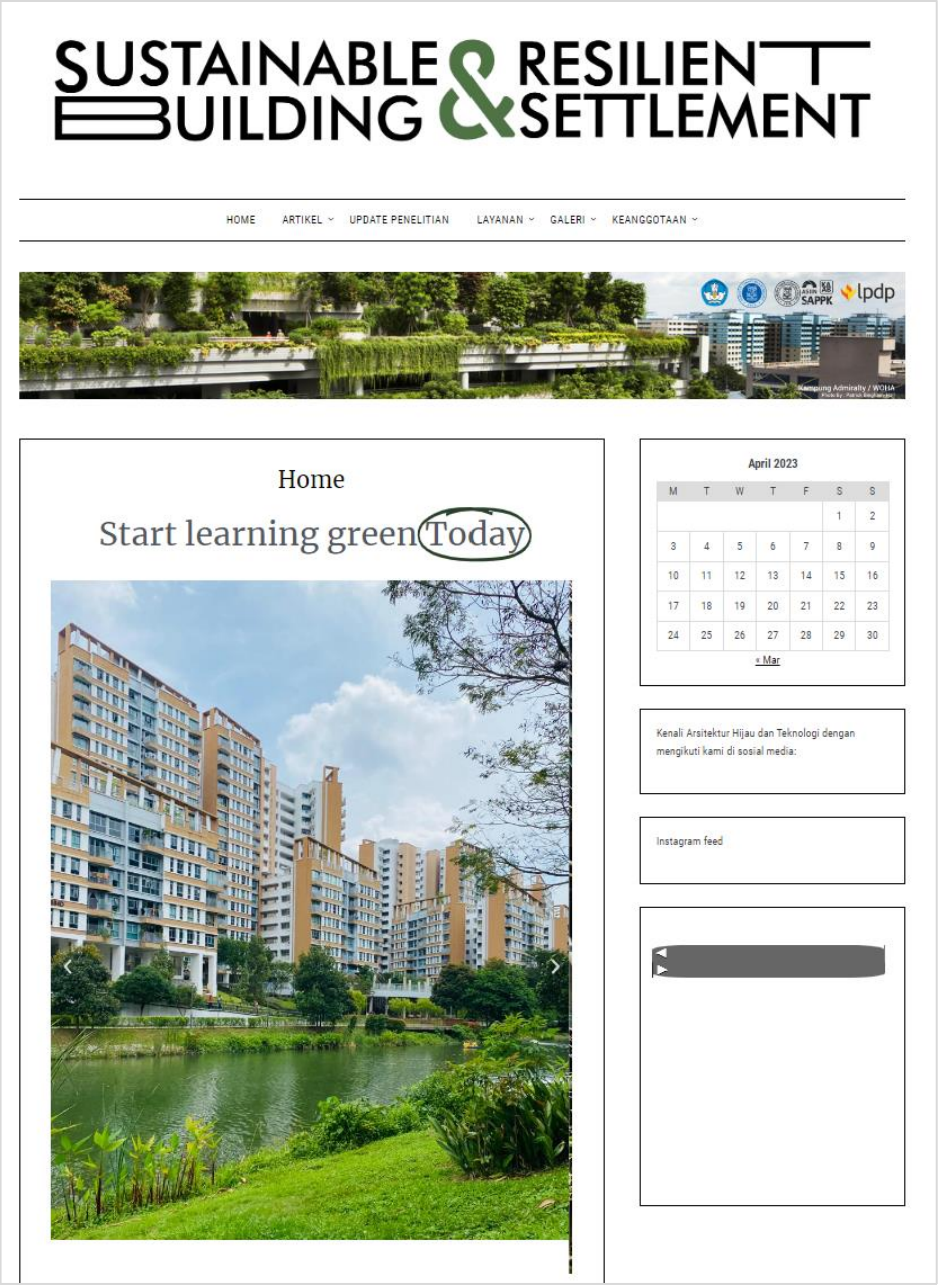




# WEBSITE CENTER OF EXCELLENT

- https://sustainableandresilient.id




thank you
danke
謝謝
gracias
merci
obrigado
dziękuję
bedankt
teşekkür ederim
ngiyabonga
спасибо
go raibh maith agat
mochchakkeram
sukriya
kop khun krap
terima kasih
