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Policy Development For Green Building Concept Implementation Towards Low Carbon City

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APEC Energy Working Group

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EXECUTIVE SUMMARY

Low-Carbon Model Town (LCMT) Project was initiated by the APEC Energy Working Group based on the 9th meeting of the APEC Energy Minister in Fukui, Japan, 2010. It informs the understanding of the Low-Carbon City as the sustainable approach that focused on carbon footprint of cities, which means to minimize the utilization of energy sourced from fossil fuels. The APEC LCMT project done with the synergy of the Ministry of Energy and Resource in Indonesia, Domestic and International Consultant, Academics, NGOs, Public-Private Enterprise, and Community.

The APEC (Asia-Pacific Economic Cooperation) Policy Development for Green Building Concept Implementation Towards Low Carbon City is part of a continuing program from the previous LCMT (Low-Carbon Model Town) Feasibility Study Project in 2017-2019. By continuing the previous Feasibility Study Project, the LCMT concept will be implemented through the green building and management platform in 2021-2022 program. This report explains the following activities and objectives then further expected through policy development and physical development realization.

Banda Aceh selected as the representative city to be a model town for Low-Carbon City in 2017 and announced as the APEC LCMT 1st Phase of Dissemination Project within 2017-2019. Banda Aceh is the capital of Aceh Province, which located in Sumatera Island; the westernmost part of Indonesia. The city got international prominence through the natural disaster of tsunami after the huge earthquake in 2004. With the total area of 61,37 km^2 and the population of 252.889 people counted in 2020 domestic census, Banda Aceh selected as the case study of this project. The First Dissemination concluded the two key aspects to realize the low-carbon city: The Public Transportation Management, and The Green Building Management.

This report informs key objectives of the study area in Banda Aceh to define the suitable roadmap on green building applied methodology through three aspects; (1) The Current and Emerging Policies of Green Building, (2) Green Building Awareness, and (3) Green Building Management. Each aspect will develop a baseline and gives roadmap or recommendation of the future Green Building Policy Development in Banda Aceh. The key activities of each aspect are held through important sessions. The 1st aspect held by Workshop activity, conducted as an initial meeting and main workshop. The 2nd aspect was highlighted as Gathering through Online Questionnaire after Initial Meeting and During Survey activities, then continued by Distribution Analysis. Thirdly, the aspect was the combination between Data Gathering and Analysis, activities Modelling and Simulation, then Retrofitting.

The analysis of the 1st aspect of Green Building Policies held through two events, which are Virtual Seminar and Discussion in 2021, and the Main Workshop in 2022. The Virtual Seminar and Discussion is an introductory meeting that promoted the city-scale topic of 'Policy Development and Implementation on Green Building Concept and Low Carbon City in Banda Aceh'. The Virtual Seminar targeted the audience of Banda Aceh City Government and Banda Aceh Societies, to bring the deeper knowledge as well to generate the most suitable recommendation or roadmap of green building management, regulation, and

implementation in Banda Aceh. This Online Seminar invited respective speakers from different background; practitioners, academics, and local scale government with the insight of green building to present. Various participants were gathered and invited to understand and define the comprehensive low-carbon concept in Banda Aceh city. The analysis related to the readiness and knowledge of Banda Aceh's society and government, which done from data collection and questionnaires. This analysis became part of the benchmark and consideration on roadmap formulation. Based on the overall session of the Virtual Seminar and Discussion in 2021, some information from presenters and discussions needs to be followed up by the government of Banda Aceh, to develop the implementation and regulation of Green Building concept. The result of comprehensive assistance also necessary to realize the roadmap guide for the local government to achieve good regulation and development implementation.

Furthermore, the Green Building Policies analysis was conducted in Main Workshop focused on domestic issues on 25th August 2022. The Main Workshop topic was titled 'The Implementation of Green Building Concept and Policies in Emerging Economies', with more than 290 participants from government, academics, and professionals. This event gives insight on the domestic and international scale with highlighting on the green building roadmaps, regulation, and the possible implementation on the emerging issues and current trends. The workshop aimed to give holistic knowledge and building capacity understanding to increase the city's policy development on Green Building, improve the awareness of Banda Aceh society, and giving views of current affairs, policies, and applicable implementation. To define the analysis, the event was divided into three sections; (1) Conceptual Framework: Contextual Green Building and Infrastructure Concept, (2) Policy and Regulation: Roadmap Towards Green Building Policy, and (3) Implementation: Best Practice for Emerging Economies/Cities. As the result, the first section explained the ongoing roadmap and projects in Indonesia related with green building management. Then, the second section informed the roadmap of green building policy, inclusive green building concept, low-carbon development roadmap, and requirements to implement to the green building policy. The last section focused on the best practice and application on the implementation of contextual green building concept in hot-humid climate of emerging cities.

Secondly, the analysis of the 2nd aspect was about Green Building Awareness in Banda Aceh as the main topic. This activity aimed to observe the public awareness to Green Building Management in Banda Aceh. The investigation was held by distributing sets of questionnaires during the virtual seminar and discussion in 2021 and during the field survey. The several questions related with public awareness of green building were (1) General Knowledge about Green Building Concept, (2) The importance of saving energy, energy consumption, and actions. Overall result of this aspect showed the majority of respondents (academician, government officials, and professionals) have already been aware of the green building concept, with the available application of local regulation and implementation. On the next question, the importance of Green Building Management is considered very important, while the possible actions of the Green Building Principles are still limited to energy saving, except the action of electricity saving through solar panel as the alternatives to get renewable energy resources. The result also showed the majority respondents prefer a designated regulation of green building and incentives as alternatives.

Thirdly, Building Management was the topic of findings. This analysis of building information aimed to get the measure of energy consumption through simulation with

energy measurement software named Open Studio and Site Survey. The location of the total four buildings case study is in Banda Aceh, which mostly had the typology of Office Buildings. The Building Management Analysis is divided into two parts; (1) Environment Condition and (2) Energy Consumption. The Environment Conditions had several parameters of Indoor and Outdoor Environments (Air Temperature, Relative Humidity, Illuminance, Wind Speed, and Electricity Consumption within the buildings). This data from the indoor environment was gathered through field surveys and measurement tools, while the outdoor data environment was gathered through open-source data (BMKG and Climate Station). The results of this stage informed the comparison between indoor and outdoor environmental conditions, the usage of energy consumption, office hours activity, and daily time basis.

Lastly, the Energy Consumption analysis was gained through data logger tools for observing Electricity Consumption, then compared which building among four cases had the highest or lowest consumption. This stage of analysis also focused on Building Retrofitting based on surveyed data and building simulation and modeling. The simulation was based on the maximum electricity usage, occupants, and building mechanical electrical system, which may result in different values, however, the pattern of energy demand had similarity. It also shows the comparison between existing usage of electricity consumption based on annual energy consumption. The simulation results found that all buildings' electrical consumption is heavily sourced from interior lighting. This stage of retrofitting the building through simulation also aimed to get the most optimal retrofit scenario in comparison with the existing simulation model. Referring to the simulated result, the annual energy consumption can be reduced both in energy consumption and the cost of the annual energy demand of the buildings.

To conclude, the identification of Green Building implementation is determined from three aspects; (1) Policy Development, (2) Public Awareness, and (3) Building Management. With Banda Aceh as the case study, these aspects become the baseline to generate a contextual roadmap or recommendation for future Green Building Policy Development.

(1) Policy Development

The supported regulation and strategy/plan concerning green building implementation on a domestic scale are already available, the next step is to find out a formulation of more contextual policies on a local scale (Banda Aceh). Several points can be noted and acted upon to implement the green building concept:

- Data gathering understanding on efforts in reducing the carbon emission or energy consumption are necessary, with mindset from global to local/city level, to gain an efficient baseline of the formulation of the regulation
- Determining the roadmap of Low Carbon development highly contributes to a successful implementation. The roadmap from GHG action plan document of DKI Jakarta can be used as reference.
- To support the green building concept is not enough by only relying on the regulations of green building and detailed spatial planning on city level, but a designated regulation is necessary, in line with the city context, challenges and opportunities.
- A skilled and conscious human resource can make a more efficient implementation.

- Net-Zero healthy building concept can be a suitable option to be applied into the building design or formulate the regulation, with guidance from the GBCI's rating tools.

The Policy Development findings recommend three important phases;

- **Short-term:** create vision with low carbon concept which include green building principles, and provide small initiatives and programs associated to green building management, which later on become the base study for further programs in larger scale,
- **Mid-term:** identify the baseline for formulation of policy development with green building principle as consideration in city level through feasibility study, with coordination with multisectoral counterpart and integration between programs
- **Long-term:** implement the vision into impactful programs and sectors through city scaled regulation and provide the designated team in controlling the green building implementation.

(2) Public Awareness

The concept of green building has become familiar to the general public, mostly in academics and government sector. There are several points to conclude this stage of analysis:

- Some city in Indonesia has already put the green building principles into regulation, and moreover being implemented
- The most possible actions that can easily think about on implement the green building are electricity and water saving action, as well as reducing waste
- In order to save energy, there are some actions that the respondents could think to increase green building engagement
- The engagement is through the designated regulation of green building and incentive as the top priority.

Furthermore, in Public Awareness discussion, the recommendation to increase the awareness and efforts to implement the green building in Banda Aceh can be incorporate into three terms, such as:

- **Short-term**: advancing the capacity building on the green building management to the local government of Banda Aceh, to be able to formulate the suitable and contextual local regulation on the green building management in Banda Aceh.
- **Mid-term:** capacity building from the local government to the public of Banda Aceh locals and communities, with formulation of the applicable and feasible implementation in the household level.
- **Long-term:** strengthen the green building awareness within Banda Aceh, through school curriculum, information center on green building, and specialized school on green building technology.

(3) Building Management

The conclusion of the Building Management findings informed several points:

- The high energy consumption is dominantly caused by lighting and HVAC, however there is an opportunity to move towards green building management, the encouragement through government programs is highly recommended

- The initial implementation of green building principles can be seen from the usage of LED lights to reduce energy consumption and the waste separation to minimize the upcoming land or water pollution and contamination
- From electricity aspect, the provision of renewable energy from solar panel can be one option to achieve nearly zero energy
- From water resource aspect, there is an opportunity to install a rainwater harvesting system into the building to provide alternative water resources
- Building retrofit becomes an alternative to reduce energy demand
- Several strategies of the retrofit can be implemented, such as changing the lighting with less energy demand (in example the LED lights), changing the HVAC system (either using the smart and energy efficient air-conditioning system or go for electric fans) and minimize the wall window ratio by optimizing the natural cross-ventilation
- Adding the Photovoltaic in retrofit the building or solar panel at the rooftop will gain more energy source from natural resources

After all, the Building Management stage recommends three phases of roadmap to incorporate with the Green Building Management:

- **Short-term:** changing the lighting system with less energy demand, the HVAC system into smart and energy efficient technology, while also preparing the rainwater harvesting system and waste separation system
- **Mid-term:** changing the ventilation by minimizing the wall-window ratio and natural cross ventilation, as well as adding the shade/canopy into the building
- **Long term:** Adding more energy sources from renewable energy, in example by Photovoltaic installation

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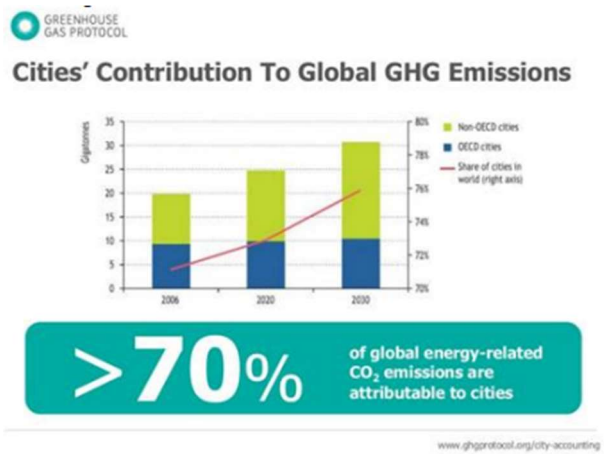
INTRODUCTION

According to IEA (International Energy Admission), 2015, Indonesia is the largest energy consumer in Southeast Asia (36% of the region's energy demand) and consumes more energy than Thailand, Malaysia, and Singapore which affect increasing carbon emissions. Urbanization and rapid population growth will affect the future trends of Asia-Pacific economics and it hastened to manage of these current challenges, particularly in energy and CO2 emissions issues. To tackle these issues, one of the efforts that can make is to reduce carbon production, at the building and regional scale. Reducing emission locally will also have an impact on reducing carbon exports globally, especially to the surrounding economies. The 9th APEC Energy Ministers Meeting in June 2010 in Fukui, Japan has also declared Low-Carbon Model Town (LCMT) Projects to support carbon emission reduction, with objectives related to the implementation of the 2030 Agenda for Sustainable Development and the Addis Ababa Action Agenda (23rd APEC Economic Leaders' Meeting).

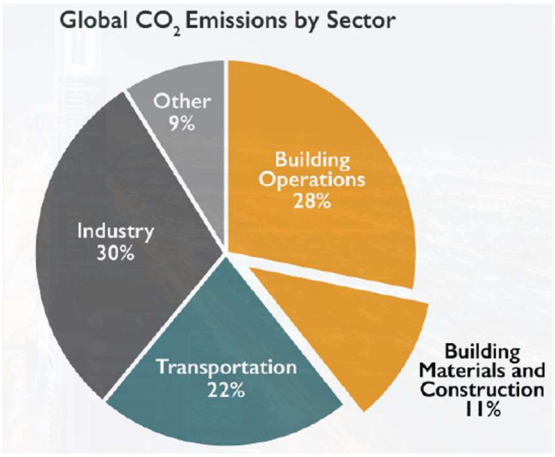
In 2021, a project proposed to APEC with the title Policy Development for Green Building Concept Implementation, focuses on energy efficiency in the building sector. The main objective of this project is promoting and guiding the emergence of policies regarding low-carbon city model and green building through several activities as a basis for further action by the local authorities as well as further collaboration to address the APEC-wide issue on innovative sustainability and digital technology. This project is also part of a continuing program from previous Feasibility Study project of LCMT in 2017-2019 with five (5) locations in Banda Aceh as the case study. The examination of green building principles implementation in Banda Aceh was done through online workshops and field survey to several government office building typology as case study and findings, as the content materials for the Final Report or the material of Recommendation Document (roadmap).

BACKGROUND

Currently, cities take part in 2/3 of the world's energy consumption and create 70% greenhouse gas emissions. Indonesia itself contribute as the 5^{h} largest carbon emitter in the world, with the most dominant issue coming from land utilization or transfer caused by the urbanization. Moreover, buildings make a significant contribution to creating carbon emissions.



Cities Contribution to Global GHG Emissions
Source: World Energy Outlook, IEA



Global CO2 Emissions by Sector
Source: ABC Global Status Report (2018)

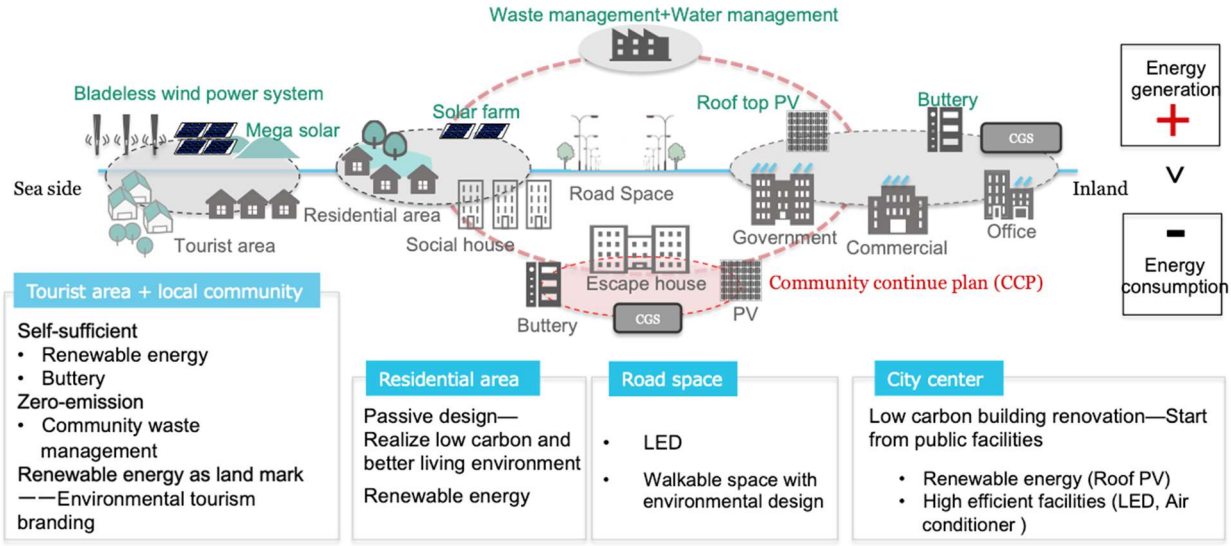
International frameworks and agreements have been established towards the low-carbon society. These include:

1) United Nations' Sustainable Development Goals , in which the concern on the adverse impacts of increasing emission of greenhouse gas onto the climate change is stated,
2) The Paris Agreement of COP21, under which all the participating economies and regions are obliged to set their Domestically Determined Contributions , and
3) UN-HABITAT New Urban Agenda, which declares the reduction of greenhouse gas emission.

Low carbon city is a sustainable urbanization approach that centers on curtailing the anthropogenic carbon footprint of cities by means of minimizing or abolishing the utilization of energy sourced from fossil fuels. It combines the features of a low carbon society and low carbon economy while supporting partnerships among governments, private sectors, and civil societies. Low-Carbon Model Town (LCMT) Project was initiated by the APEC Energy Working Group based on the 9th meeting of the APEC Energy Minister in Fukui, Japan in 2010.

In 2017, Banda Aceh as one of representative city in Indonesia was selected to be model town for the low carbon city implementation and acted as APEC LCMT Dissemination Phase 1 Project within 2017-2019. This project was done with collaboration of international and domestic consultant, the ministry of energy and resources of Indonesia, with multi stakeholder from local and domestic government, community, academics, NGO, as well as the private and public enterprise that represent the energy management in Banda Aceh. Phase 1 dissemination resulted in two important aspects to be urgently prepared to realize

the low carbon city, which is the public transportation management and the green building management.



APEC LCMT Dissemination Phase 1 (2017-2019)
Source: Final Report of APEC LCMT Project Dissemination Phase 1 (2019)

Continuing the feasibility study that has been carried out previously, in 2021-2022 the LCMT concept will be implemented through green building and management platform. The results of this program are then expected to be followed up through policy development and further realization in physical development.

This document is prepared to determine the suitable roadmap on green building implementation, with focus on three main parts, such as:

A. Current Regulation and The Emerging Policy concerning Green Building Management in Banda Aceh
B. Green Building Awareness in Banda Aceh
C. Green Building Management in Banda Aceh

GREEN BUILDING MANAGEMENT SCHEME IN BANDA ACEH

A. Methods

Three aspects will be discussed to see the current green building management scheme in Banda Aceh. Those three aspects are:

- **The Current and Emerging Policies on Green Building**

  The study of policy development in this project covers the current and emerging regulation as well as the plan concerning carbon emission reduction and green building in domestic scale (Indonesia) and city scale (Banda Aceh), through introductory meeting/webinar and main workshop. Banda Aceh became the main participant in both online meetings, with the government officials, academics, and professionals as the representatives.

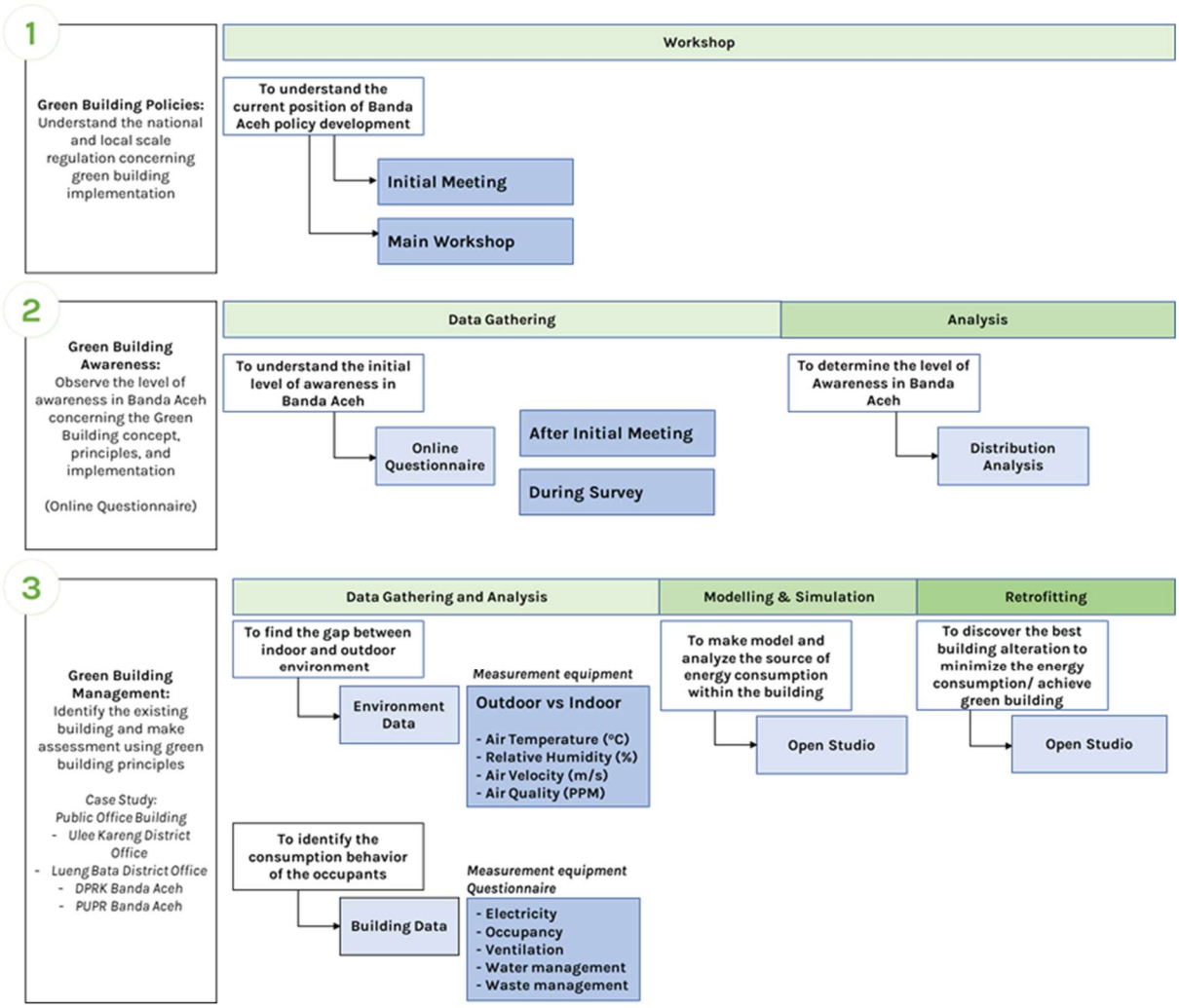
- **Green Building Awareness**

  The identification of green building awareness in Banda Aceh was targeted to the participant of the workshop and field survey, to gain understanding on how much the participant aware of the concept and principles of green building, furthermore the implementation on daily basis. The answers were collected through an online questionnaire, distributed after the workshop and during the survey. Analysis of these answers becomes the initial illustration of how the people of Banda Aceh understand the importance of Green Building and which actions are considered as energy saving movement.

