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# ROADMAP FOR AN ENERGY EFFICIENT, LOW-CARBON BUILDINGS AND CONSTRUCTION SECTOR IN INDONESIA,



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## Acronyms and abbreviations

<b>AC</b>	Air-Conditioning
<b>ACE</b>	ASEAN Centre for Energy
<b>ASEAN</b>	Association of Southeast Asian Nations
<b>ATR/BPN</b>	Kementerian Agraria dan Tata Ruang/Badan Pertanahan Nasional (Ministry of Agrarian Affairs and Spatial Planning / National Land Agency)
<b>Bappenas</b>	Badan Perencanaan Pembangunan Nasional (Ministry of National Development Planning/National Development Planning Agency)
<b>BAU</b>	Business as Usual
<b>BEA</b>	Building Efficiency Accelerator
<b>BIM</b>	Building Information Modelling
<b>BIPV</b>	Building-integrated photovoltaic
<b>BNBP</b>	Badan Nasional Penanggulangan Bencana (National Disaster Management Authority)
<b>BPS</b>	Badan Pusat Statistik (Statistics Indonesia)
<b>BREEAM</b>	Building Research Establishment Environmental Assessment Method
<b>CHP</b>	Combined heat and power
<b>CO<sub>2</sub></b>	Carbon dioxide
<b>EDGE</b>	Excellence in Design for Greater Efficiencies
<b>EE</b>	Energy Efficiency
<b>EEI</b>	Energy Efficiency Index
<b>EI</b>	Energy Intensity
<b>EPC</b>	Energy Performance Certificate
<b>EPD</b>	Environmental Product Declaration
<b>ESCO</b>	Energy Services Company
<b>EUI</b>	Energy Use Intensity
<b>EV</b>	Electric Vehicle
<b>GBC</b>	Green Building Code
<b>GBCI</b>	Green Building Council Indonesia
<b>GBPEN</b>	Global Building Performance Network
<b>GDP</b>	Gross domestic product
<b>GHG</b>	Green House Gases
<b>GIS</b>	Geographic Information System
<b>GlobalABC</b>	Global Alliance for Buildings and Construction
<b>GWP</b>	Global warming potential
<b>HPDs</b>	Health Product Declaration
<b>HVAC</b>	Heating Ventilation and Air-Conditioning
<b>IEA</b>	International Energy Agency
<b>IPEEC</b>	International Partnership for Energy Efficiency Cooperation
<b>LCA</b>	Life-Cycle assessment
<b>LEED</b>	Leadership in Energy and Environmental Design
<b>MEMR</b>	Ministry of Energy and Mineral Resources, Indonesia
<b>MEPS</b>	Minimum Energy Performance Standard
<b>MEPS</b>	Minimum energy performance standards



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<b>MOEF</b>	Ministry of Environment and Forestry
<b>MOF</b>	Ministry of Finance
<b>MOHA</b>	Ministry of Home Affairs
<b>MOT</b>	Ministry of Transportation
<b>MPWH</b>	Ministry of Public Works and Housing, Indonesia
<b>MPWT</b>	Ministry of Public Works and Transport, Indonesia
<b>NDC</b>	Nationally determined contribution
<b>NGO</b>	Non-governmental organization
<b>O&amp;M</b>	Operations and maintenance
<b>OTTV</b>	Overall Thermal Transfer Value
<b>PACE</b>	Property Assessed Renewable energy
<b>PIP</b>	Project Implementation Plan, Indonesia
<b>PV</b>	Photovoltaic
<b>R&amp;D</b>	Research and development
<b>RIKEN</b>	Rencana Induk Konservasi Energi Nasional/ National Energy Conservation Master Plan
<b>SDG</b>	Sustainable Development Goals
<b>SDS</b>	Sustainable Development Scenario
<b>SHGC</b>	Solar heat gain coefficient
<b>UN</b>	United Nations
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>USD</b>	United States dollar
<b>VAT</b>	Value added tax
<b>WBCSD</b>	World Business Council for Sustainable Development



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## Introduction by Ministry of Public Works and Housing

The Government of Indonesia along with other countries around the globe has committed to maintain the global temperature rise below 2-degree Celsius as contained in the Paris Agreement. Aligned with this commitment, several serious measures have been taken. Ministry of Public Works and Housing has enacted the Minister Regulation Number 21 Year 2021 on Green Building Performance Rating. This regulation shows the kind intention of the Government in supporting the national effort of energy conservation in various scales of building, dwelling, and region, and in various aspects of performance ranging from thermal condition, water consumption, to waste and site management. Developed by public sector since 2012 through iterative steps of synchronization and revision adjusting to the novel development of infrastructure in Indonesia, this rating tool is not intended to gain profit, which made it a suitable means to gain broadest attention and raise public awareness on energy conservation.