grazie
arigatō
dakujem
takk
tapadh leat
감사합니다
ありがとう
мерси
dank je
hvala
mauruuru
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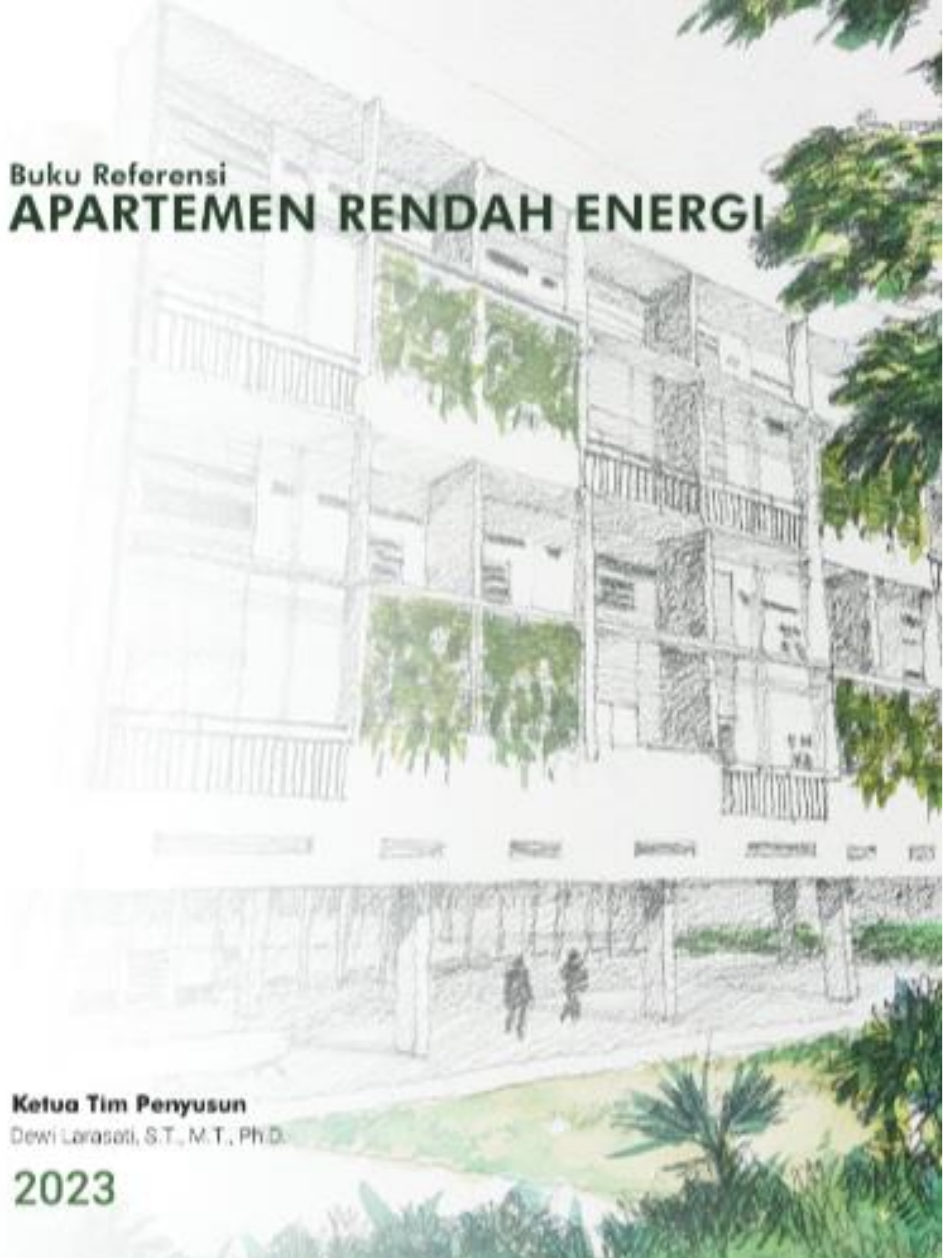
taiku
ευχαριστώ
рахмат
Баярлалаа


Buku Referensi
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2023