- **Building Management**

  The observation of building management in Banda Aceh was focusing on the public office building owned by the government of Banda Aceh. Several objectives were measured to identify the current condition of the existing building and make assessment using green building principles. The outdoor and indoor environment are compared to identify the gap between two environments, and correlate to the building data taken from the questionnaire. The building data becomes the source for modelling and simulation as well to analyze the energy consumption within a year and the possible source. Later, the best building alteration will be determined to minimize energy consumption in order to achieve green building, with building retrofit as recommendation.

Each of these aspects will develop a baseline and gives roadmap or recommendation of the future Green Building Policy Development in Banda Aceh.



Project Methodology for Green Building Management Identification in Banda Aceh

B. Findings

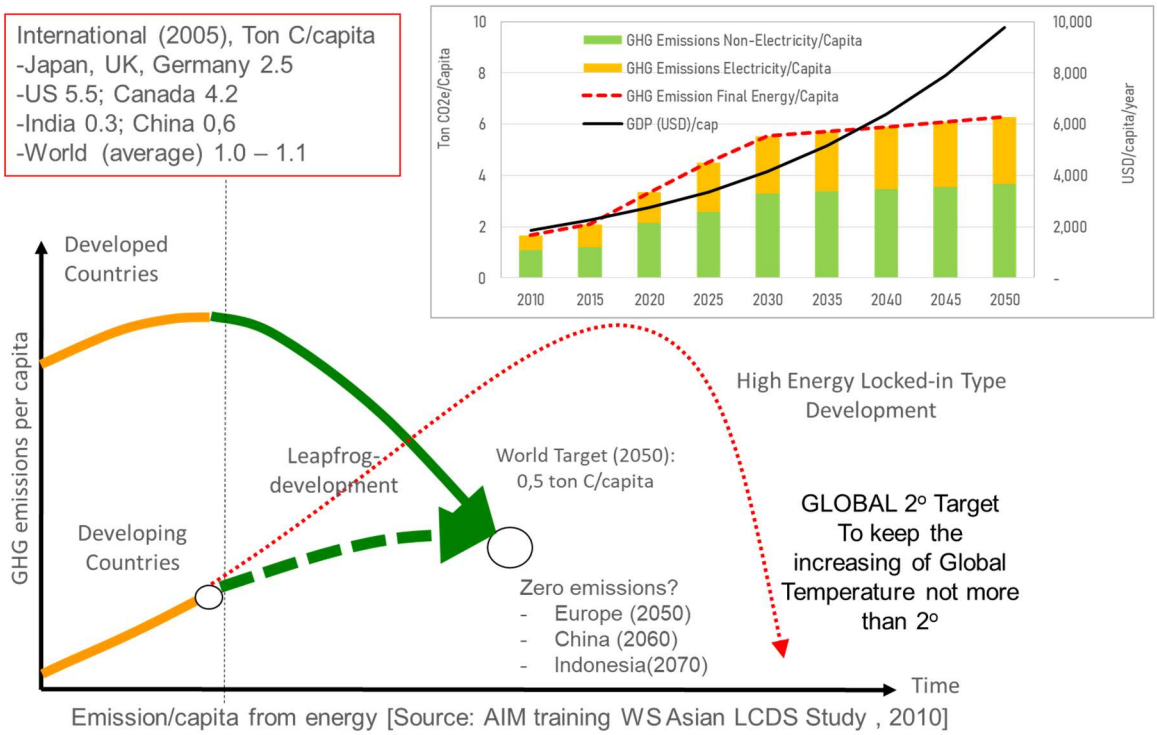
B.1. Green Building Policies

B.1.1. Virtual Seminar and Discussion: Policy Development and Implementation on Green Building Concept & Low Carbon City in Banda Aceh

B.1.1.1. *Global Context and Domestic Regulation related to The Green Building and Low Carbon City in Indonesia*

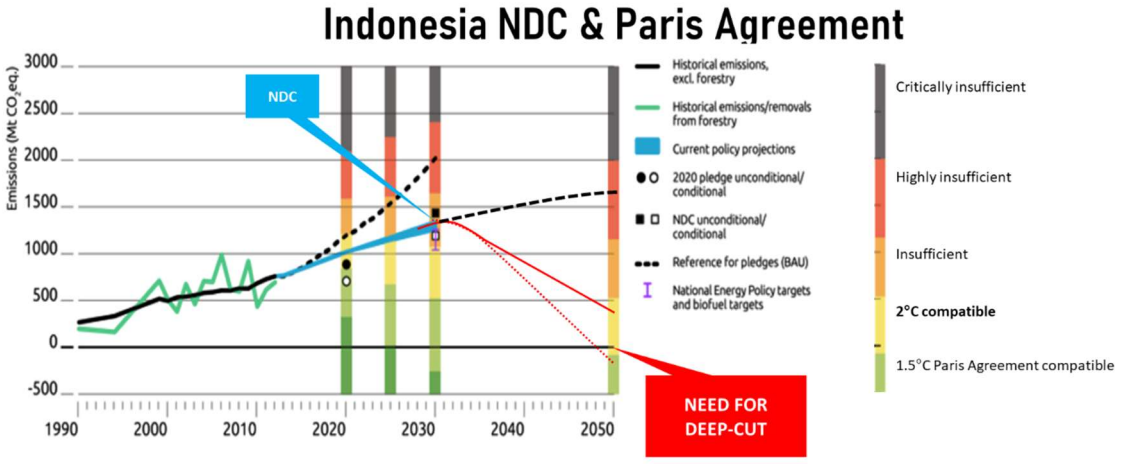
Global Challenges in Reducing the Carbon Emission

The emergence of domestic policies and strategies regarding greenhouse gas (GHG) emission reductions is basically based on the results of the Paris Agreement, where each economy has commitment on determine the targets and strategies on decrease the GHG emission. Indonesia is considered as part of developing economies, with a relatively lesser carbon emission than the developed economies but have the same target on decrease the carbon emission with towards the increasing temperature below 2 degrees.



Global Challenges in Reducing the Carbon Emission
Source: AIM training WS Asian LCDS Study, 2010

On the domestic level, NDC (Domestically Determined Contribution) has been established based on the Paris Agreement, as the foundation on strategies formulation.



Updated Indonesia NDC (*Nationally Determine Contribution*)

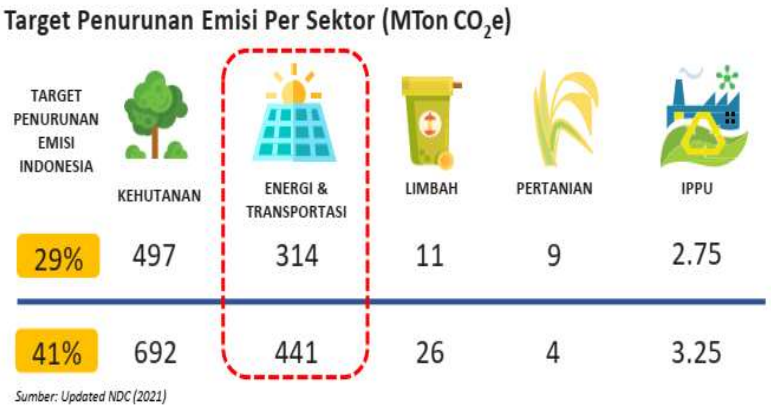
Sektor	Base Year, 2010 (MTon CO2-e)	GHG Emission 2030 (Mton CO_2-e)			% reduction of BaU	
		BaU	CM1	CM2	CM1	CM2
Energy*	**453.2**	**1,669**	**1,355**	1,228	**11%**	15.4%
Waste	88	296	285	270	0.38%	0.9%
IPPU	36	69.6	66.85	66	0.10%	0.1%
Agriculture	110.5	119.66	110.39	116	0.32%	0.1%
Forestry**	647	714	217	22	17.20%	24.1%
Total	1,334	2,869	2,034	1,703	29%	41%

*Including fugitive; **Including peat fire; CM1 = unconditional, CM2 = conditional

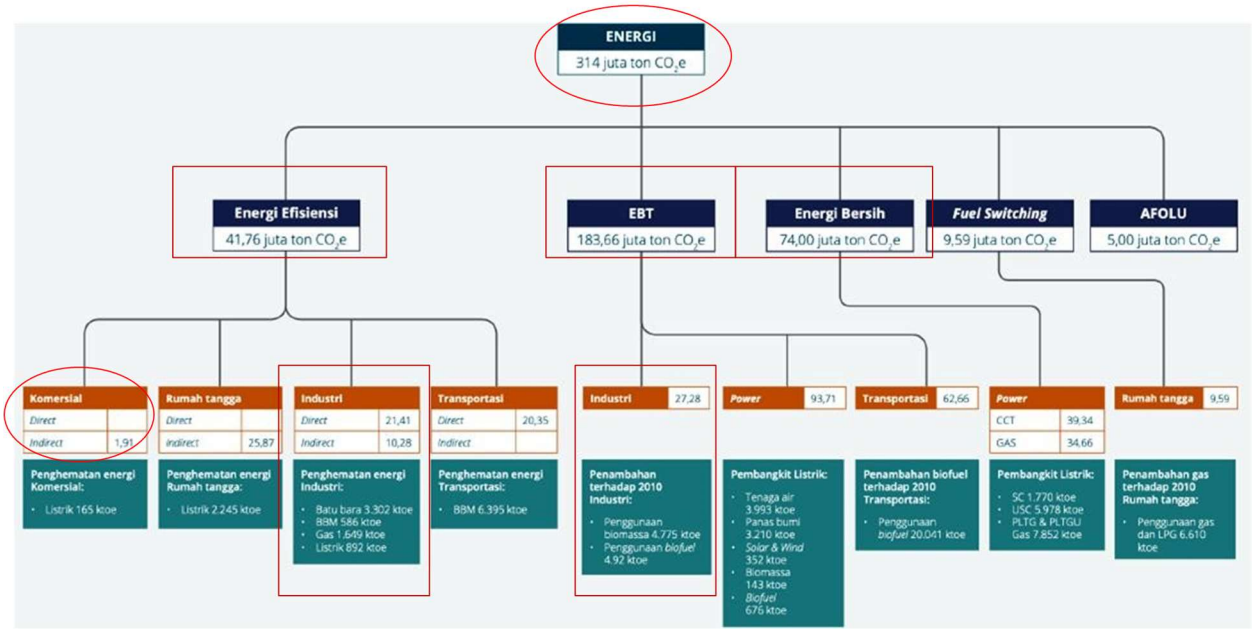
Remarks

BaU	Development Path not deliberated the mitigation policies
CM1	Mitigation scenario & considers sectoral development target (Unconditionally)
CM2	Ambitious mitigation scenario + International support available (conditionally)

Source: Climate Action Tracker (2017); Indonesia first NDC (2016)

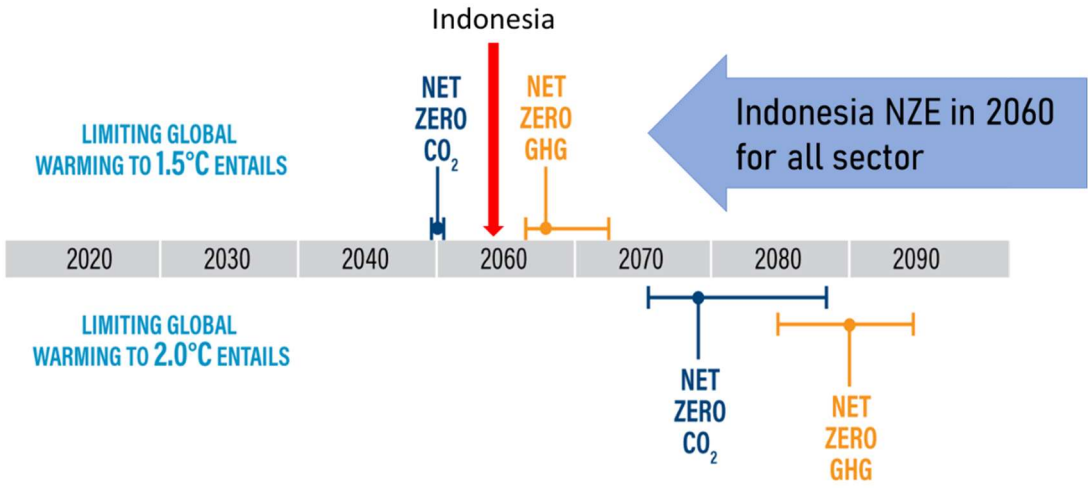


NDC Indonesia Objectives and Targets
Source: Climate Action Tracker (2017); Indonesia first NDC (2016)

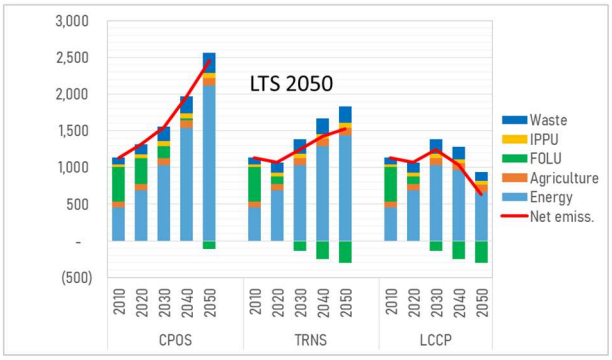


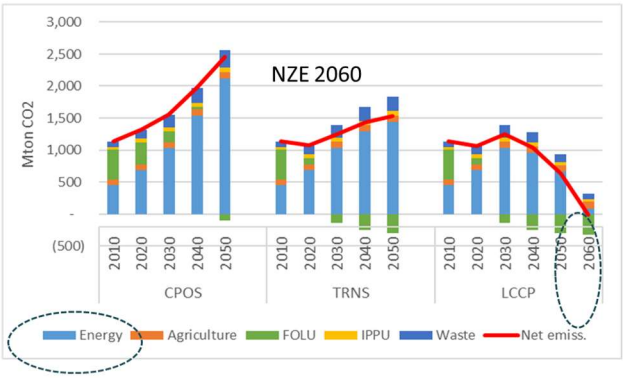
Unconditional NDC 2030 Targets on Energy Sector
Source: Indonesia NDC (2016)

Several important target from NDC Indonesia 2030 in energy sector comes from energy efficiency on commercial sector indirectly (electricity 165 ktoe) and industry sector both direct and indirect (coal 3.302 ktoe, fuel 586 ktoe, gas 1.649 ktoe, and electricity 892 ktoe) as well as EBT from industry sector and clean energy.



Global Timeline: Net-Zero Emissions
Source: IPCC Special Report on Global Warming of 1.5 degree





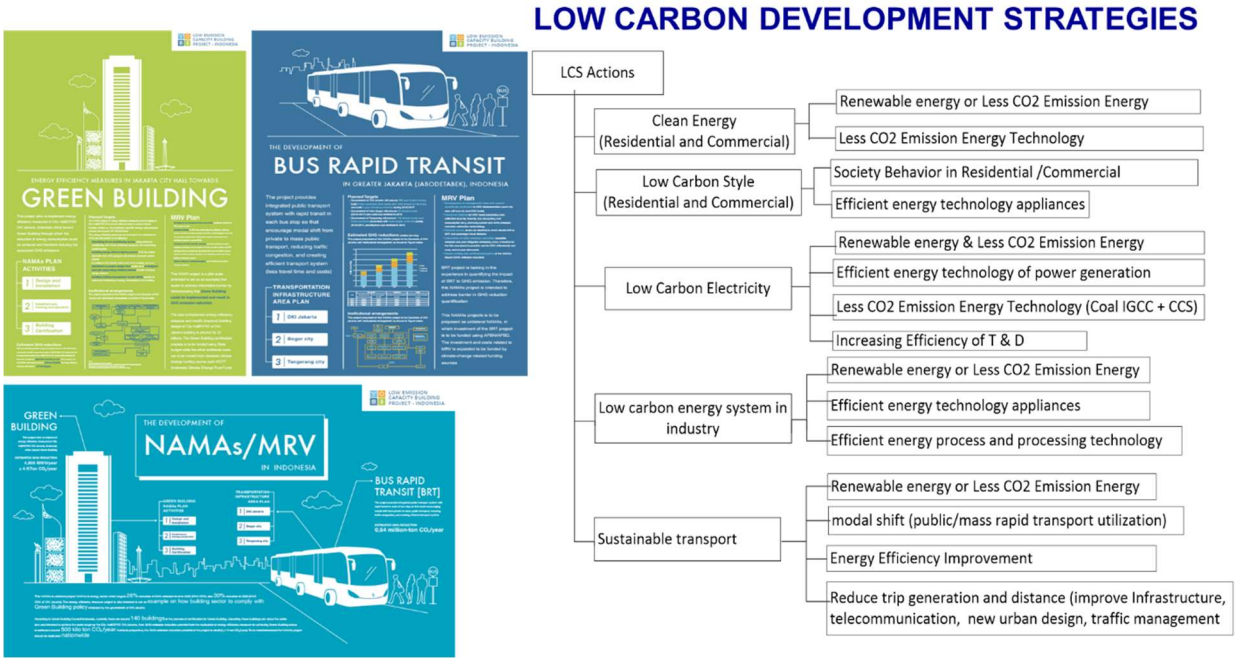
Sumber: LTS LCCR Indonesia, KLHK (2021)

- **CPOS** (Current Policy)
- **TRNS** (Transition)
- **LCCP** (Low Carbon Scenario Compatible with Paris Agreement Target)

LCCP: Peaking 5 sektor di tahun 2030 dengan net sink Sektor FOLU

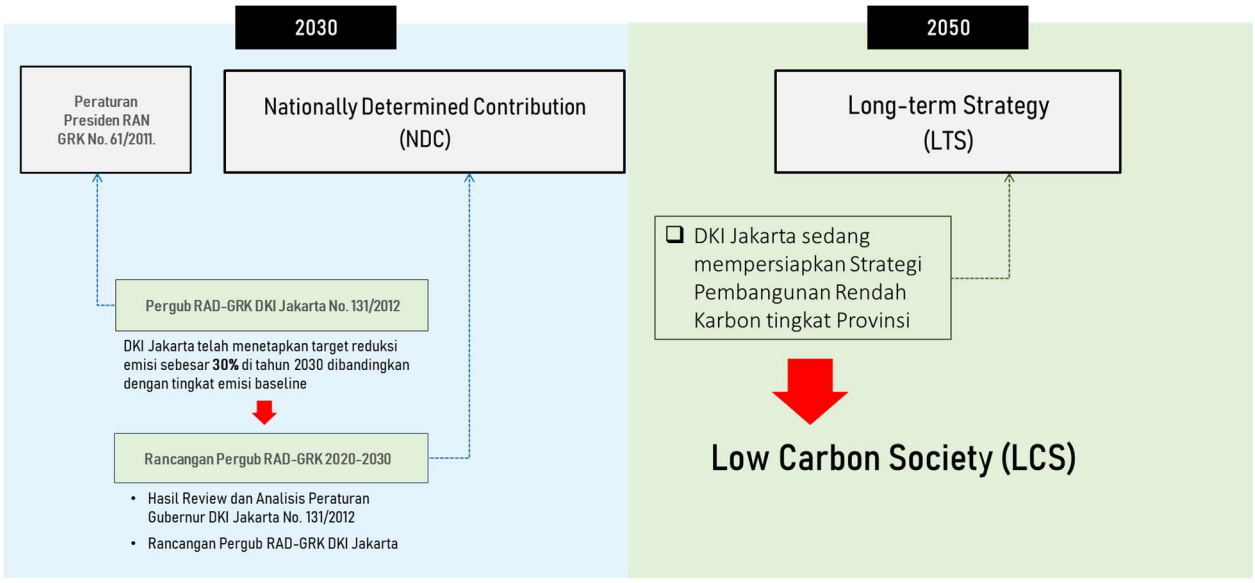
Indonesia LTS LCCR (Long Term Strategy for Low-Carbon and Climate Resilience)
Source: LTS LCCR Indonesia, KLHK (2021)

B.1.1.2. Green Building Roadmap (Case Study: Jakarta)

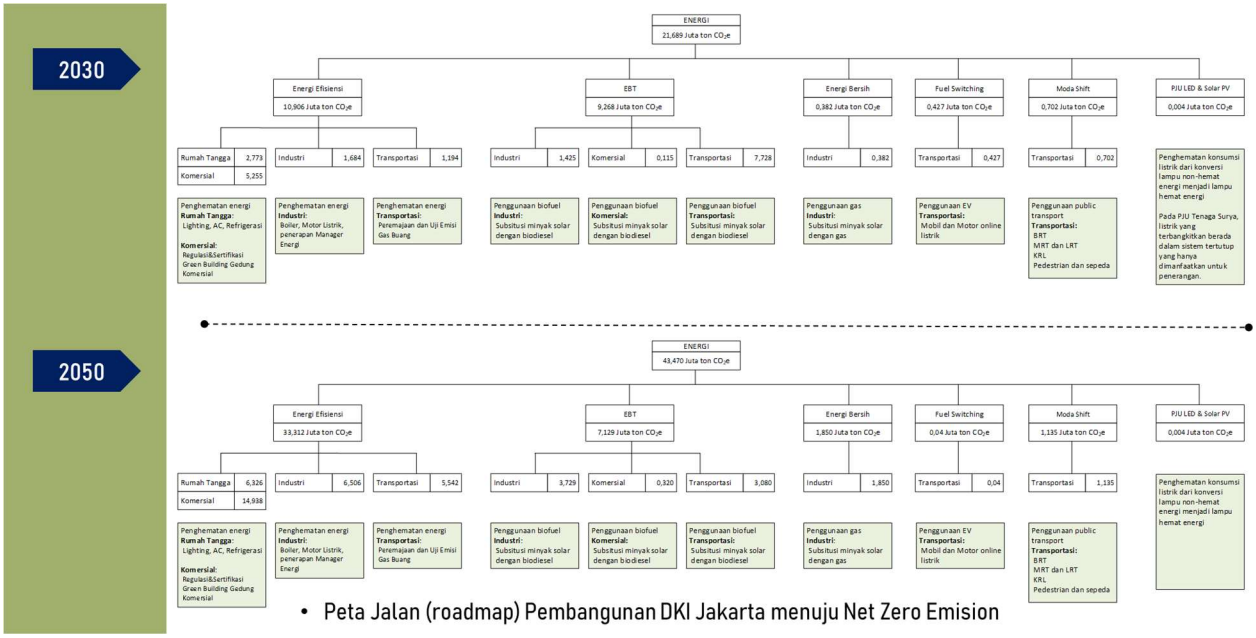


Low Carbon Development Strategies
Source: LTS LCCR Indonesia, KLHK (2021)

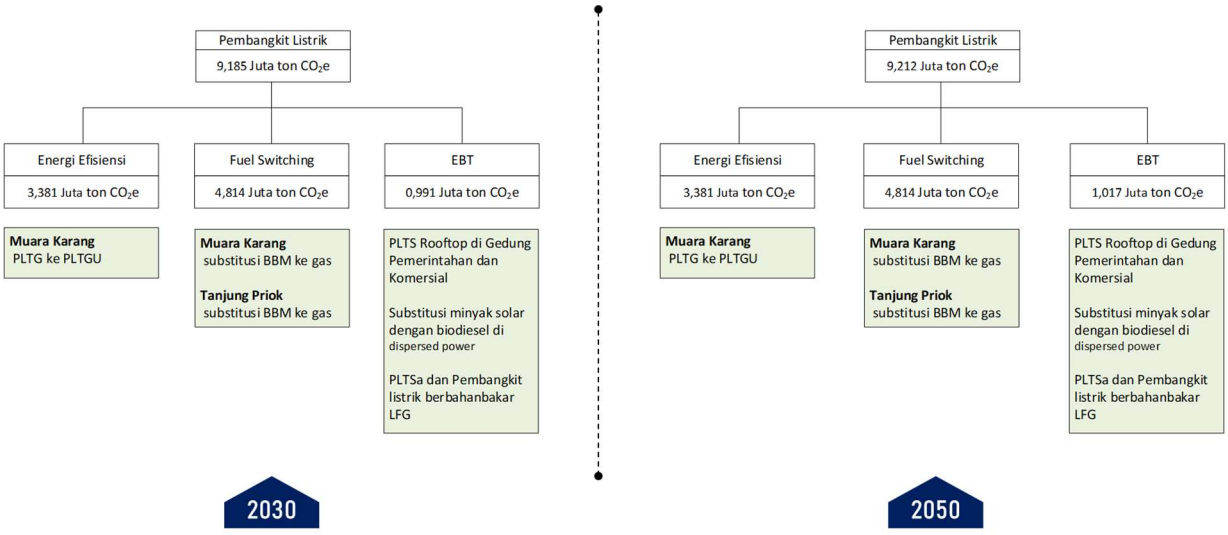
To realize the low carbon development, especially in green building management, regulation and implementation, Jakarta suitable as the case study of the green building implementation in Indonesia. For example, green buildings have become part of NAMAs (Domestic Appropriate Mitigation Actions) Program.



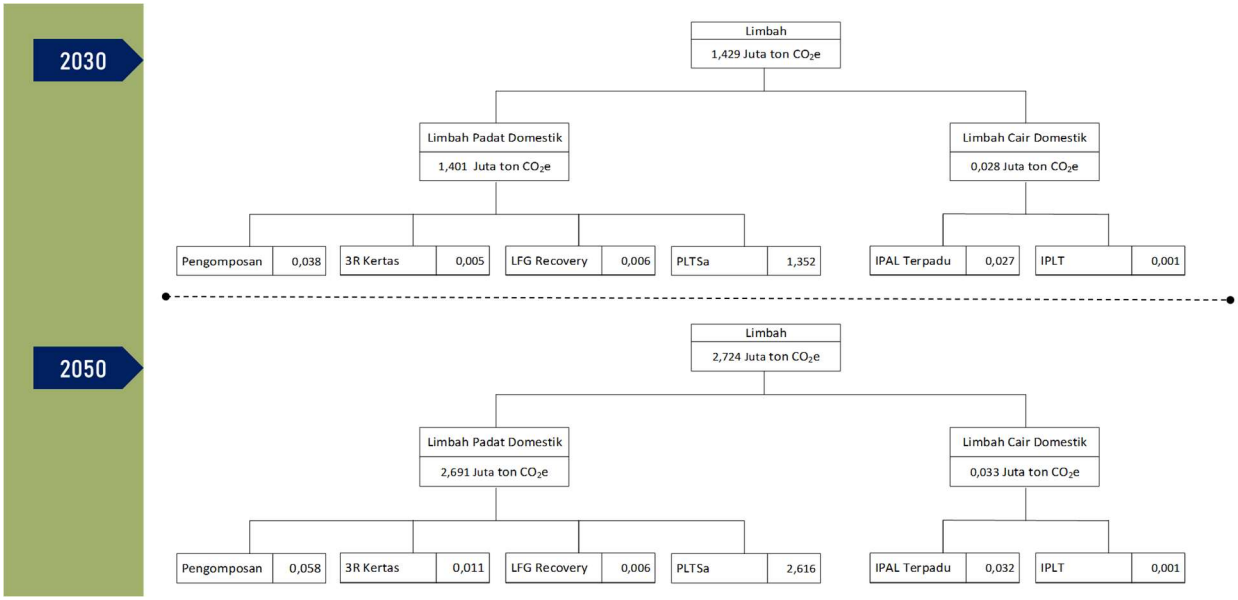
GHG Emission Reduction Target and Roadmap in DKI Jakarta
Source: Rencana Aksi Daerah Gas Rumah Kaca DKI Jakarta (2012)



GHG Emission Reduction Target DKI Jakarta on Energy Sector
Source: Rencana Aksi Daerah Gas Rumah Kaca DKI Jakarta (2012)



GHG Emission Reduction Target DKI Jakarta on Power Supply Sector
Source: Rencana Aksi Daerah Gas Rumah Kaca DKI Jakarta (2012)



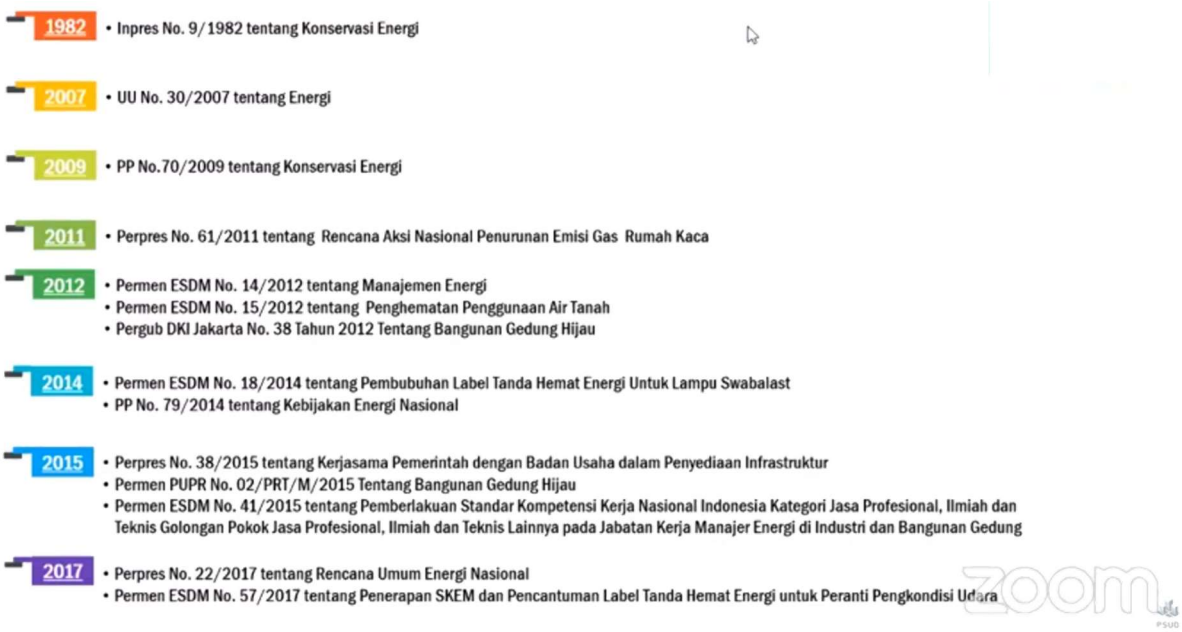
GHG Emission Reduction Target DKI Jakarta on Waste Management Sector
Source: Rencana Aksi Daerah Gas Rumah Kaca DKI Jakarta (2012)

B.1.1.3. Green Building Policy Formulation Methods

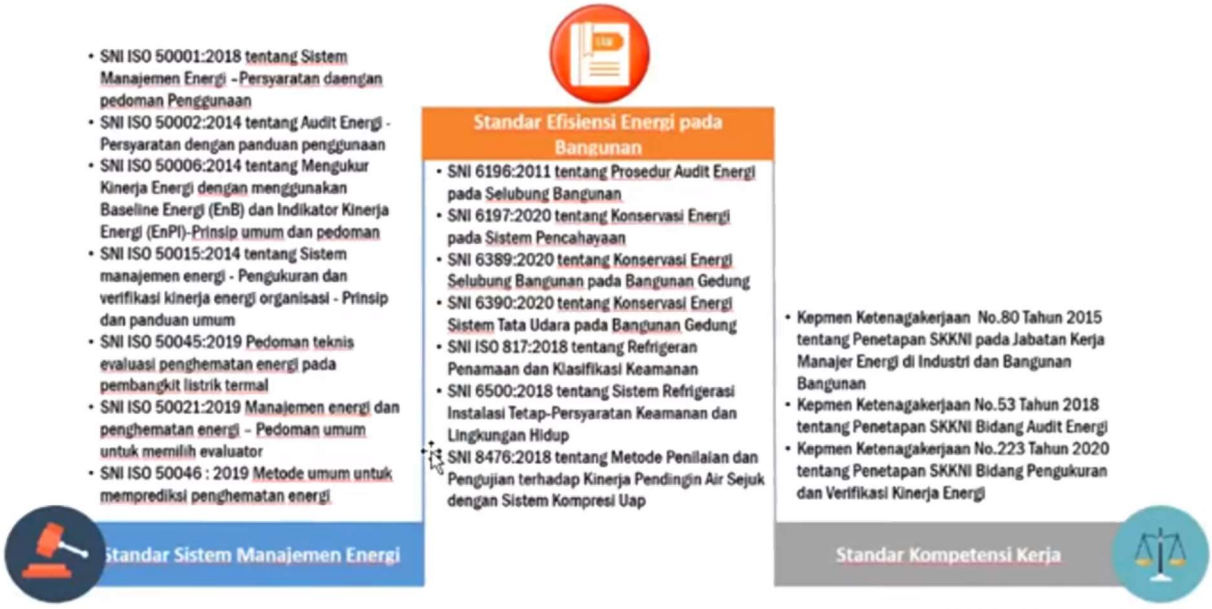
Green Building Standards and Regulations

Green Building Standards and Financial Related Policies in Indonesia
Source: GBPN Report (2021)

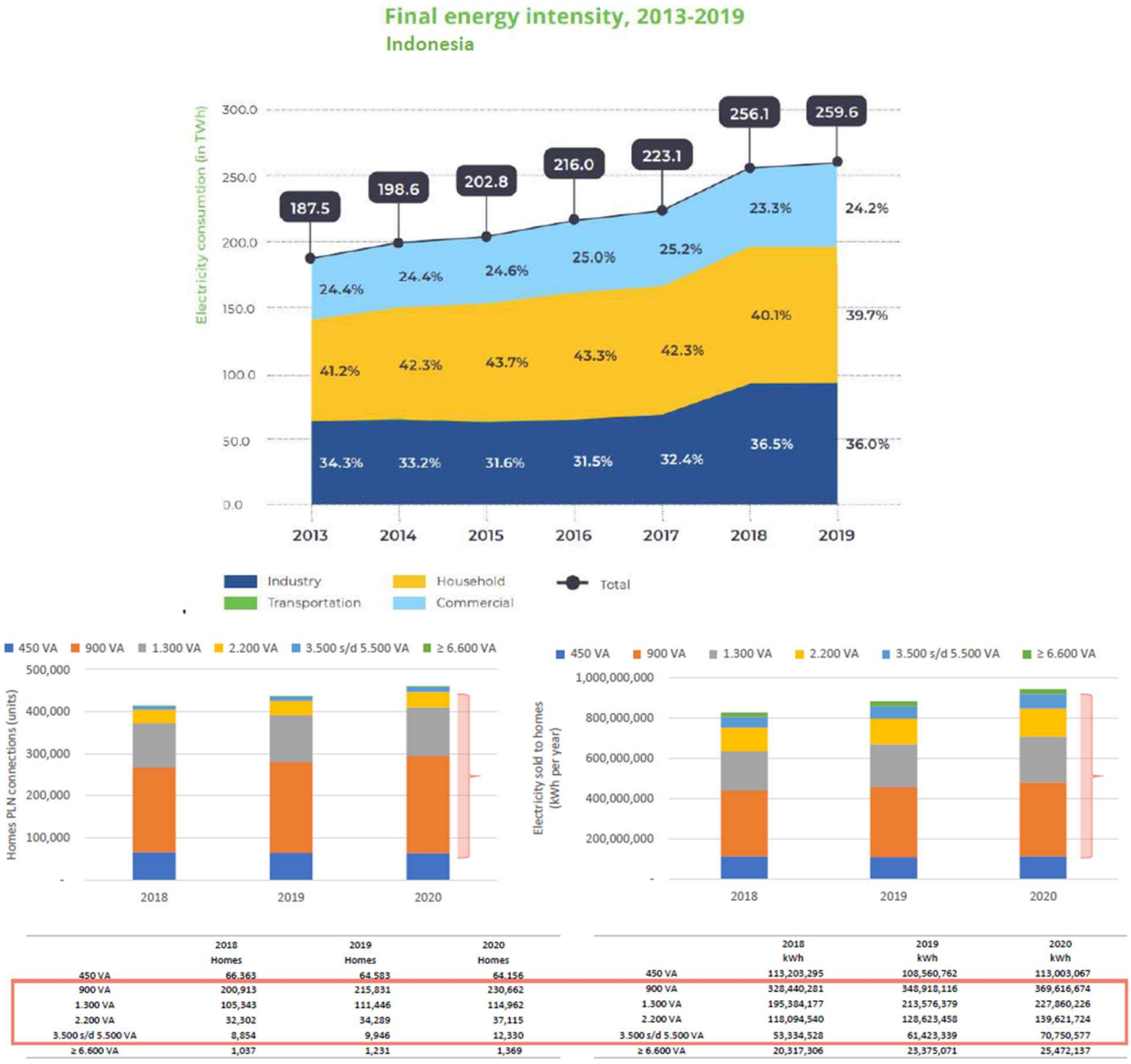
Several policies related to green building have been formulated by the local and domestic governments. Some have contributed to and implemented the green building concept and principles on their regulation, such as Jakarta, Bandung, Semarang, Samarinda, and Bali. The ministry of energy and resources has created regulations on energy conservation since 1982 and specifically add the green building regulation in 2012.



Regulation on Energy Conservation Related to the Green Building
Source: Presentation material from Ministry of Energy and Resources (2021)



Energy Conservation Standards Related to the Green Building
Source: Presentation material from Ministry of Energy and Resources (2021)



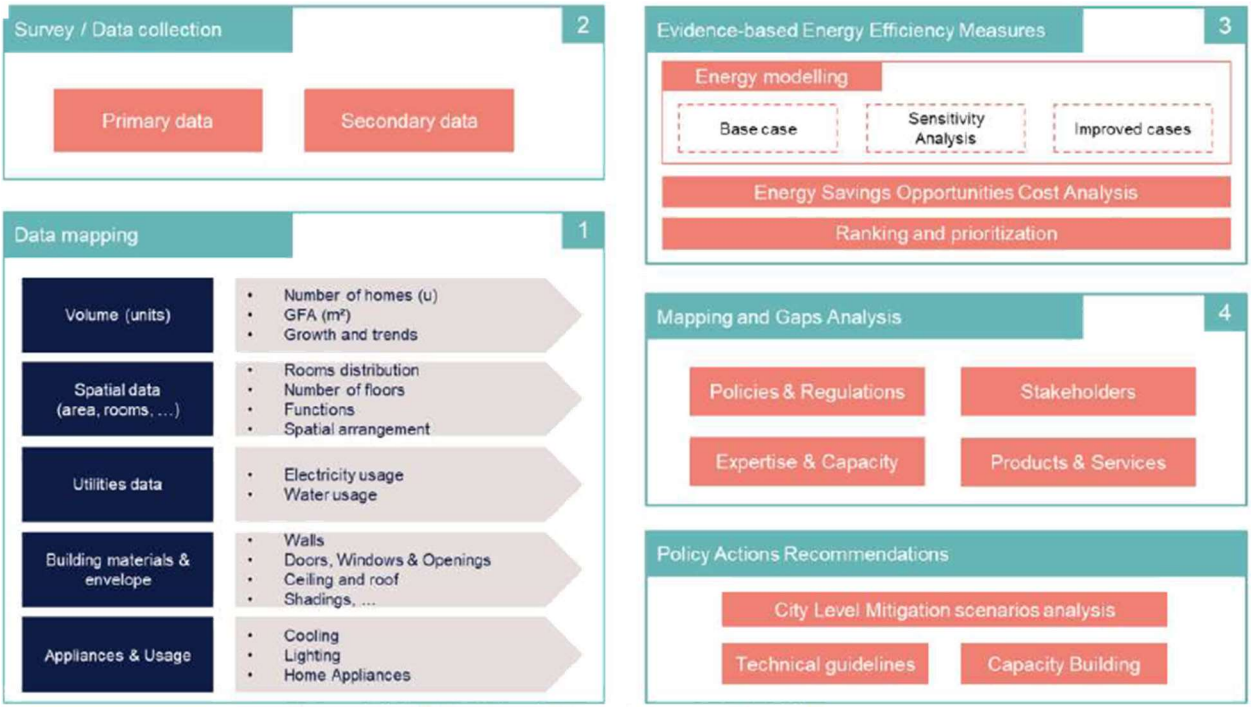
	2018 Homes	2019 Homes	2020 Homes
450 VA	66,363	64,583	64,156
900 VA	200,913	215,831	230,662
1.300 VA	105,343	111,446	114,962
2.200 VA	32,302	34,289	37,115
3.500 s/d 5.500 VA	8,854	9,946	12,330
≥ 6.600 VA	1,037	1,231	1,369

	2018 kWh	2019 kWh	2020 kWh
450 VA	113,203,295	108,560,762	113,003,067
900 VA	328,440,281	348,918,116	369,616,674
1.300 VA	195,384,177	213,576,379	227,860,226
2.200 VA	118,094,540	128,623,458	139,621,724
3.500 s/d 5.500 VA	53,334,528	61,423,339	70,750,577
≥ 6.600 VA	20,317,306	23,375,071	25,472,137

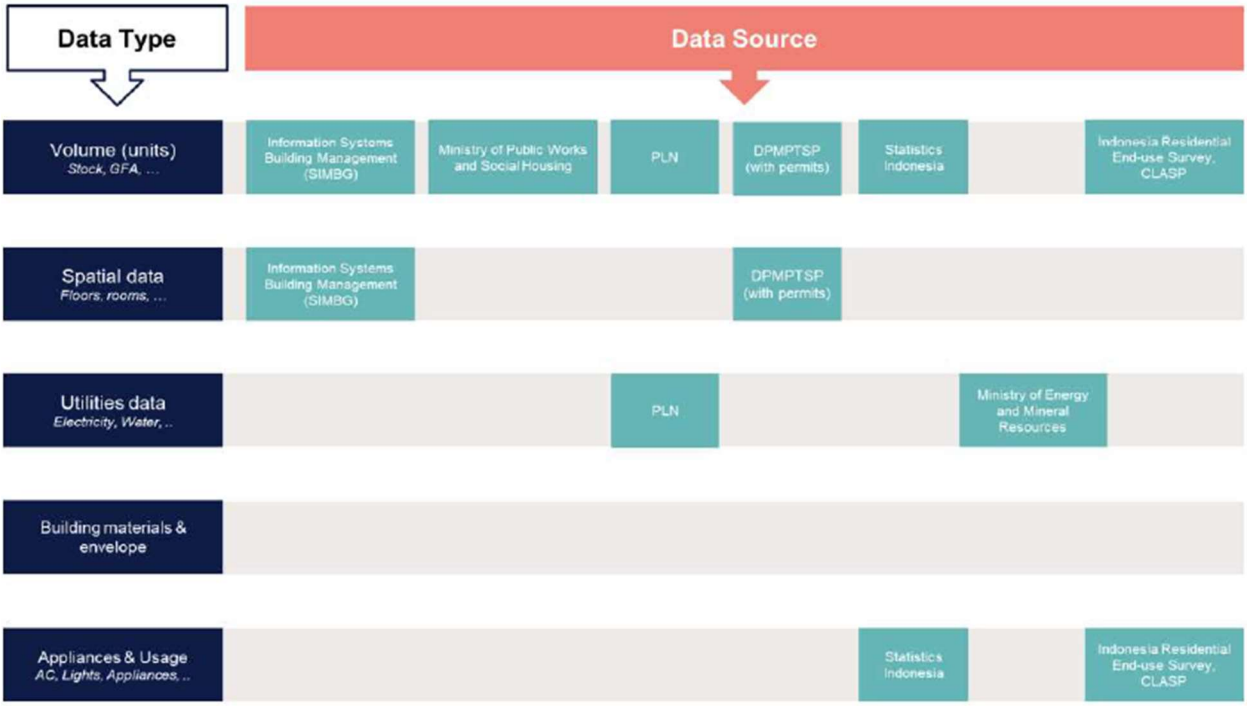
Increasing Energy Intensity in Indonesia and Samarinda

Source: IESR, Indonesian Energy Transition Outlook (2021), PLN Samarinda (2021)

The most optimum implementation strategy on decreasing the carbon emission is by minimizing the effort but make a maximum impact and the strategy should be scalable. Here is the baseline study and methodology that could be applied in Banda Aceh.



GPBN Baseline Study and Survey methodology
Source: GBPN & Climate Works Foundation Report (2021)



Data Mapping of Indonesian Housing Stock
Source: GBPN & Climate Works Foundation Report (2021)

Challenges and Strategies for the Implementation

Challenges and Strategies on The Green Building Concept Implementation
Source: GBPN & Climate Works Foundation Report (2021)

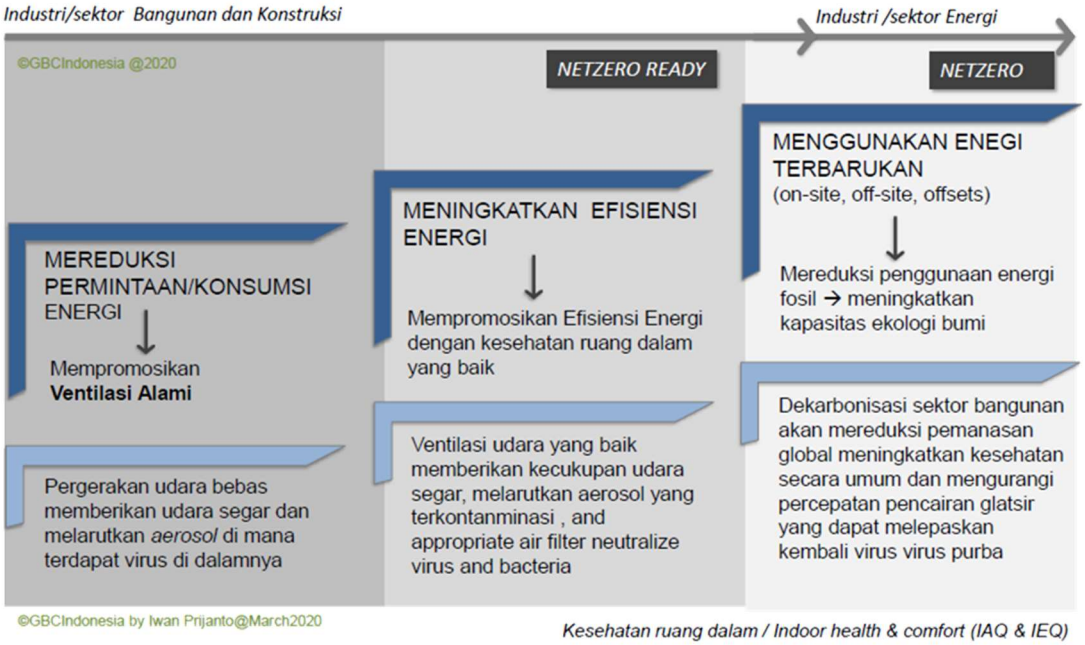
Net Zero Healthy Building Concept

To manage the issue of increasing carbon emission and the emerging Covid-19, which has a close relation to pollution, air quality and human health as the occupant of the building and outdoor area.

Several concepts to inject the Net Zero Healthy Building into the tropical climate are

- Natural Ventilation (passive design)
- Natural + Mechanical Ventilation (window + mechanic fan)
- Hybrid Natural Ventilation (NV + MV + DOAS)

The roadmap to design the Net-Zero Healthy Building is already available and can be directly used for implementation, made by GBCI with rating tools from GREENSHIP,



Roadmap towards Net Zero Healthy Building in Indonesia
Source: GBC Indonesia (2020)

Plan, Policies, and Implementation related to Green Building Concept in Banda Aceh City

Banda Aceh as one of the westernmost cities in Indonesia has a hot humid climate and surrounded by the coasts of Sumatera Island. Banda Aceh government has committed to become a low and green city in Indonesia with vision To Realize the Green and Environmentally-Friendly Building for The Better Future . Regulation on domestic and local level in Banda Aceh that support the green building implementation are:

Domestic Regulation

- Law of the Republic of Indonesia No. 11 of 2020 on Job Creation
- Government Regulation No.21 of 2021 on Spatial Planning
- Government Regulation No.16 of 2021 on Implementing Law of the Republic of Indonesia No. 28 of 2002 concerning Buildings
- Regulation of The Ministry of Public Works No. 21 of 2021 on Green Building Performance Assessment

Local Regulations

- Banda Aceh City Regulation (Qanun) No.2 of 2018 on the Revision of Qanun No. 4 of 2009 on Regional Spatial Planning of Banda Aceh in 2009-2029
- Mayor Regulation No. 13 of 2021 on Detailed Spatial Plan and Zoning of Banda Aceh in 2021-2041

The plan and implementation of the Green Building concept in Banda Aceh has been formulated by the local government, consists of

- **The inspection of building permits with a team of building experts**

In each building permit, there will be a hearing session and site visitation by the local agency of public works with a team of building experts and designated multi sectoral

building permit team, which later will give a technical recommendation with green building as one of the recommendation items.

- **The assessment of the building drawing for the building permit with a team of building experts**

In each building drawing for building permit, there will be a hearing session and assessment by the local agency of public works with a team of building experts, which later will give a technical recommendation with green building as one of the recommendation items.

- **Revision of local regulation (Qanun) No 10 of 2004 concerning Buildings**

The revision of Qanun has been done by adopting the green building principles as spatial regulation and adjusting to the updated regulations

B.1.2. Main Workshop

B.1.2.1. APEC Workshop on The Implementation of Green Building Concept and Policies In Emerging Economies

The main workshop was held through online on 25 August 2022, with more than 290 participants from government, academics, and professionals to discuss the emerging concepts and policies in Green Building Implementation. The workshop was divided into three sections, consisting of:

Section 1 - Conceptual Framework: Contextual Green Building and Infrastructure Concept

This section was concerning the emerging contextual green building and infrastructure concept framework, represented by expert from academician from Pennsylvania University. The contextual green building concept in Makassar and USA was the case study, followed by the Indonesian Ministry of Public Works expert by explaining the ongoing roadmap and projects in Indonesia related to the green building management.

Section 2 - Policy and Regulation: Roadmap towards Green Building Policy

This section was related to the current roadmap and applicable policy and regulation for an efficient and inclusive green building concept. The representatives of this session came from experts of Indonesia Research Institute of Decarbonization (IRID) with the role of green buildings and cities to tackle the climate issues, Energy Policy Center ITB with topic on the low carbon development roadmap and requirements to implement the green building policy, and Global Building Performance Network (GBPN) concerning the roadmap of green building policy

Section 3 - Implementation: Best Practice for Emerging Economies/Cities.

The last session demonstrated the best practice and application on implementing a contextual green building concept in hot-humid climate of the emerging cities. This session represented by the academician from Universitas Pendidikan Indonesia by presenting the green building added value from building construction and expert from Ministry of Energy and Mineral Resources of Indonesia concerning the energy management towards NZE 2060.

Event Poster and Theme of Each Session for Main Workshop

Session A: Opening

The opening session started with the opening speech from Dr. Ir. Dadan Kusdiana, M.Sc. as the Directorate General of Renewable Energy and Energy Conservation (DG EBTKE) of the Ministry of Energy and Mineral Resources of Republic Indonesia. His speech highlighted that Indonesia become one the largest energy consumer within the region, resulting a high carbon emission. Several programs from the government were initiated to overcome the carbon production, and together with the Ministry of Public work, there are collaborated programs related to the construction works and housing, standardization of energy conservation and regulations concerning the green building.

He was also added the importance of The LCMT project, as one of the ministry programs in collaboration with APEC, which was held from 2010. In coordination with Banda Aceh government, eagerly the city become one of the pilot studies, with feasibility study resulting on green building and sustainable transportation. The continuity of the program was shown from the main workshop to guide a better green building implementation in Banda Aceh with participation and support of multiple stakeholders to realize carbon emission reduction.

The opening session was continued by the introduction of APEC Main Workshop and the current findings from the field survey. Mr. T.M. Aziz from Pusat Studi Urban Desain explained that the current LCMT is a continuous project since 2017, with present program is focusing on green building topic through main workshop, survey and simulation, resulting a draft recommendation. To observe the readiness of green building implementation in Banda Aceh, with pilot study in Ulee Kareng district office, three aspects were identified, which are: Policy Development, Building Management and its Occupant's Behavior, as well as the Electricity Consumption.

Based on the initial field survey and analysis, several findings were found, such as

- **Policy development:** support from the domestic program has already available, but to apply this regulation and programs to local regulation of Banda Aceh, need to look into the context thoroughly
- **Building management and occupant's behavior:** the energy saving management has been seen from the usage of LED light and waste separation, but those two components were also contributing a large amount of expense.
- **Electricity consumption:** based on the direct measurement and simulation, the energy consumption in Ulee Kareng office is considered high, and retrofitting is recommended

Session B: Main Workshop

The Main Workshop was defined into three sections,

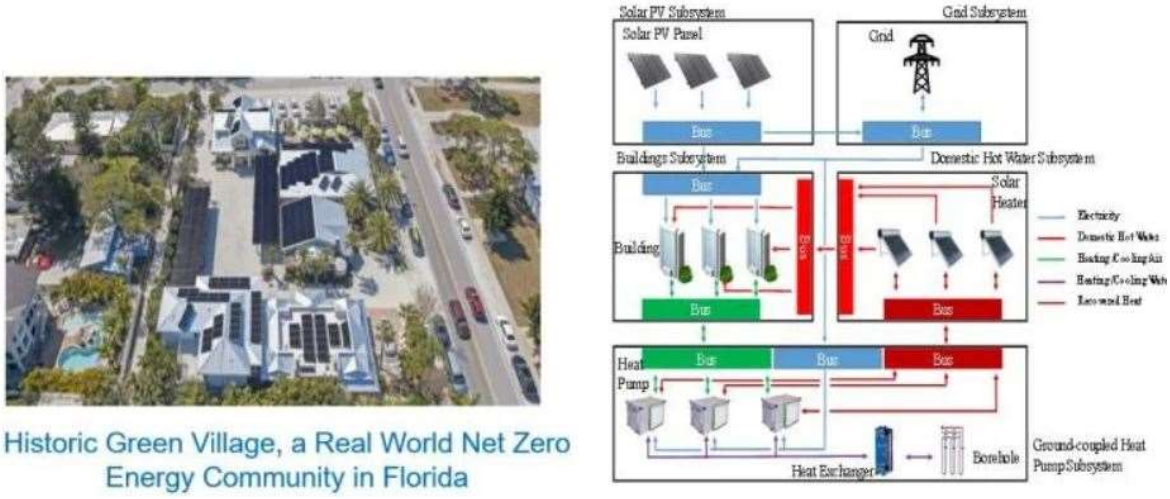
Section 1 – Conceptual Framework: Contextual Green Building and Infrastructure Concept

B.1.2.2. From Zero Energy Communities to Smart Garden Alleys

In the US, building plays significant role in energy usage, as people spend 90% time indoor, and soon, the city will create a great demand of energy and create CO2 emission by more than 70%. Energy management in community scale will become one of a step towards future sustainable city.

Zero energy community: an energy-efficient community where on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy (US DOE, 2015). The best practice of this concept can be found in a Historic Green Village, Florida Modeling of zero energy community has been tested using a hierarchical system model: PV subsystem. Follow-up research was done with grid integration through model-based optimization.

Some of the community technology can be applied in the developing economy through smart garden alley with case study in Makassar city, inspired by biomimicry philosophy of human being. The objective of this project is to integrate innovation in smart and connected communities to improve garden alley within Makassar Municipality. The current stage of this project is in a cell phase with garden alley distributed throughout the city. The future works will reach the nerves stage where distributed sensor network of the garden alleys provide feedback and the brain will be developed by city government leverages machine learning and optimization algorithms to create a most efficient and suitable action to the garden.



Source: *https://sites.psu.edu/sbslab/research/city/comprehensive-pliant-permissive-priority-optimization/)*

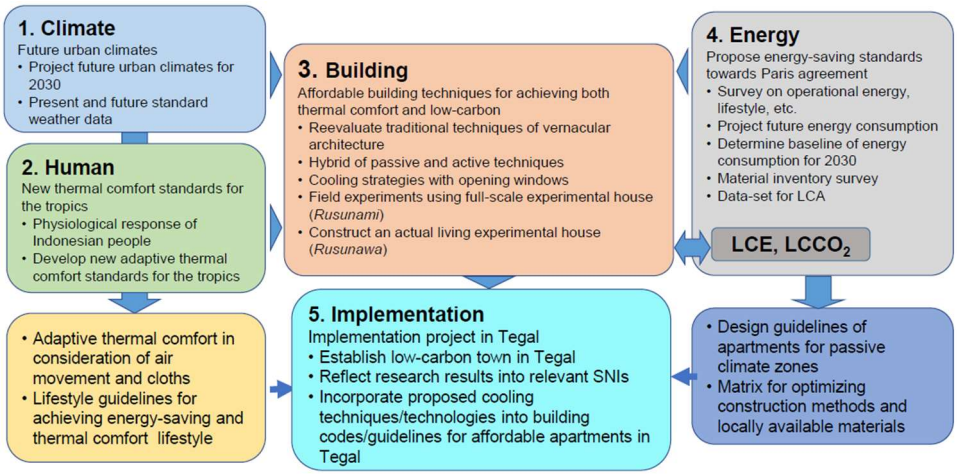
B.1.2.3. Green Building Policy and Its Implementation in Indonesia

Several policies from the domestic scale that has been established to realize the green building implementation, supported by the Law No 17/2020 article 24, government regulation no 16/2021 and regulation from The Ministry of Public Works no 21/2021 concerning the green building assessment. The green building concept on domestic level itself has been introduced and will be implemented in the current development Indonesia new capital city, with vision The World City of All."

The Ministry of Public Work itself has applied the concept of green building on its main building and several public facilities (markets, schools, hospitals, and sport/cultural facilities), with certified green building and win an award (Graha Wiksa Praniti, Bandung as the 1st winner of ASEAN energy award 2020).

The green building roadmap on the domestic level has already been determined since 2010 and resulted in a Regulation of the Ministry of Public Works No 2/2015 concerning green building as the early step. Post designation of this ministerial regulation, the roadmap for energy efficient, low carbon buildings and construction sector in Indonesia was developed, as well as capacity building for the public servants, professionals, and experts

Innovation on the public housing sector was observed from the ongoing research on green building technology, in collaboration with JICA and JST called SATREPS is trying to realize the concept standard of low carbon building, with the case study in the high-rise apartment in Tegal through a holistic approach.



Source: Dian Irawati Presentation (2022)

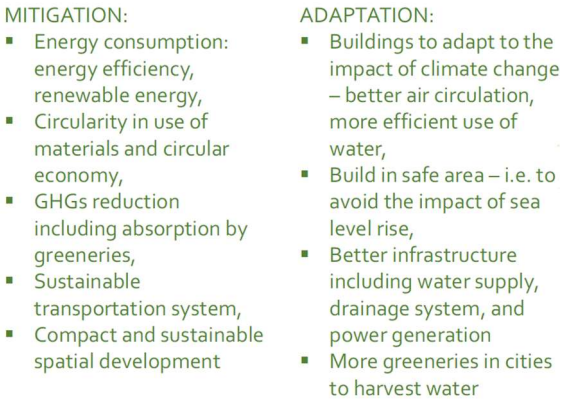
Section 2: Policy and Regulation: Roadmap towards Green Building Policy

B.1.2.4. Role of Building and Cities in Climate Actions

Building sector become the largest potential for significantly reducing greenhouse gas emissions compared to other major emitting sectors by 38% contribution and make energy savings of 50% or more in 2050.

Green Building design, construction or operation can create positives impacts on our climate and natural environment, while preserve it and improve our quality of life. Beyond Green Building is Green Cities, and it is important to look after the cities itself not just the building. We have infrastructure, sprawling slums, chaotic traffic, air pollution, lacks of green space, inequity, etc. as the problems. Green City will promote the energy efficiency and renewable energy, green solutions, land compactness with mixed-use practices of planning, and anchors the local development for equity growth.

Building and Cities have role in climate actions, for both mitigation and adaptation. Green Building Policy must be an integral part of green city policy as a Roadmap, which refer the economy's target and commitment under Paris Agreement, and refer to initiatives towards net zero emissions and climate resilience, and beyond technical challenge (socio-economics issues consideration).



Source: Kuki Soejachmoen Presentation (2022)

B.1.2.5. Roadmap Towards Green Building Policy

It is important to see the connected Paths to SDGs and ESG (Environmental Social and Governance) especially number 7, 11, and 13 of SDG. Energy sector in Indonesia NDC & Paris Agreement need the commit, because in our current policy, we still in the level of Highly Insufficient to achieve below degree when discuss the Paris Agreement compatibility, need for deep-cut

The government of Indonesia already prepare for LTS LCCR (Long Term Strategy for Low Carbon and Climate Resilience) but remain the energy emission is high. But if the target is in 2060 for NZE (Net Zero Emissions), energy sector has a big impact.

In 2030, the target of indirect GHG (Greenhouses Gas) emissions from the use of electricity is accounted by building (64%) and industry (36%). We can compare between 2010 and 2018, the indirect emission is coming from Building Sector (residential & commercial).

in LCS (Low Carbon Society Pathway) there are many actions and key factors can be implemented to the society, through Clean Energy, Low Carbon Style, Low Carbon Electricity. We can see China or Japan with high technology quality and compact society to become low carbon. Last time around 2014, we just released our study in green building and MRT in Jakarta, which we published to promote sustainable transportation.

Energy efficiency can work as mitigation aspect, with the standard not the label, but also equipment and appliances, also materials. There are 4 pillars of energy efficiency of the Decarbonization for The Achievement of Indonesia NDC 2030. Service sector of Indonesia is focusing on building, and we can see the efficiency standard with the importance of NDC. To ensure that energy efficient building codes (incl. standards) and government regulations on EE in building as well as Green Building, are widely implemented.

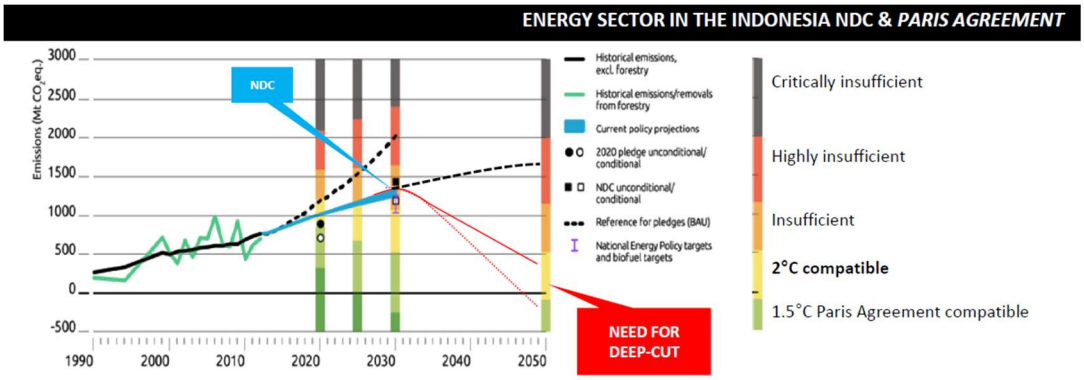
Source: Totok Sulistiyanto, GBCI Updated (2022)

B.1.2.6. Policy and Regulation: Roadmap Towards Green Building Policy

The building and construction sector are the sleeping giant in the fight against climate change. 184 economies have contributed NDCs under the UN Framework Convention on Climate Change, Indonesia is not part of 136 mention buildings in their NDCs, it should be conducted very soon

We have been negligent in dealing with climate change that is occurring slowly, even the environment is devastating. Every target of Paris Agreement until 2050 should be conducted on each phase with Domestically Determined Contributions (NDCs). The most effective for targeting Net Zero Emissions and Decarbonizing are in the Buildings & Construction sectors.

Not only we are facing the shortness of energy and natural resources, but we need directives and sustainable targets to reach the healthy building, and conduct the assessment of Green Building since the very beginning.



Updated Indonesia NDC (*Nationally Determine Contribution*)

Sektor	Base Year, 2010 (MTon CO2-e)	GHG Emission 2030 (Mton CO_2-e)			Reduction of BaU (Mton CO2e)		% reduction of BaU	
		BaU	CM1	CM2	CM1	CM2	CM1	CM2
Energy*	453.2	1,669	1,355	1,223	314	446	11%	15.5%
IPPU	36	70	67	66	3	4	0.1%	0.1%
Agriculture	110.5	120	110	116	10	4	0.3%	0.1%
Forestry**	647	714	217	22	497	692	17.3%	24.1%
Waste	88	296	285	256	11	40	0.4%	1.4%
Total	1,334	2,869	2,034	1,683	835	1,186	29%	41%

*Including fugitive; **Including peat fire; CM1 = unconditional, CM2 = conditional

Remarks

BaU	Development Path not deliberated the mitigation policies
CM1	Mitigation scenario & considers sectoral development target (Unconditionally)
CM2	Ambitious mitigation scenario + International support available (conditionally)

Source: Climate Action Tracker (2017); Indonesia Updated NDC (2021)

Section 3: Implementation: Best Practice for Emerging Economies/Cities.

B.1.2.7. Cool Roof for UHI Countermeasure a Green Building Added Value

Three main things happen when solar radiation hits the surface of the roof material are absorption, solar reflectance, and thermal emittance. The value of solar radiance in Indonesia is not big but has long duration of exposure. Urban Heat Island (UHI) is created when a material with low albedo values exposed by the solar radiation partially reflected and partially absorbed with only heat released at night.

In Indonesia, the albedo value is still need to be investigated to make a best approach in making intervention in city level to countermeasures the UHI, with consideration the material properties of the city should have high u-value and albedo. Solar reflectance index (SRI) is an indicator of the surface temperature of a material under solar radiation.

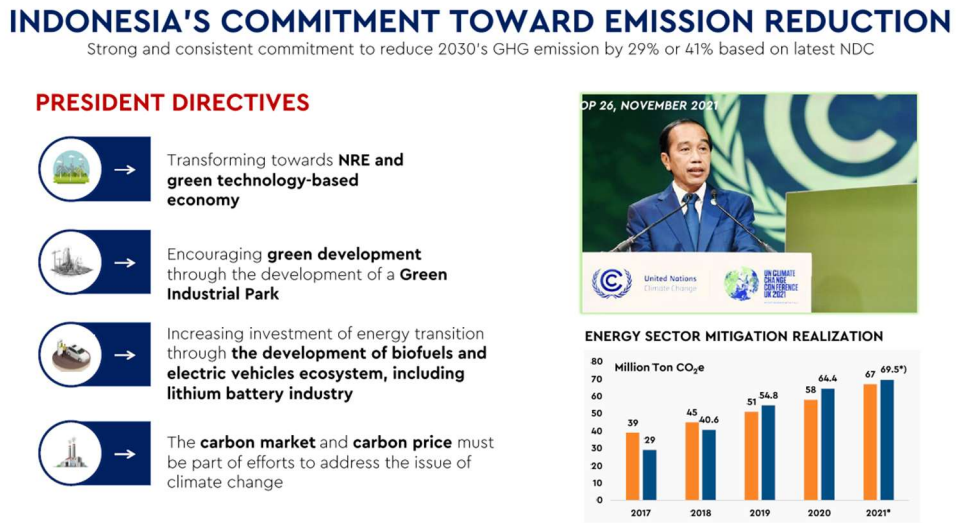
The SRI value of a material depends on its ability to reflect solar radiation and emits heat from the sun.

Cool roof becomes one alternative to reduce the UHI in building and city level. Cool roofs are coating (generally on roofs and can be used on walls) that reflect the solar radiations that reduce the temperature difference. This is important for buildings without artificial cooling (AC) in hot humid tropical climates where daily maximum temperatures are above 30 C. Some application can be found on a complex of PT Mayora Indah, Tangerang, Aaksen Studio, Bandung and Daarul Hasanah, Bangka Belitung.

Source: Beta Paramita Presentation (2022)

B.1.2.8. Implementation of Energy Management in Building Towards Net Zero Emission 2060

Emission reduction has been included as Indonesia's commitment through president directives. The current state of emission reduction in Indonesia has the reached target and expected to achieved more within the next year. Grounded from Domestic Energy Policy (Domestic Regulation No 79/2014), the energy conservation target in 2050 consists of reducing energy intensity by 1% per year with final energy saving of 39%. The large final energy consumption is in transportation and the industrial sector.



Source: KESDM Presentation (2022)

Domestic energy saving by around 10%-30% will aim the energy saving behavior using energy audit on the industrial, transportation and commercial sectors, and awareness on household sector. Transportation and building (particularly commercial) sector will be mandatory to give report concerning energy efficiency, derived from the government regulation no 70/2009 concerning the energy conservation. Selected strategies to implement the energy efficiency to increase Net Zero Energy (NRE) consists of energy saving standardization and labelling, application of energy saving technology, application of energy management, energy conservation business development as well as awareness and awards.

Various strategies to achieve efficient energy implementation and management are:

- Energy management optimalization using high efficiency equipment on commercial building
- Develop policy and regulation concerning green building implementation and Net Zero Energy Building
- Develop the energy management system, with ISO 50001 become the guidelines for domestic scale. Through ISO 50001, numerous energy sector company, buildings and industry sector has participated and several buildings has certified, including airports and government building
- Utilize the active and passive design to reduce energy consumption. Respective
- Advancing the roadmap of equipment standardization and energy efficient awareness, one of them through award (ESDM has created Subroto Award to appreciate and promo the implementation of energy efficient management)
- Upgrade the capacity of energy manager and energy auditor
- Integrate the data information on energy. SINERGI (System Informasi Konservasi Energi) become government tools for reporting, determining the existing trend and submitting application for Subroto Award.

Lesson Learned

While the introductory meeting provides low carbon and green building concepts, methods and principles that closely related to the context of Banda Aceh, the main workshop gives insight on the international and domestic scale with focusing on the green building roadmaps, regulation and possible implementation following the current trend and emerging issues. These workshop and discussion aim to give deeper understanding and capacity building to increase the awareness of Banda Aceh people as well strengthening the city's policy development by giving views concerning current affairs, supporting policies and applicable implementation.

Some points that can be noted and acted upon to implement the green building concept in order to move towards a low-carbon city, including:

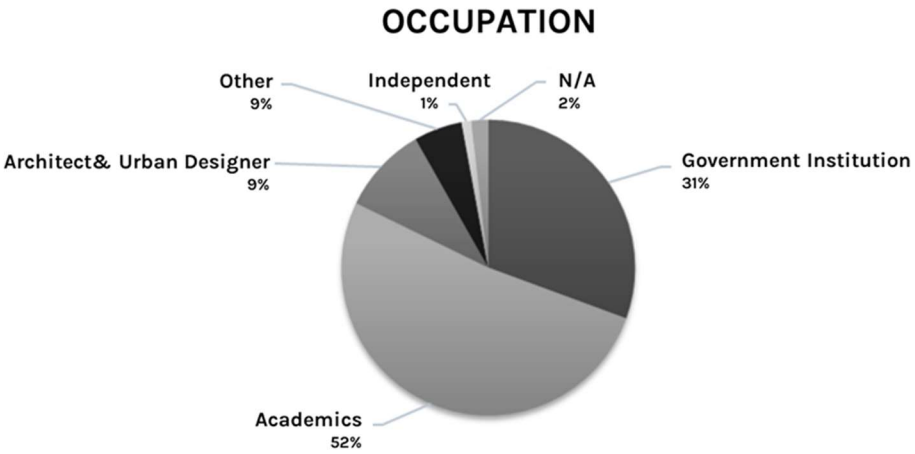
- Data gathering understanding on efforts in reducing the carbon emission or energy consumption are necessary, with mindset from global to local/city level, to gain an efficient baseline of the formulation of the regulation
- Determining the roadmap of Low Carbon development highly contributes to a successful implementation. Current roadmap from domestic level (within the scale of Indonesia, ministries) and city level (in example DKI Jakarta) needs to be considered to gain more contextual result suits for Banda Aceh
- To support the green building concept is not enough by only relying on the regulations of green building and detailed spatial planning on city level, but a designated regulation is necessary, in line with the city context, challenges and opportunities.
- A skilled and conscious human resource can make a more efficient implementation.
- Several intervention and strategies to succeed the green building implementation comes physically and through proper management. Physical retrofit with cool roof, active and passive design as well as net-zero building design, added with well-organized energy management with SINERGI, energy standard and awards.

B.2. Green Building Awareness in Banda Aceh

Observation on Public Awareness to Green Building Management

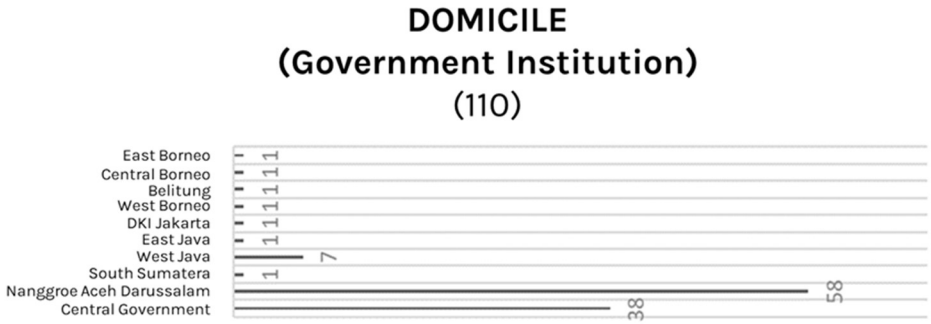
The initial observation of green building awareness in Banda Aceh were investigated by distributing sets of questionnaires during the virtual seminar and discussion in 2021 and during the site survey. The first questionnaires were targeting the audience of the webinar with majority of Banda Aceh locals, and the second questionnaires were targeting the owner/manager of the selected building during site survey.

Based on the collected answers from the webinar, there are 372 respondents participated in the event and fill in the questionnaire with most of the respondent's occupation were the academics (52%), followed by the government (31%), architect and urban designer (9%), institution (5%), independent (1%) and anonym (2%).



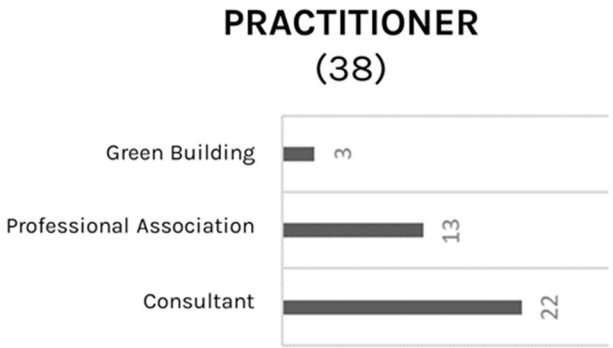
Occupation of the Respondents
Source: Project Team (2022)

110 respondents came from government institutions, with 38 respondents were the central government, and 72 respondents were local governments, with majority of the respondents (58 respondents) from Nanggroe Aceh Darussalam, 7 respondents from West Java, and the rest of respondents were coming from East Kalimantan, Central Kalimantan, Bangka Belitung, West Kalimantan, DKI Jakarta, East Java, and South Sumatera.



Domicile of The Government Institution of the Public Officials
Source: Project Team (2022)

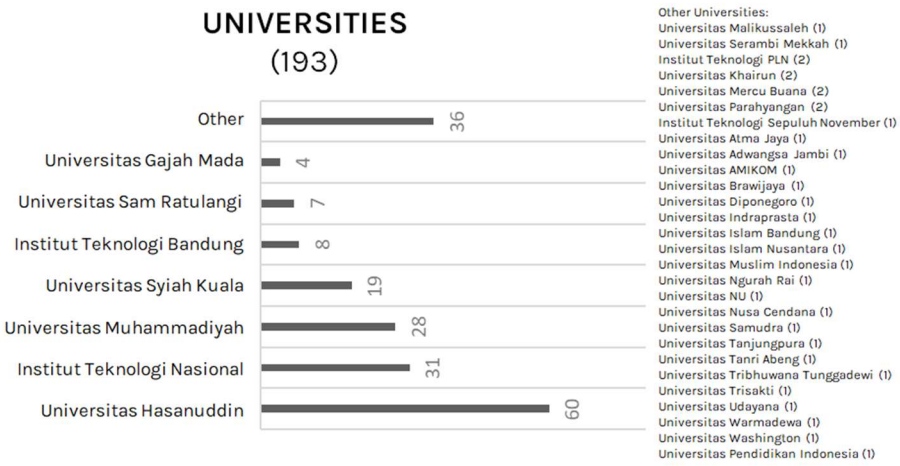
Meanwhile, another 38 respondents were practitioners specialized in green building (3 respondents), from association of a profession (13) and most of the respondents (22 respondents) were consultants.



The Professional Background of the Practitioners

Source: Project Team (2022)

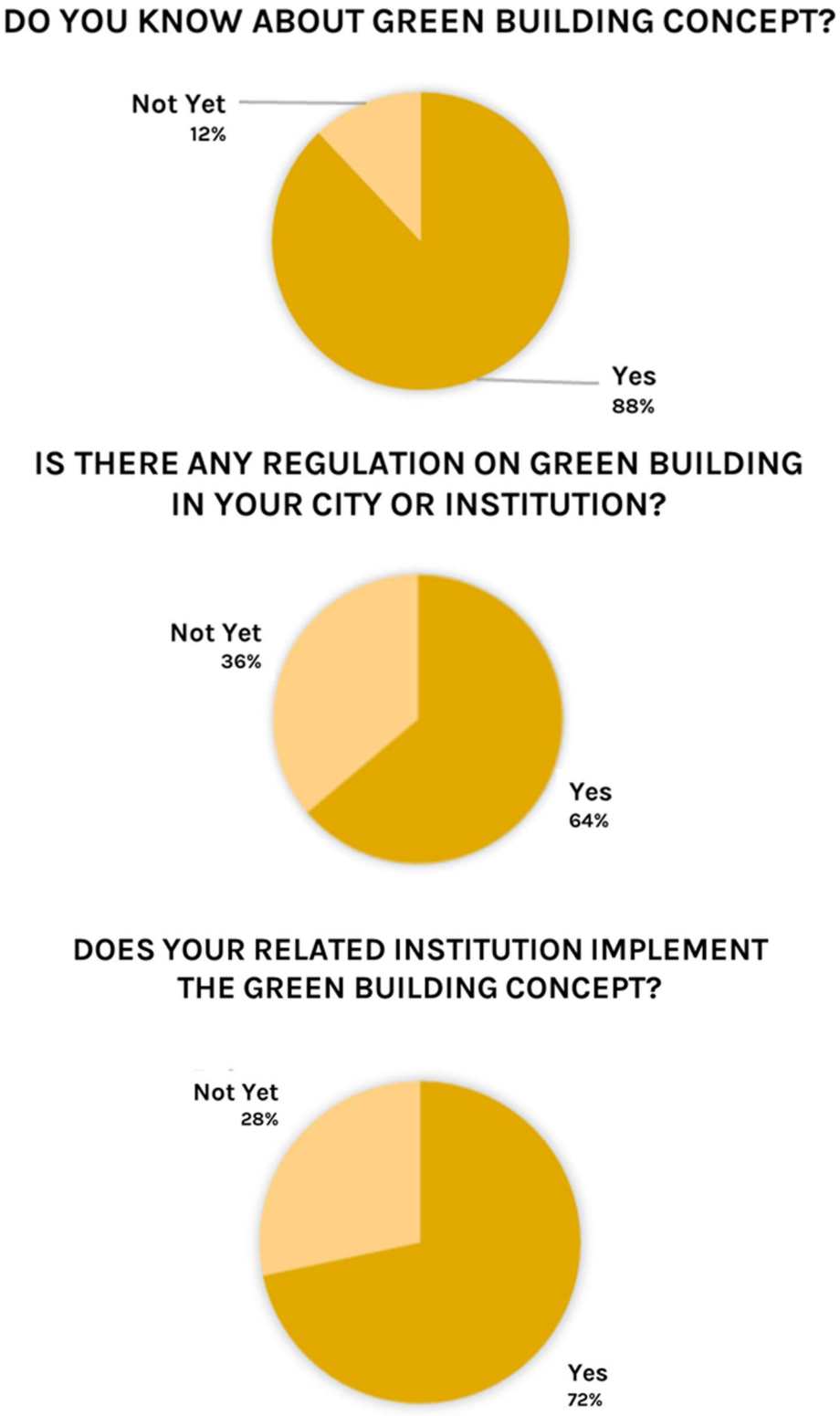
Academics became the most dominant respondents with a total of 193 respondents. Most of the academics came from University of Hasanuddin in South Sulawesi (60 respondents), followed by Institut Teknologi Nasional in West Java (31 respondents), University of Muhammadiyah (28 respondents), University of Syiah Kuala in Banda Aceh (19 respondents), Institute Technology of Bandung in West Java (8 respondents), University of Sam Ratulangi in North Sulawesi (7 respondents) University of Gajah Mada in Yogyakarta (4 respondents) and other universities (36 respondents).



The Affiliated University of Respondents

Source: Project Team (2022)

Several questions were answered by a total 166 respondents concerning the green building general knowledge. Most of respondents already knew (88%) the concept of green building and there were regulations on green building on most of respondents' city or institution (64%). And lastly, 72% of the institutions where the respondents work has already had implemented the green building concept.

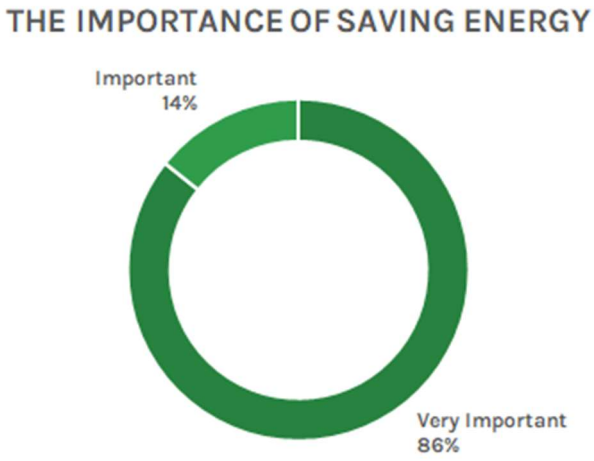


Distributed Data on The Green Building Concept, Regulation, and Implementation
Source: Project Team (2022)

The second questionnaire during the survey has conducted as well to the building owner or management at several public office buildings in Banda Aceh. With a total of 7 office

buildings owned by the government as the representative in Banda Aceh, questions concerning green building management were distributed using online questionnaire.

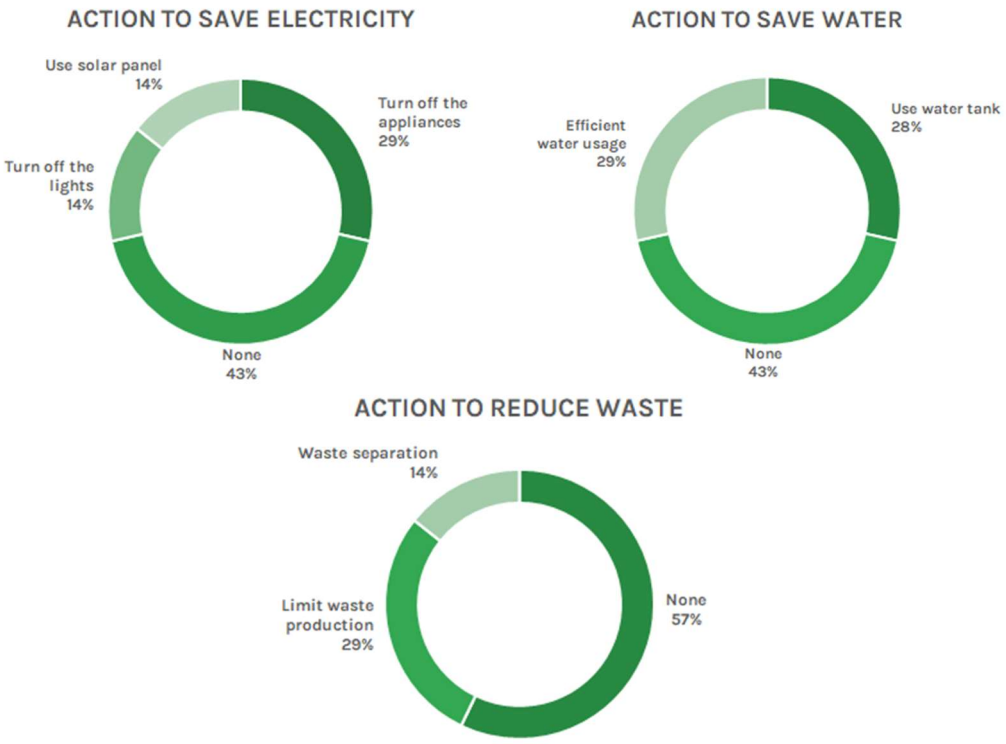
A question concerning the importance of saving energy was asked with the Likert scale from 1 (not important) to 4 (very important) to the building owner/manager. The dominant answer from 7 building owner/manager were very important (4) with 86% share, while 14% of the respondents answered important (3).



The Importance of Saving Energy
Source: Project Team (2022)

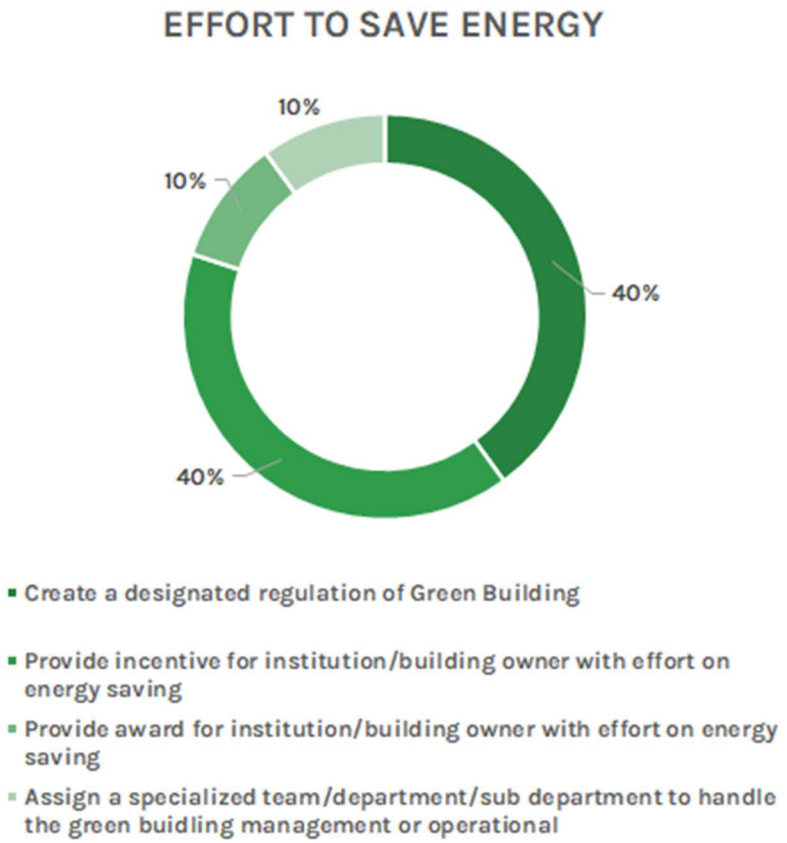
Several questions related to the action to reduce energy consumption in the building were questioned, such as the actions to save electricity, water and reduce waste. Despite the respondents believing that saving energy is important, the action from the majority of respondent is considered none, with 43% on saving electricity and water, and 57% share on reducing waste.

In order to save energy, there are some actions that the respondents could think of. To save electricity, the answers come from the respondents were related to the turn off the electronic appliances (such as AC) by 29% share, turn off the lights, and use solar panel as alternative energy resource with the same share by 14%. To save water the respondents believe the possible action are related to efficient water usage (29%) and use the water tank as water storage (28%). And lastly, to reduce waste, the possible actions the respondents can think about are related to waste separation (14%) and limiting waste production (29%).



Actions related to the Green Building Principles
Source: Project Team (2022)

A question related to the recommended efforts to save energy was asked to the building owners/managers. With 4 options as the possible efforts to increase the energy saving action, majority of respondents answered the designated regulation of green building and incentive becomes the top priority, with each answer give 40% share. 10% of respondents consider the award and the assignment of specialized team/department are important as well.



Efforts to Save Energy
Source: Project Team (2022)

Recommendation towards Green Building Awareness in Banda Aceh

In accordance with the answered questions, most of the respondents with academician, government officials and professionals have already been aware of the concept of green building, with availability of applicable local regulation on green building and the implementation in the respective institution has considered initiated. While from the building owner the importance of Green Building management is considered very important, but the possible actions to implement the green building principles are still limited to energy saving, except for the action to save electricity with the use of solar panel, which means that there is a possibility to gain another alternative renewable energy resource. To increase the effort to save energy, many respondents prefer a designated regulation on green building and incentives as options.

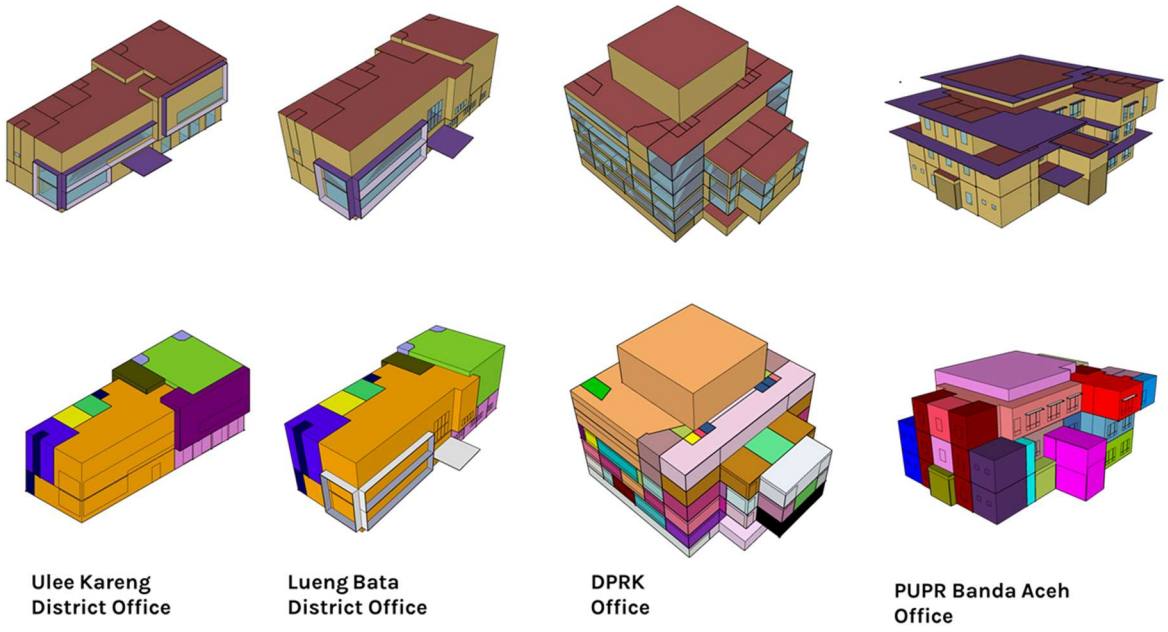
B.3. Building Management

B.3.1. Building Information

Four government office buildings were selected to measure the monthly and annual energy consumption through simulation with energy measurement software called Open Studio and site survey. The location of these four buildings is in the Banda Aceh Municipality with position as seen on the map below.

The Location of The Selected Building in Banda Aceh
Source: Project Team (2022)

The site survey of these buildings consists of the outdoor and indoor environment measurement, and the electricity consumption as well. The parameters for outdoor and indoor environments are air temperature (°C), Relative Humidity (%), and Wind Speed (m/s). The electricity consumption within the buildings was measured by the data logger measurement device, placed at the electricity panel of each building, to record the electricity outputs in 24 hours. This data will be the input for building modelling and simulation. After the result of electricity consumption from the existing condition of the building was determined, the next step is modifying the building, lighting, and the ventilation system to gain the most efficient electricity reduction.

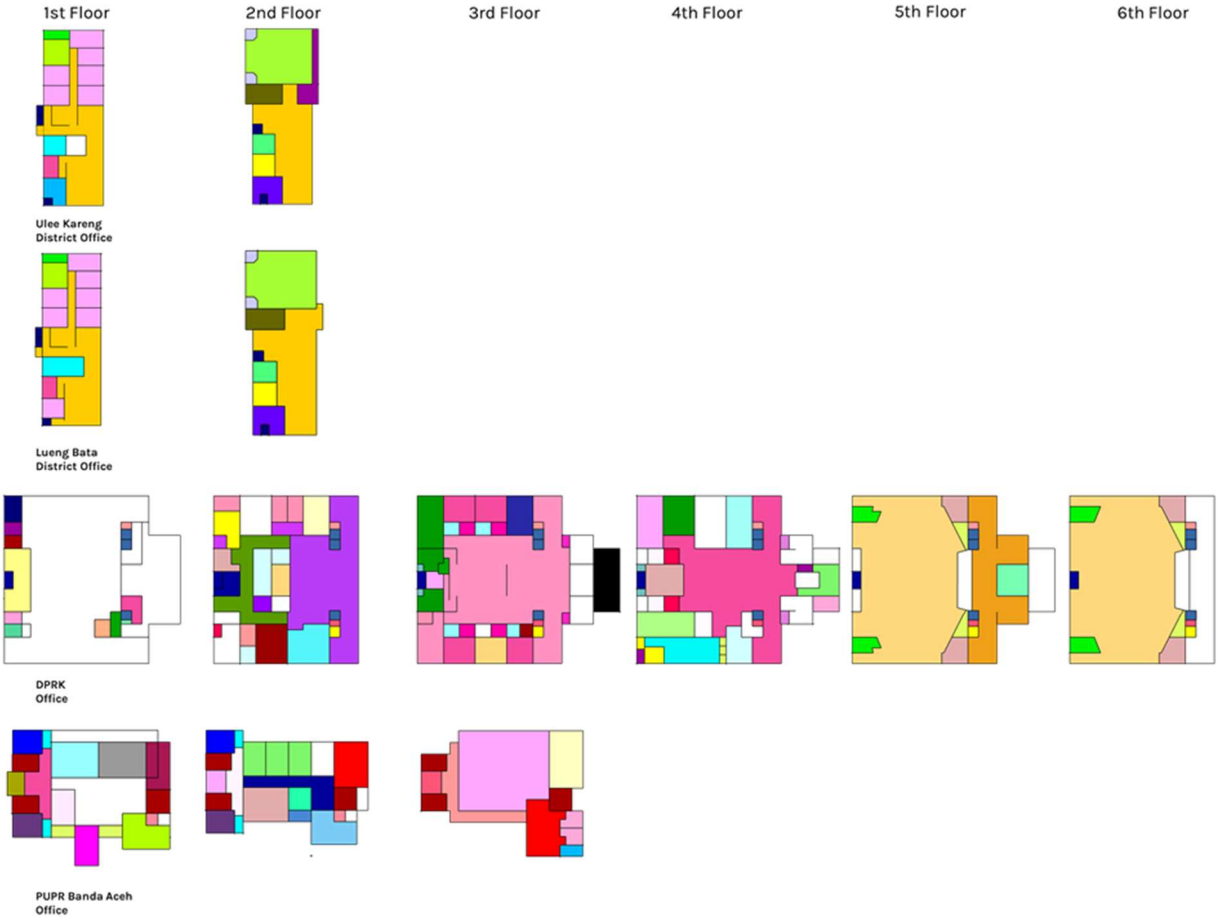


Building Models and Thermal Zones
Source: Project Team (2022)

The settings for building models are concentrated into three types of setting, consist of:

1. **Thermal zone:** This setting is focused on the thermal setting inside the room, such as the HVAC system with 3 options, using air conditioner (AC), using fan, or with natural ventilation.
2. **Construction:** This setting is focused on the construction material in the specified climate setting. The architectural element included in construction comprises of wall, floor, ceiling, openings, and shading.
3. **Loads:** This setting is focused on the lighting power and the number of occupants per square meter in each room.

Each of the buildings has a designated thermal zone, in each of its rooms. Ule Kareng and Lueng Bata District Office have a typical floor plan with 2 stories and thermal zone between 13-16 zones, while DPRK Office has 6 stories on its building with 89 thermal zones and PUPR Banda Aceh Building has 3 stories with 39 thermal zones on its building.



Floor Plan of the Selected Buildings

Source: Project Team (2022)

Building Information

Component	Building			
	Lueng Bata District Office	Ulee Kareng District Office	DPRK Banda Aceh	PUPR Banda Aceh
Floor Area	**866,92 m²**	**859,8 m²**	**8449,92 m²**	**1398.59 m²**
1st Floor	420 m	436,8 m²	1414,08 m	476,3 m
2nd Floor	446,92 m	459 m²	1267,2 m	445,45 m
3rd Floor	-	-	1500,48 m	476,84 m
4th Floor	-	-	1500,48 m	-
5th Floor	-	-	1500,48 m	-
6th Floor	-	-	1267,2 m	-
Spatial Configuration				
Total Room	25	27	164	54
Thermal Zone	13	16	89	39
Occupancy				
Capacity	23 people/day	15 people/day	95 people/day	135 people/day
Duration	8,5 hours/day on weekdays	8,5 hours/day on weekdays	5 hours/day on weekdays	8 hours/day on weekdays
Electricity				

Capacity	P-1/TR (5.501 – 200 kVA)	R-1/TR (451 – 900 VA)	R-2/TR (2.201 VA – 5.500 VA)	B-1/TR (1.301 – 5.500 VA)
Monthly Electricity bill	IDR 2.700.000	IDR 2.000.000	IDR 42.000.000	IDR 5.000.000
Monthly Consumption	1.588,67 kWh	1.479,29 kWh	24.712,71 kWh	4.545.45 kWh
Lighting				
Number of Lighting	100 lights with 70 LED lamps and approx. 50 lights on in a day	99 lights with 26 LED lamps and approx. 51 lights on in a day	350 lights with 60 LED lamps and approx. 200 lights on in a day	50 lights with 20 LED lamps and approx. 40 lights on in a day
Daily usage	6-12 hours/day	>12 hours/day	6-12 hours/day	<6 hours/day
Air Condition				
Number of AC appliances	10 AC Split	12 AC Split and 2 Electric Fan	70 AC Split and 14 Electric Fan	10 AC Split
Duration	AC: 6-12 hours/day	AC & Fan: 6-12 hours/day	AC: 6-12 hours/day Fan: < 6hours/day	AC: <6 hours/day
AC temperature setting	16-18^{0}C	19-21^{0}C	19-21^{0}C	19-21^{0}C
Water Management				
Source of water	Public water resources company (PAM/PDAM)	Public water resources company (PAM/PDAM)	Public water resources company (PAM/PDAM)	Public water resources company (PAM/PDAM)
Monthly water bill	IDR 500.000	IDR 220.000	IDR 1.300.000	IDR 1.500.000
Number of Toilet	3 restrooms with 3 small bathtub/water container	5 restrooms with 5 small bathtub/water container	25 restrooms	4 restrooms
Waste Management				
Waste separator	available	available	N/A	available
Monthly waste bill	IDR 1.000.000	IDR 1.200.000	IDR 200.000	IDR 250.000

Building Information

Source: Project Team (2022)

The building data above represents the building management for government office within the office hours. Ulee Kareng and Lueng Bata District Office become the representative of a low-rise building, meanwhile PUPR and DPRK become the example for mid-rise building.

The monthly electricity bill of each building varies, because each building uses a different electricity tariff. Within a month, Ulee Kareng District Office has electricity consumption with total 1,72 kWh/m^2, Lueng Bata District Office 1,8 kWh/m^2, DPRK 2,92 kWh/m^2, and PUPR gives the highest consumption with 3,25 kWh/m^2.

Observation on how the green building principles are being applied in the building is measured by several parameters, such as the lighting and HVAC system as well as the water and waste management. The lighting system of all the buildings has already applied LED lights, with approximately 20%-50% installation. The lights are on for 6-12

hours per day using more than half of the lights. Due to the hot humid climate condition in Banda Aceh, air conditioning (either from air conditioner or fan) become essential for many of the buildings. The AC setting in these offices usually sets for at least 6 hours during office working hours with temperature setting between 16-21^{0}C.

Meanwhile the water supply is heavily coming from state-owned companies, with no information related to the rainwater harvesting/storage on the building. Three buildings have a waste separator, making it a step closer to the green building implementation.

On an overall observation, the initial implementation of green building principles can be seen from the usage of LED lights to reduce energy consumption and the waste separation to minimize the upcoming land or water pollution and contamination. An opportunity to install a rainwater harvesting system into the building to provide alternative water resources and the provision of renewable energy from solar panel as one option to achieve nearly zero energy from electricity aspect.

B.3.2. Environment Condition

The parameters for the outdoor and indoor environments measurement are based on the comparison between air temperature (^{o}C), Relative Humidity (%), Wind Speed (m/s), and Illuminance (lx). The outdoor environment data source collected from the BMKG (Meteorology, Climatology, and Geophysical Agency) and Aceh Station. The analysis conducted in 4 existed Banda Aceh buildings; Ulee Kareng District Office, Lueng Bata District Office, PUPR (Ministry of Public Works and Public Housing) Office, DPRK (City Council of People's Representatives) Office.

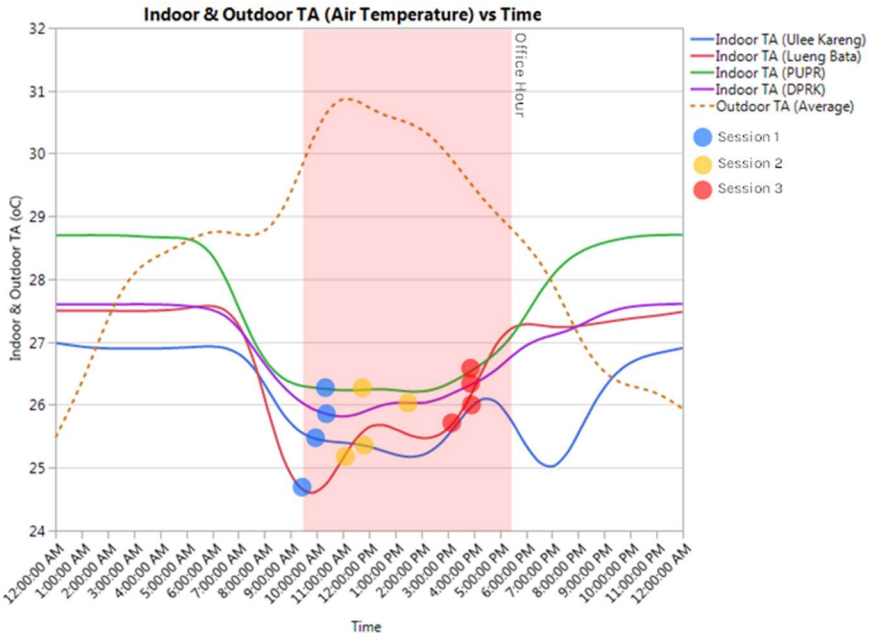
The indoor environment's condition was measured through various tools, such as T&D Ui Data Logger for analyzing the Temperature, Relative Humidity, and Illuminance. The other equipment is Lutron Heat Index WBGT (Wet-Bulb Globe Temperature) for measuring the indoor Ambient Temperature, and Lutron Anemometer to observe the Air Velocity.

Most of the time duration of the field survey to analyze the indoor environment of each building is held in 2-4 days, depending on the field condition. The Ulee Kareng and Lueng Bata District Offices analysis were conducted from 4 to 5 August 2022, while the PUPR Office measured in 3 days from 9 to 11 August 2022, and the DPRK Office checked from 15 to 18 August 2022. The indoor environment data were collected in the interval of minutes, to reach the most precise of the climate condition.

Then, the data processing is taken through the average calculation between each building and parameters in 24-hour duration, with the interval shown in every hour. The analysis also included the Electricity Consumption within the buildings, which measured by the data logger measurement device using Eyedro Home Electricity Monitor Equipment, and placed at the electricity panel of each building to record the electricity outputs in 24-hours average.

Tools of Environment Measurement

1. **Air Temperature (°C):** Air temperature parameter is a benchmark for identifying the temperature conditions related to the thermal comfort in the room. Time conditions, artificial air conditioning / cooling settings system, the number of user activities, the area, and type of room can affect the difference in air temperature. The analysis conducted in 3 sessions from the morning, noon, and afternoon. With the minimum duration of 1 hour of each session, the interval led with various time and field condition activities, started from around 9 AM (first session), 11 AM (noon session), and ended around 5 PM (afternoon session).

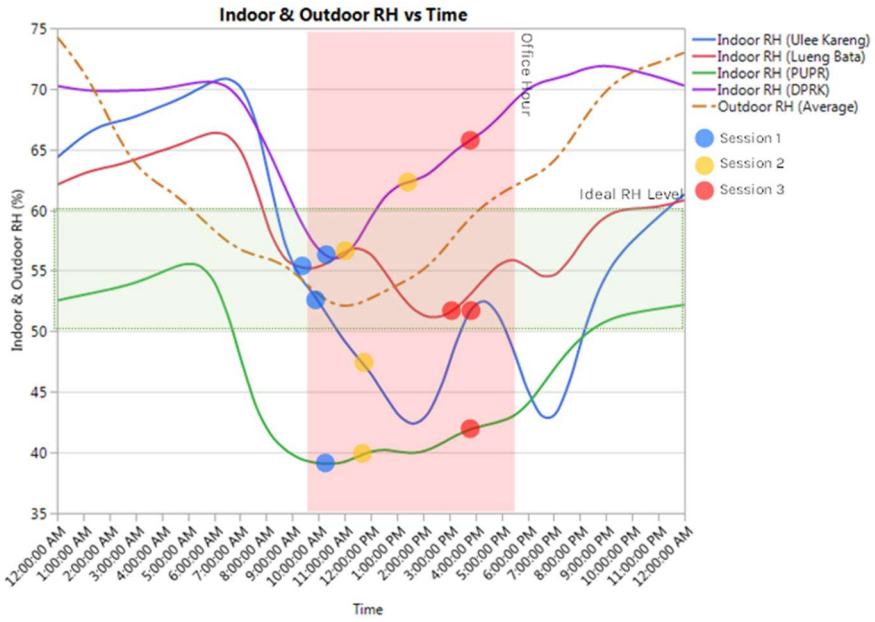


Air Temperature Condition
Source: Project Team (2022)

- The indoor TA was higher before office hours, and dramatically decreased during, then it increased again after 5 PM or after office hours.

- The indoor highest TA is shown in the PUPR Office, before and after the office hours with approximately 28,7 °C.
- The indoor lowest TA recorded in Lueng Bata District Office during office hours, with the temperature showed 24,3 °C at 10:13 until 10:18 AM.
- The first session (morning time) had the lowest temperature compared with the second session (noon time), and the third session (afternoon time).
- Overall, the Indoor Air Temperature (TA) during office hours is lower than the outdoor Air Temperature, with the average gap showing more than 3 °C.
- Meanwhile, the after-office hours showed that the indoor TA are higher than the outdoor TA.

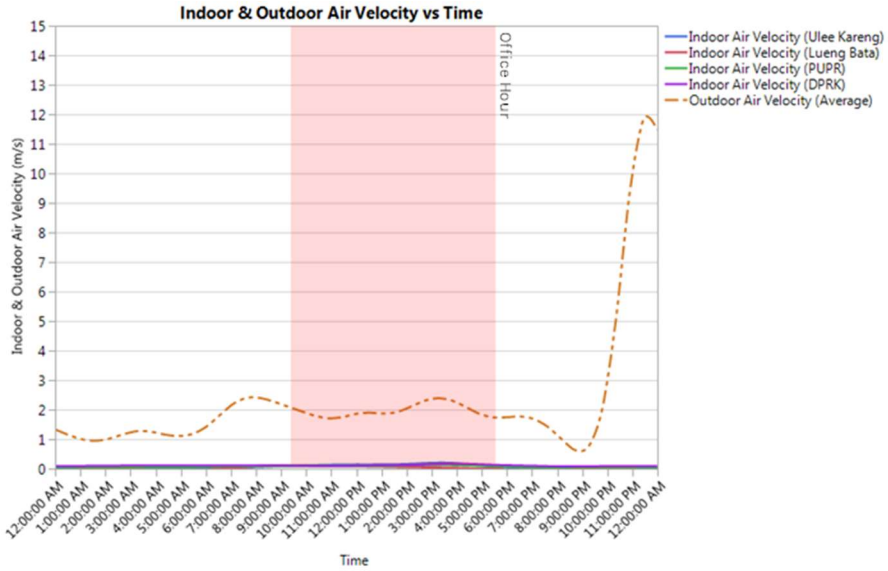
2. **Relative Humidity (%):** relative humidity is a parameter to measure the humidity level of the room, compared with the outdoor environment condition. In thermal comfort, this parameter is used to describe the amount of water vapor contained in the water-air mixture in the gas phase.



Relative Humidity Condition
Source: Project Team (2022)

- The Indoor RH level in PUPR Building was below the ideal level rooms of Relative Humidity (RH) global standard set by World Health Organization (WHO) in 2020, which is at 50-60% during office hours.
- During office hours, the RH rate of Ulee Kareng District and DPRK Office reached the ideal level only in Session 1. Meanwhile, Lueng Bata District Office showed at ideal level for all Session from the morning to afternoon.
- DPRK office building exceeded the ideal level of RH in the Session 2, Session 3, and beyond the office hours.
- Only 3 buildings (Ulee Kareng District Office, PUPR, DPRK) with total 6 sessions which had non-ideal level of RH.

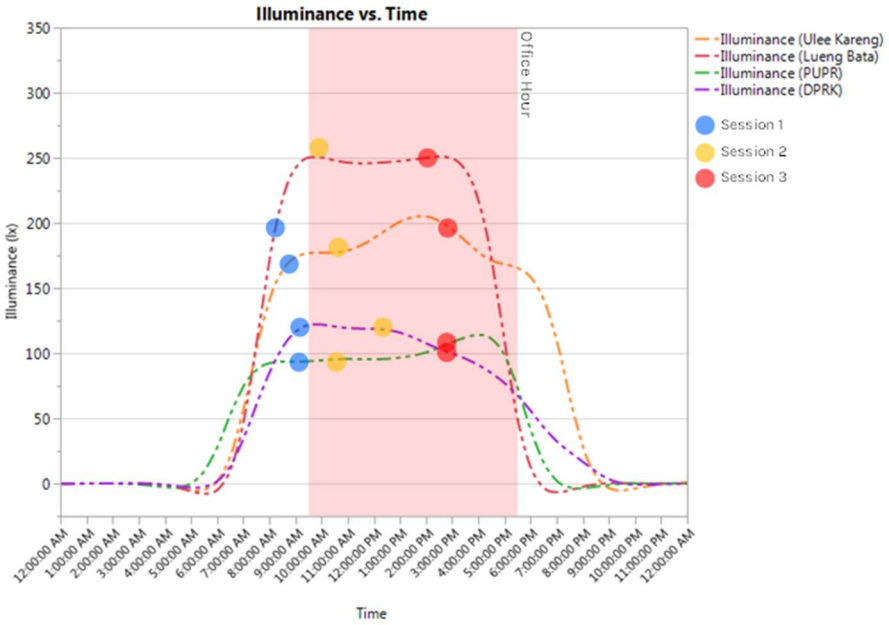
3. **Air Velocity (m/s):** Wind speed is measured and compared between the outdoor and indoor environment. This measurement is related to obtain the climate context that can support the comfortable use of space for residents. The Outdoor Air Velocity are calculated by the average speed (m/s) of 4 buildings and 8 days field measurement into 24-hours duration.



Air Velocity Condition
Source: Project Team (2022)

- All Indoor Air Velocity rate average (0,08 m/s) are below the Outdoor Air Velocity rate average (2,26 m/s).
- During office hours, the Indoor Air Velocity of DPRK Office is higher than others.
- After 9 PM, the Outdoor Air Velocity rate rocketed to around 12 m/2.
- The highest Indoor Air Velocity rate recorded in DPRK Office with 0,39 m/s at 3:05 PM, while the lowest rate showed in the Lueng Bata District Office with 0 m/s.

4. **Indoor Illuminance (lx):** This lighting level parameter is based on the usage of the indoor area, and the building function. Indoor illuminance is a measure of how much the incident light illuminates the surface, wavelength-weighted by the luminosity function to correlate with human brightness perception. Similarly, luminous emittance is the luminous flux per unit area emitted from a surface The Illuminance Standard is based on the newest revision of SNI 6197:2020 document for Office Workspace building typology with the Human Comfort Level of Lighting is 350 lx, and the Density Power is 7,52 W/m^2.



Illuminance Rate Condition

Source: Project Team (2022)

Nomor	Fungsi ruangan	Sebelum revisi (SNI 6197:2011)		Sesudah revisi (SNI 6197:2020)	-
		Tingkat pencahaya (lux)	Densitas daya (W/m2)	Tingkat pencahaya (lux)	Densitas daya (w/m2)
1	Ruang kerja kantor	350	12	350	7,53
2	Ruang kelas	350	15	350	11,95
3	Laboratorium sekolah	500	13	500	12,16
4	Perpustakaan	300	11	350	10,33
5	Ruang operasi	300	10	1000	24,33
6	Pekerjaan menengah-industri	500	15	500	8,61
7	Lobi hotel	350	12	200	5,49
8	Ruang pemeriksaan imigrasi	-	-	300	5,49

Standard Level of Illuminance

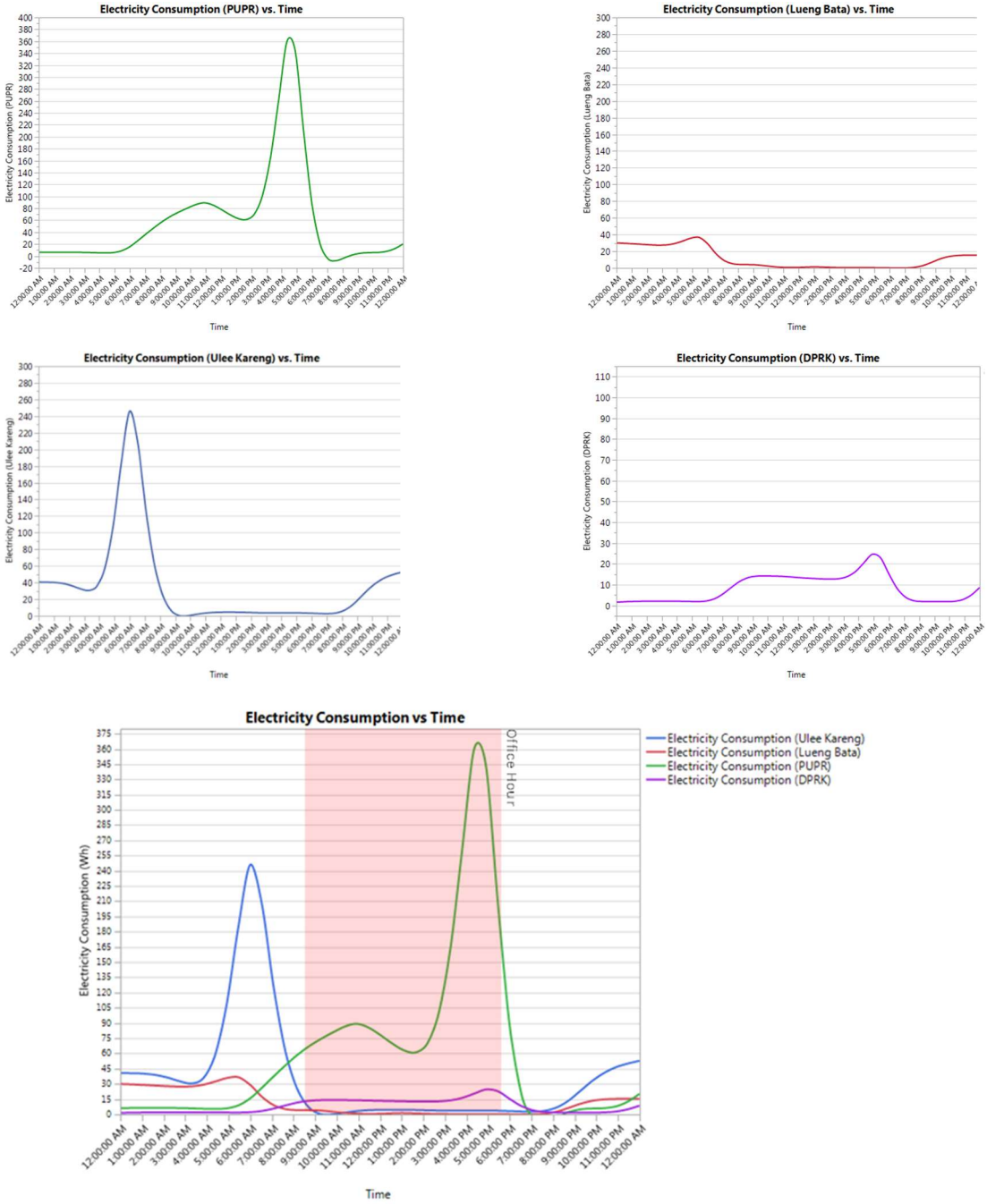
Source: SNI 6197:2011 and SNI 6197:2020

- All buildings were shown below the standard level of Illuminance in Office Building Typology.
- The illuminance level increased significantly during the office hours.

- During office hours, only Lueng Bata District Office nearly reached the standard level of Illuminance, while the PUPR Office had the furthest level to reach the illuminance standard.

B.3.3. Energy consumption

Electricity Consumption (Wh): Electricity Consumption is the form of energy consumption that uses electrical energy. Electric energy consumption is the actual energy demand made on the existing electricity supply for building usage.



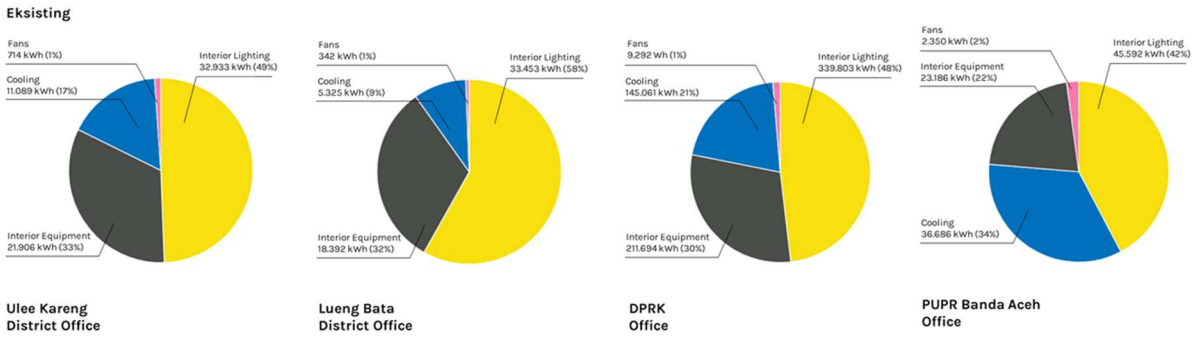
Comparison of Electricity Consumption

Source: Project Team (2022)

- PUPR Office Building had the highest Electricity Consumption in 24-hours duration (87,21 KWh) compared with others, followed by Ulee Kareng District Office Electricity Consumption (52,54 KWh) in a day.
- The highest Electricity Consumption recorded during office hours in the PUPR Building (2.121, 93 Wh) at 4:32 PM.
- Ulee Kareng District Office reached the highest level of Electricity Consumption before the office hours at 5 AM.
- Lueng Bata District Office had the lowest Consumption of Electricity during office hours, while after the office hours, Ulee Kareng District Office had the highest.

Building Retrofitting

The annual energy consumption of four surveyed buildings based on the simulation shows the proportion of the electricity consumption from interior lighting, interior equipment (the possible electronic equipment in the office, for example the computer), electric fan, and cooling system. Referring to the simulation result, all buildings electrical consumption is heavily from interior lighting, followed by interior equipment (except in PUPR cooling become the second largest consumption, followed by interior equipment), and then cooling and lastly electric fan.



Existing Annual Energy Consumption

Source: Project Team (2022)

The existing simulated annual energy consumption becomes the baseline to find the most suitable retrofitting strategy for the building. The building retrofit is determined into six steps, according to the easiest strategy to be applied in the building. First is to change the lighting system into LED light. This type of light has less energy consumption than the usual light bulb. With the same purpose, second, change the air conditioner to an electric fan. Next step is minimizing the opening ratio, to reduce the solar heat from the outside. Later, adding shades to the openings, to provide more shadow to the building. And lastly, add solar panels on the available area on the rooftop to provide more energy from renewable resources.

Energy Reduction Based on Building Retrofitting

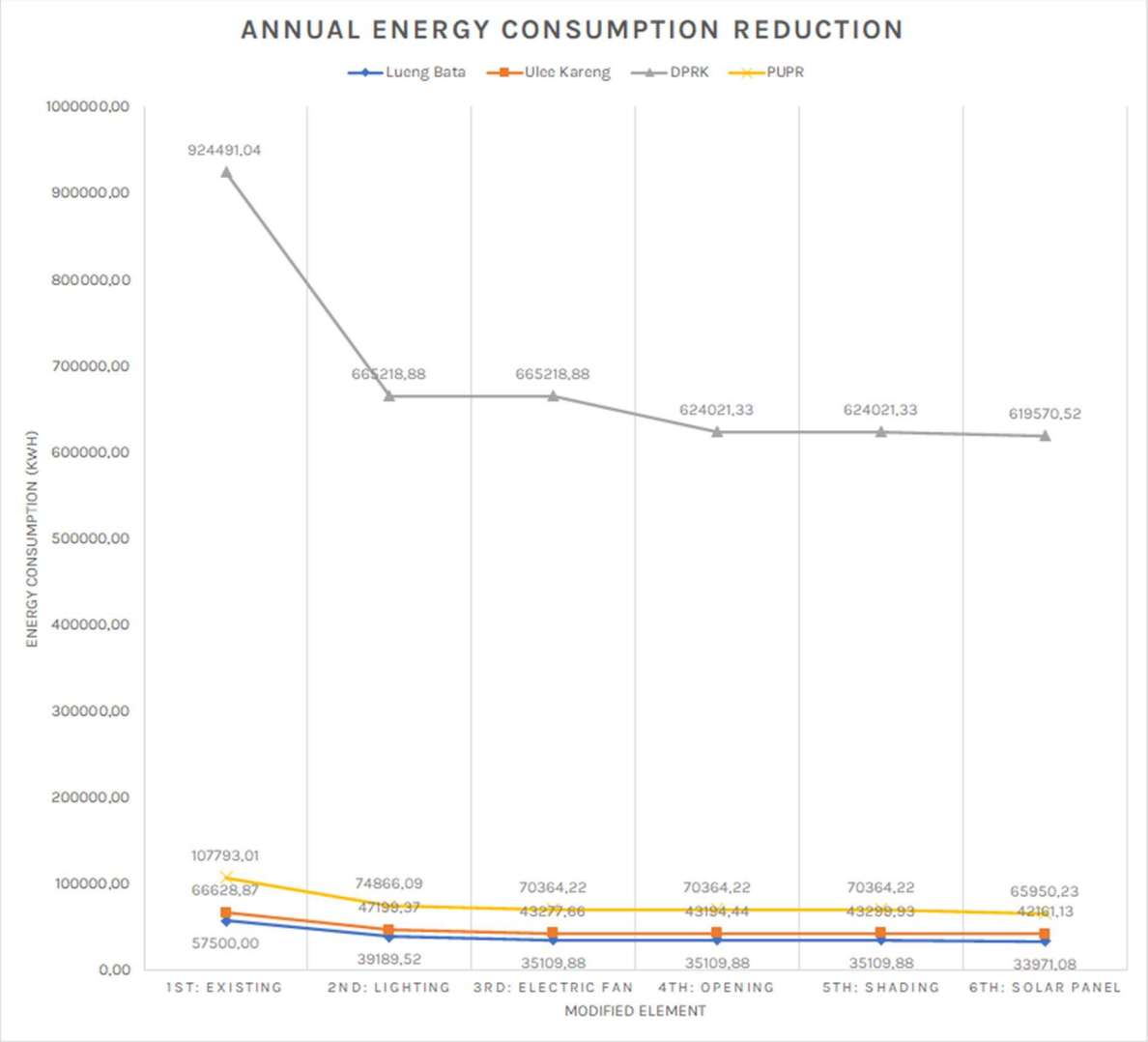
Office Building	Annual Energy Demand (kWh)						%
	1st: Existing	2nd: Lighting	3rd: Electric Fan	4th: Opening	5th: Shading	6th: Solar Panel	
Lueng Bata	57500,00	39189,52	35109,88	35109,88	35109,88	33971,08	59%
Ulee Kareng	66628,87	47199,37	43277,66	43194,44	43194,44	42161,13	63%
DPRK	924491,04	665218,88	665218,88	624021,33	624021,33	619570,52	67%
PUPR	107793,01	74866,09	70364,22	70364,22	70364,22	65950,23	61%

Notes

The modification is not significant

Source: Project Team (2022)

Following the simulation result of four selected buildings, the most optimal retrofit comes from the lighting. The change of electric fan and minimize the opening give a slight reduction to the energy consumption within the building and shading give an insignificant reduction to the energy consumption. The addition of solar panels gives a slight energy reduction as well, making the overall reduction on the buildings within 59-67%.



Annual Energy Consumption Reduction

Source: Project Team (2022)

Since the simulation of the buildings were based on the maximum electricity usage, occupants, and building mechanical electrical system, the results may differ in term of exact number/value, but the pattern of energy demand may have similarity. Therefore, by looking into the simulated estimate cost of annual energy demand of the buildings, we can identify the cost of the existing building is decreasing after the building retrofitting.

Comparison of Estimate Cost from Building Annual Energy Demand of Existing Building, and Retrofitted Building

Building Name	Existing Building Annual Energy Demand (kWh)	Cost of Existing Building Annual Energy Demand	Latest Retrofitted Building Annual Energy (kWh)	Cost of Retrofitted Building Annual Energy Demand

Lueng Bata Municipal Office	57.500,00	Rp 97.722.975,-	3.3971,08	Rp 57.734.870,-
Ulee Kareng Municipal Office	66.628,87	Rp 90.082.232,-	42161,13	Rp 57.001.848,-
DPRK Office	924.491,04	Rp 1.571.200.257,-	619.570,52	Rp 1.052.978.686,-
PUPR	107.793,01	Rp 118.572.311,-	65.950,23	Rp 72.545.253,-

Source: Project Team (2022)

CONCLUSION

Identification on Green Building implementation are determined from three aspects, the policy development, the public awareness, and the building management. With Banda Aceh as the case study, these aspects become the baseline and generate a contextual roadmap or recommendation of the future Green Building Policy Development in Banda Aceh.

A. Policy Development

The supported regulation and strategy / plan concerning green building implementation in domestic scale already available, the next step is to find out a formulation of a more contextual policies in local scale (Banda Aceh).

Some points that can be noted and acted upon to implement the green building concept in order to move towards a low-carbon city, including:

- Data gathering understanding on efforts in reducing the carbon emission or energy consumption are necessary, with mindset from global to local/city level, to gain an efficient baseline of the formulation of the regulation
- Determining the roadmap of Low Carbon development highly contributes to a successful implementation. The roadmap from GHG action plan document of DKI Jakarta can be used as reference.
- To support the green building concept is not enough by only relying on the regulations of green building and detailed spatial planning on city level, but a designated regulation is necessary, in line with the city context, challenges and opportunities.
- A skilled and conscious human resource can make a more efficient implementation.
- Net-Zero healthy building concept can be a suitable option to be applied into the building design or formulate the regulation, with guidance from the GBCI's rating tools.

To gain a holistic and comprehensive policy development in Banda Aceh, three important phase needs to be considered, such as:

- **Short-term:** create vision with low carbon concept which include green building principles, and provide small initiatives and programs associated to green building

management, which later become the base study for further programs in larger scale,

- **Mid-term:** identify the baseline for formulation of policy development with green building principle as consideration in city level through feasibility study, with coordination with multisectoral counterpart and integration between programs
- **Long-term:** implement the vision into impactful programs and sectors through city scaled regulation and provide the designated team in controlling the green building implementation.

B. Public Awareness

The concept of green building has become familiar to the general public, mostly in academics and government sector. Some city in Indonesia has already put the green building principles into regulation, and moreover being implemented. The most possible actions that can easily think about on implement the green building are electricity and water saving action, as well as reducing waste. In order to save energy, there are some actions that the respondents could think of. The general favor in order to increase green building engagement are through the designated regulation of green building and incentive becomes the top priority,

The recommendation to increase the awareness and efforts to implement the green building in Banda Aceh can be incorporate into three terms, such as:

- **Short-term**: advancing the capacity building on the green building management to the local government of Banda Aceh, to be able to formulate the suitable and contextual local regulation on the green building management in Banda Aceh.
- **Mid-term:** capacity building from the local government to the public of Banda Aceh locals and communities, with formulation of the applicable and feasible implementation in the household level.
- **Long-term:** strengthen the green building awareness within Banda Aceh, through school curriculum, information center on green building, and specialized school on green building technology.

C. Building Management

Although the high energy consumption is still dominantly caused by lighting and HVAC, there is an opportunity to move towards green building management, but more encouragement through government programs is highly recommended.

On an overall observation, the initial implementation of green building principles can be seen from the usage of LED lights to reduce energy consumption and the waste separation to minimize the upcoming land or water pollution and contamination. An opportunity to install a rainwater harvesting system into the building to provide alternative water resources and the provision of renewable energy from solar panel as one option to achieve nearly zero energy from electricity aspect.

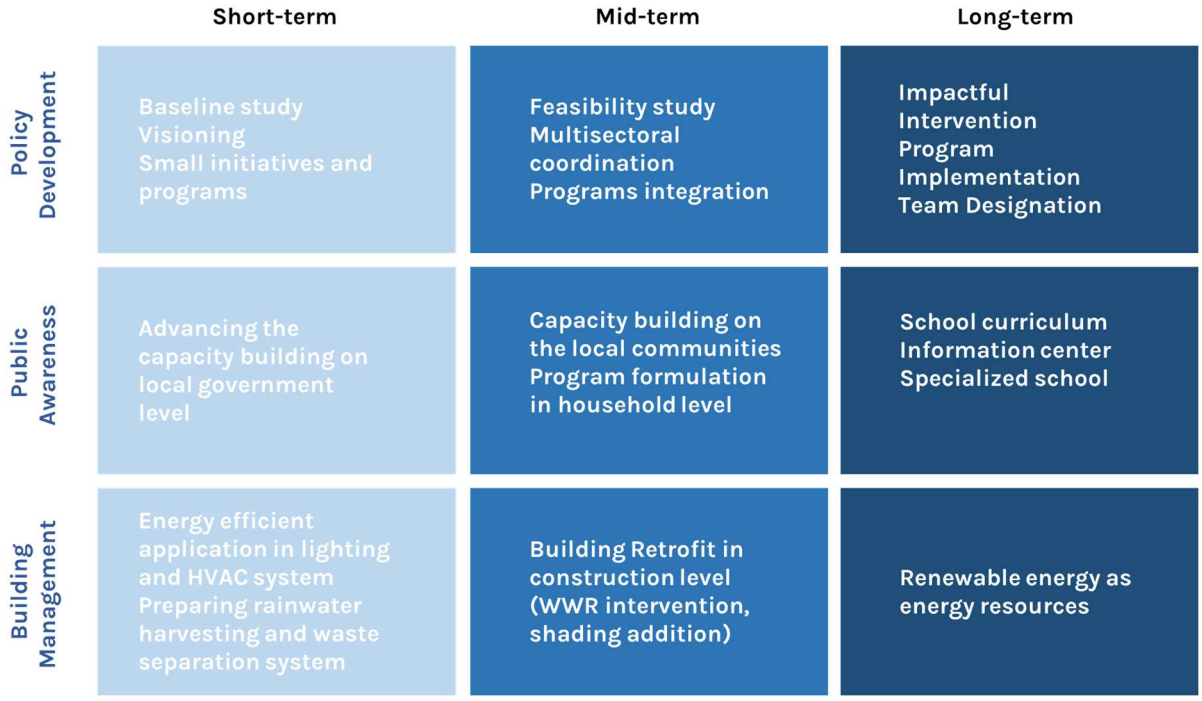
A building retrofit becomes an alternative to reduce energy demand. Several strategies can be implemented, such as changing the lighting with less energy demand (in example the

LED lights), changing the HVAC system (either using the smart and energy efficient air-conditioning system or go for electric fans) and minimize the wall window ratio by optimizing the natural cross-ventilation. Adding the Photovoltaic or solar panel at the rooftop will gain more energy source from natural resources.

These recommendations can be classified into three phases, consists of:

- **Short-term:** changing the lighting system with less energy demand, the HVAC system into smart and energy efficient technology, while also preparing the rainwater harvesting system and waste separation system
- **Mid-term:** changing the ventilation by minimizing the wall-window ratio and natural cross ventilation, as well as adding the shade/canopy into the building
- **Long term:** Adding more energy sources from renewable energy, in example by Photovoltaic installation.

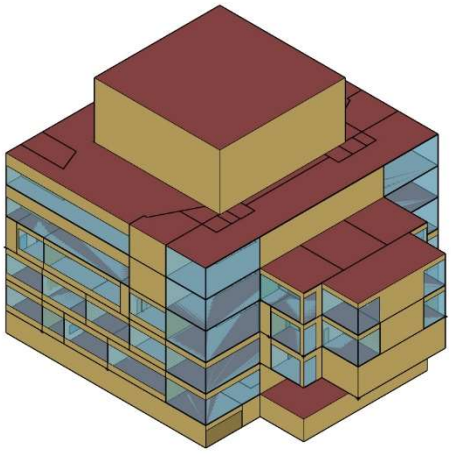
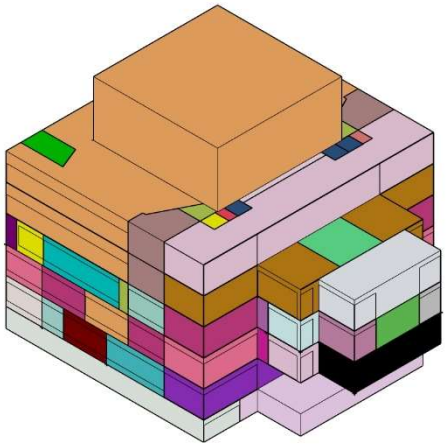
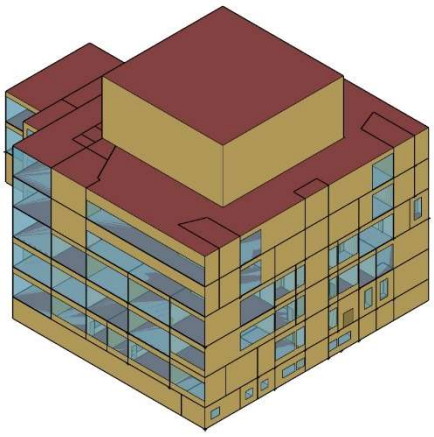
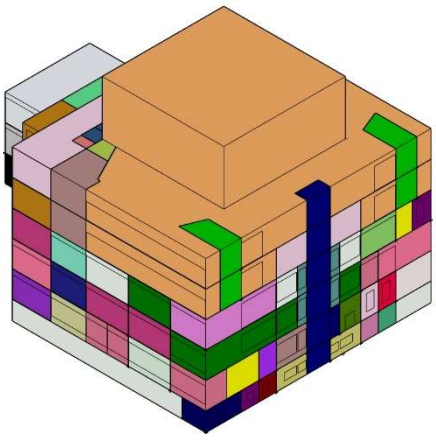
ROADMAP



Roadmap Strategy
Source: Project Team (2022)

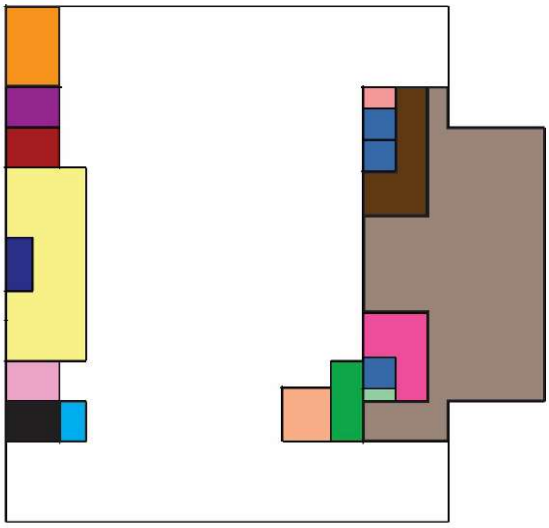
ANNEX / APPENDIX

1. DPRK Office

Angle	Spaces	Thermal Zones
1		
2		

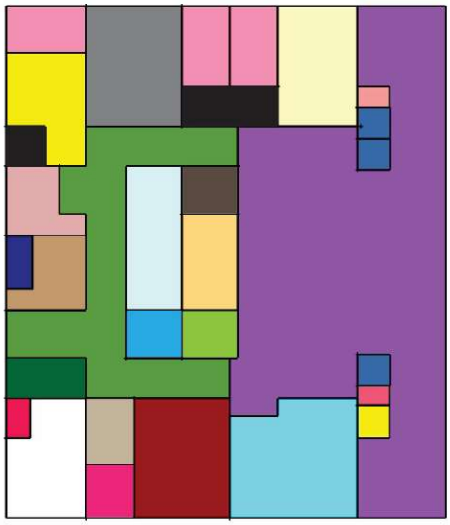
Simulation Modeling of DPRK Office

Source: Project Team (2022)



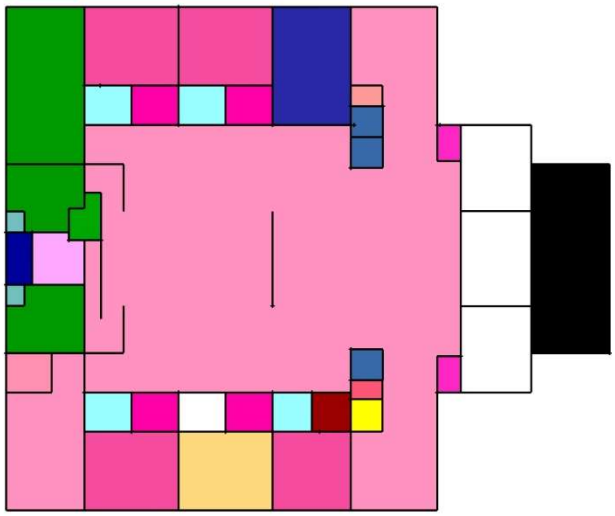
Floor 1

Function	Conditioning
= Lift	No conditioning
= Shaft 1	No conditioning
= Shaft 2	No conditioning
= Shaft 3	No conditioning
= Lift's Lobby 1	No conditioning
= Lift's Lobby 2	No conditioning
= Canteen	No conditioning
= Panel	No conditioning
= Driver's	No conditioning
= Security	No conditioning
= Break Room 1	No conditioning
= AHU	No conditioning
= Ladies' Toilet 1	No conditioning
= Gents' Toilet 1	No conditioning
= Clinic	No conditioning



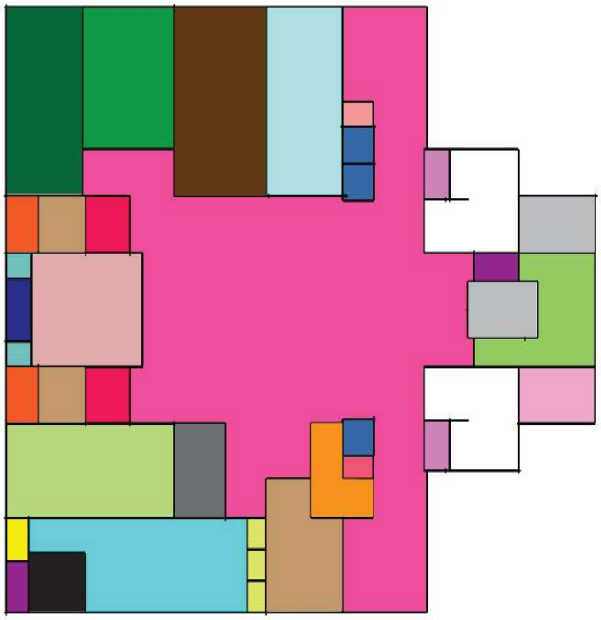
Floor 2

Function	Conditioning
= Lift	No conditioning
= Shaft 1	No conditioning
= Shaft 2	No conditioning
= Shaft 4	No conditioning
= Gents' Toilet 2	No conditioning
= Ladies' Toilet 2	No conditioning
= Pantry 1	No conditioning
= Office 1	AC
= Storage 1	AC
= Division Head's Office 1	AC
= Office 2	AC
= Office 3	AC
= Lobby 1	AC
= Office 4	AC
= Office 5	AC
= Office's Lobby 1	No conditioning
= Division Head's Office 2	AC
= Office 6	AC
= Toilet 1	No conditioning
= Supplies	AC
= Photocopy	AC
= Division Head's Office 3	AC
= Supplies' Storage	AC
= CCTV	No conditioning
= Corridor	No conditioning



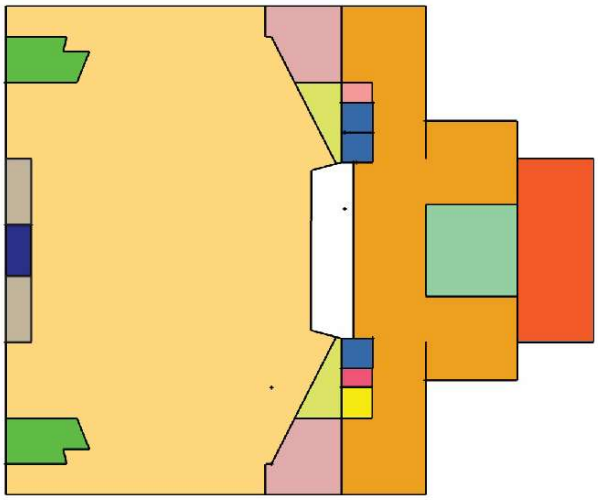
Floor 3

Function	Conditioning
= Lift	No conditioning
= Shaft 1	No conditioning
= Shaft 2	No conditioning
= Shaft 4	No conditioning
= Service 1	No conditioning
= Lobby 2	AC
= Gents' Toilet 3	AC
= Ladies' Toilet 3	AC
= Office 7	AC
= Office's Lobby 2	AC
= Meeting Room 1	AC
= Office 8	No conditioning
= Meeting Room 2	No conditioning
= Toilet 2	No conditioning
= Office 9	AC
= Storage 2	AC
= Pantry 2	No conditioning
= Meeting Room 3	No conditioning
= Engineer's Room	No conditioning
= Office 10	AC
= Office 11	AC



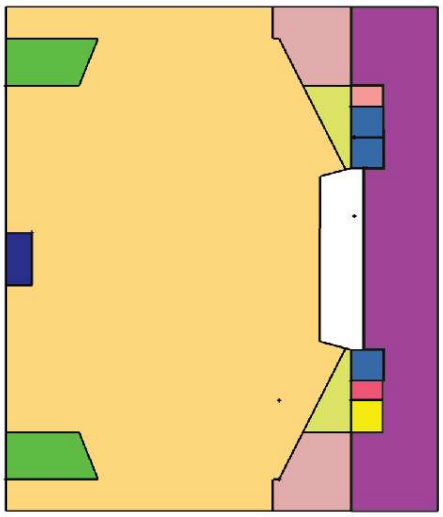
Floor 4

Function	Conditioning
= Lift	No conditioning
= Shaft 1	No conditioning
= Shaft 2	No conditioning
= Shaft 4	No conditioning
= Service 1	No conditioning
= Prayer Room	AC
= Shoe Rack	No conditioning
= Ablution	No conditioning
= Toilet 3	No conditioning
= Meeting Room 4	No conditioning
= Chief Head Office	No conditioning
= Toilet 4	No conditioning
= Pantry 3	No conditioning
= Lobby 3	AC
= Office Room 12	AC
= Meeting Room 5	AC
= Bathroom 1	No conditioning
= Lavatory 1	No conditioning
= Break Room 2	No conditioning
= Bathroom 2	No conditioning
= Office Room 13	No conditioning
= Office Room 14	No conditioning
= Bathroom 3	No conditioning
= Meeting Room 6	No conditioning
= Meeting Room 7	AC
= Spare Room 1	AC
= Spare Room 2	AC
= Spare Room 3	AC



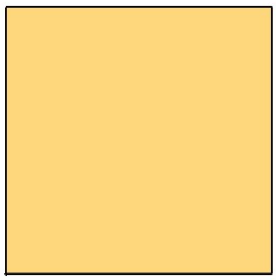
Floor 5

Function	Conditioning
= Lift	No conditioning
= Shaft	No conditioning
= Shaft	No conditioning
= Shaft	No conditioning
= Storage 3	No conditioning
= Auditorium's Storage 1	No conditioning
= Auditorium's Storage 2	No conditioning
= Auditorium's Storage 3	No conditioning
= Auditorium's Toilet	No conditioning
= Auditorium	AC
= Auditorium's Entrance	No conditioning
= Auditorium's Lobby 1	AC
= Book Room	AC
= Reading Room	AC



Floor 6

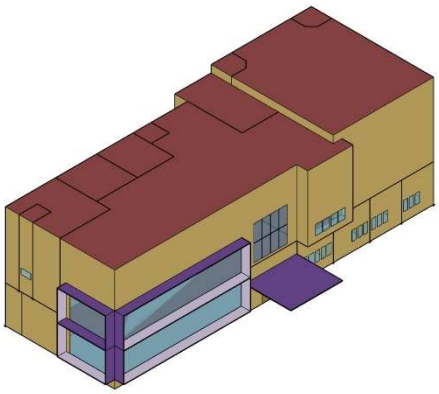
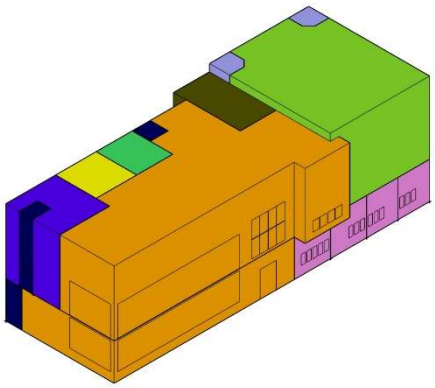
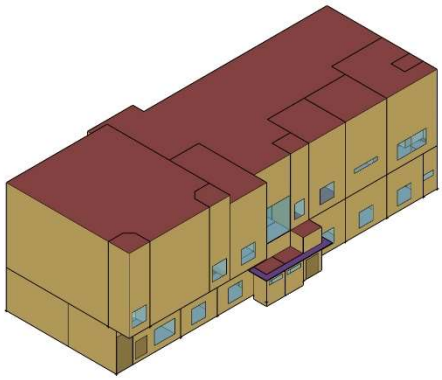
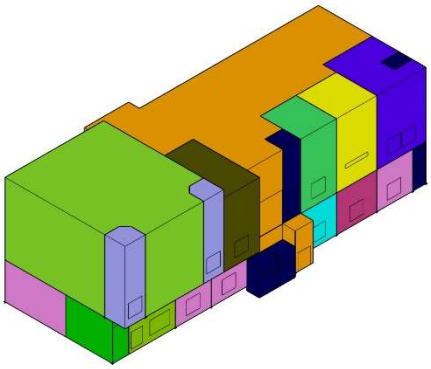
Function	Conditioning
= Lift	No conditioning
= Shaft 1	No conditioning
= Shaft 2	No conditioning
= Shaft 4	No conditioning
= Storage/Service Room	No conditioning
= Auditorium's Storage 1	No conditioning
= Auditorium's Storage 2	No conditioning
= Auditorium's Toilet	No conditioning
= Auditorium	AC
= Auditorium's Entrance	No conditioning
= Auditorium's Lobby 2	AC



Floor 7

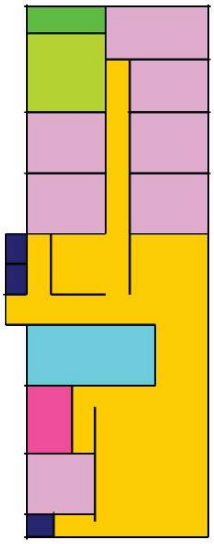
Function	Conditioning
= Auditorium's Dome	AC

2. Lueng Bata District Office

Angle	Spaces	Thermal Zones
1		
2		

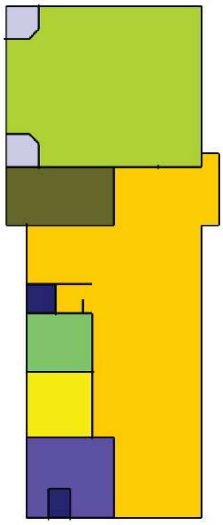
Simulation Modeling of Lueng Bata D Office

Source: Project Team (2022)



Floor 1

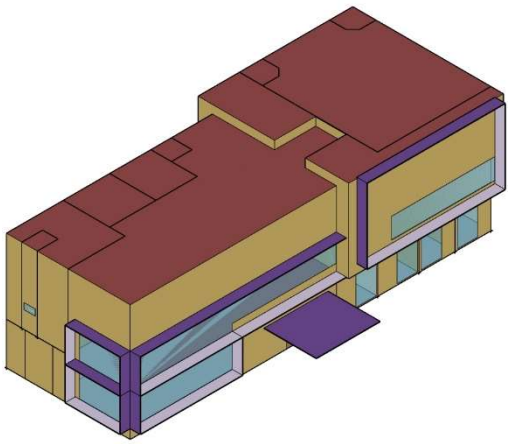
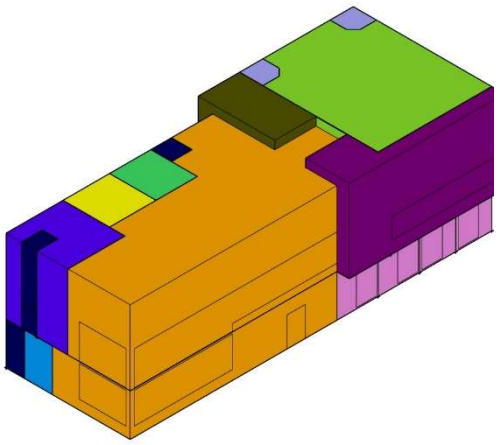
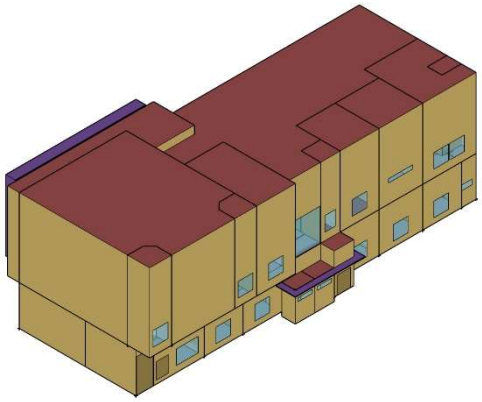
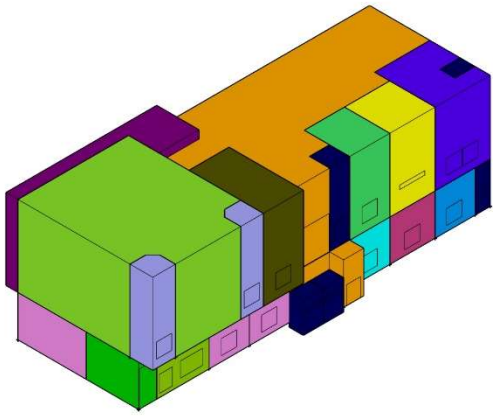
Function	Conditioning
= Lobby	No conditioning
= Office 1	AC
= Office 2	No conditioning
= Office 3	AC
= Toilet	No conditioning
= Praying Room	No conditioning
= Ablution	No conditioning



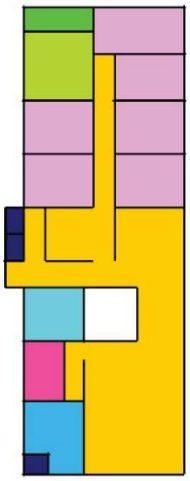
Floor 2

Function	Conditioning
= Lobby	No conditioning
= Head Office	No conditioning
= Office 4	No conditioning
= Office 5	No conditioning
= Meeting Room	No conditioning
= Toilet	No conditioning
= Multi-purpose Room	No conditioning
= Storage	No conditioning

3. Ulee Kareng District Office

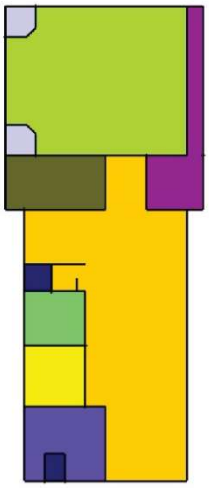
Angle	Spaces	Thermal Zones
1		
2		

Simulation Modeling of Ulee Kareng District Office
Source: Project Team (2022)



Floor 1

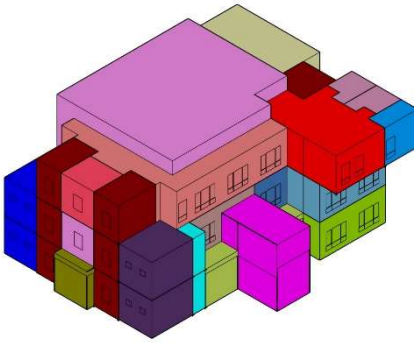
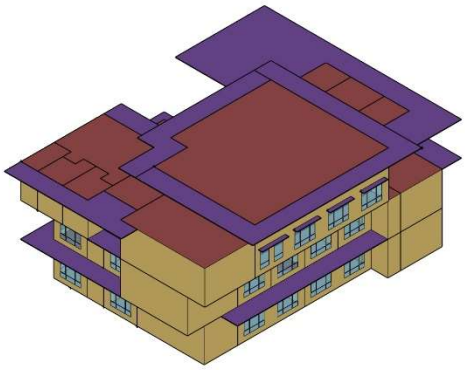
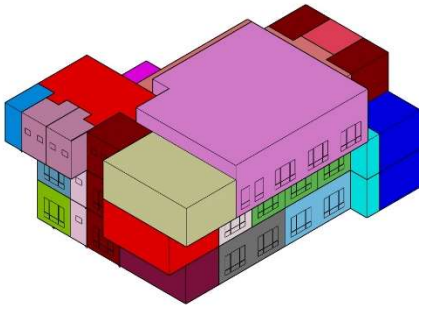
Function	Conditioning
= Lobby	No conditioning
= Office 1	AC
= Office 2 (Secretary)	AC
= Lactating Room	No conditioning
= Toilet	No conditioning
= Praying Room	No conditioning
= Ablution	No conditioning
= Storage 1	No conditioning
= Storage 2	AC



Floor 2

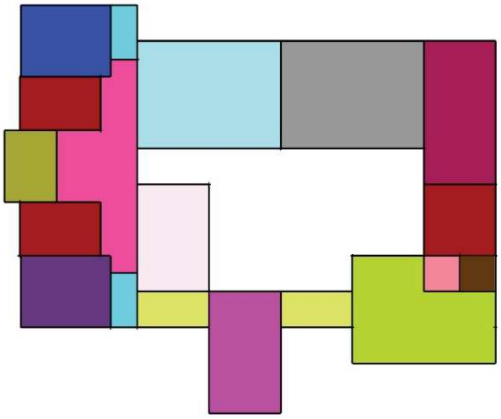
Function	Conditioning
= Lobby	No conditioning
= Head Office	AC
= Office 5	AC
= Office 6	AC
= Meeting Room	AC
= Toilet	No conditioning
= Multi-purpose Room	No conditioning
= Storage 3	No conditioning
= Hall/Corridor	No conditioning

4. PUPR Banda Aceh Office

Angle	Spaces	Thermal Zones
1		
2		

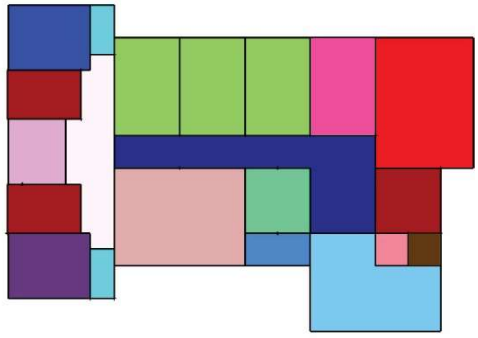
Simulation Modeling of PUPR Banda Aceh Office

Source: Project Team (2022)



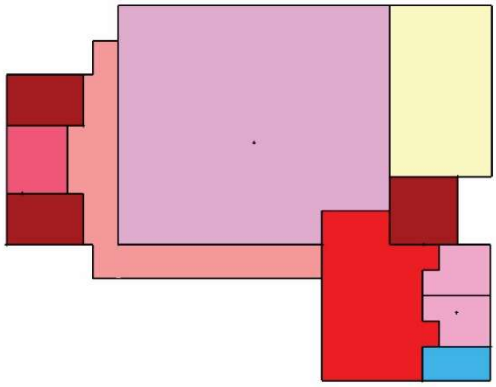
Floor 1

Function	Conditioning
= Lobby Type 1	No conditioning
= Side Lobby Type 1	No conditioning
= Stairs	No conditioning
= Storage	No conditioning
= Ladies' Toilet	No conditioning
= Gents' Toilet	No conditioning
= Toilet	No conditioning
= Lavatory room	No conditioning
= Terrace (Entrance)	No conditioning
= Terrace (Side Entrance)	No conditioning
= Terrace	No conditioning
= Staff Office Type 1	AC
= Staff Office Type 2	AC
= Secretarial Room	AC
= Other Office Type 1	AC
= Monitoring Room/ Data Room	AC



Floor 2

Function	Conditioning
= Lobby Type 2 and Corridor	No conditioning
= Side Lobby Type 2	No conditioning
= Stairs	No conditioning
= Storage	No conditioning
= Ladies' Toilet	No conditioning
= Gents' Toilet	No conditioning
= Toilet	No conditioning
= Lavatory room	No conditioning
= Archive Room Type 1	No conditioning
= Secretary Room	AC
= Corridor	No conditioning
= Head Division Room Type 1	AC
= Head Division Room Type 2	AC
= Other Office Type 2	AC
= Meeting Room	AC



Floor 3

Function	Conditioning
= Corridor	No conditioning
= Lobby	AC
= Stairs	No conditioning
= Storage	No conditioning
= Toilet	No conditioning
= Stage	No conditioning
= Multi-Function Room	AC
= Archive Room Type 2	AC

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