The Ministry of Public Works and Housing has envisioned a sustainable city path. Green city is set to be the second stage within the path targeted for 2035, as followed up from the first stage of livable city in 2025 and as a steppingstone toward smart city by 2045. Green city is believed to be one of the best paths to reduce the effects of urban heat island and greenhouse gas emission due to anthropogenic activities. It ensures the energy and other natural resources are effectively and efficiently utilized. The continuous development of these three city concepts in the end will reach the ultimate goal of sustainable city.

A division of Ministry of Public Works and Housing, the Directorate of Engineering Affairs for Human Settlements and Housing, Directorate General of Human Settlements, has the obligation to implement quality assurance within the sectors of building, housing, human settlements, and urban development in addition to waste, sanitation, and drinking water sectors. It is within the Directorate function that continuous support are to be provided in ensuring the implementation of energy conservation.

We therefore would like to express our appreciation to the Danish Energy Agency and Danish Embassy which have kindly facilitated the Roadmap for an Energy-Efficient, Low-Carbon Buildings and Construction Sector in Indonesia. We believe that this roadmap will provide some directions to lead transition toward strategic implementation of low GHG emission, energy efficient and environmentally friendly buildings and construction in Indonesia. The roadmap will surely inspire and trigger other parties to produce similar useful output, to be widely utilized and shall be instrumental to withhold the global rise temperature.

Jakarta, 21 April 2022



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### **Introduction by Danish Energy Agency,**

On behalf of the Danish Energy Agency, I am very proud to present this road map on energy efficiency in buildings and construction. Indonesia has set ambitious climate targets and the building sector is an important area, where the potential for reducing the CO<sub>2</sub> emissions is substantial. The Danish Energy Agency is honored to be able to share some of the experience we have gathered over many years on how to optimize the use of energy in the building and construction sector under the Indonesia Denmark Energy Partnership Project (INDODEPP). We have experienced a very high engagement and openness in the discussions and the stakeholder meetings on how to initiate the work on energy efficiency in buildings in Indonesia.

Energy efficiency is a very important part of the solution in order for Indonesia to reach the ambitious target of “net zero emissions” in near future. Here it is important to use the energy as efficient as possible and focusing on existing buildings and in buildings to be built is a strong way towards reduced energy consumption. We are proud to be a partner of EBTKE in the Indonesian efforts, and I am sure there will be many opportunities to develop our cooperation even further in the future.

### **Ole Emmik Sørensen**

Director for Centre for Global Cooperation,  
Danish Energy Agency



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## 1. EXECUTIVE SUMMARY

The global buildings and construction sector is responsible for about 38% of the global energy-related CO<sub>2</sub> emissions (GlobalABC, 2020)<sup>1</sup>. The CO<sub>2</sub> emission comes from the energy consumption for keeping the indoor climate within the comfort levels for the occupants. Measures to reduce GHG emissions in the building and construction sector in the medium and long term are urgently needed to meet the goals of the Paris Agreement.

According to the International Energy Agency (IEA) NZE Report<sup>2</sup>, the floor area in the buildings sector worldwide is expected to increase 75% between 2020 and 2050, of which 80% is in emerging market and developing economies. IEA also estimates that the number of buildings in the world - and thus the demand for energy - will double by 2050 compared to 2020. Furthermore, the number of air conditioning units in both new and existing buildings is increasing rapidly. Energy used for space cooling in buildings accounts for about 60% of energy used in buildings in countries with a hot and humid climate. The need for space cooling is predicted to triple between 2016 and 2050. Nearly 70% of the increase is estimated to come from residential buildings, mostly in emerging economies. Global sale of air conditioning (AC) systems has nearly quadrupled to 135 million units since 1990 with now about 1.6 billion AC systems in use<sup>3</sup>. This trend is set to continue and intensify especially in hot and tropical countries like Indonesia, following high demand for new housing and infrastructure, which is driven by population growth, and rising incomes.

Indonesia, with a population of more than 270 million citizens spreading across 17,000 islands, is expected to become the world's fourth-largest economy by mid-century. Its young population, rich natural resources, vast untapped renewable energy potential and the ambitions to modernize its energy sector put Indonesia in a prime position to become a major player in the future of global energy.

In Indonesia, the building and construction sector plays a key strategic role for the economic and sustainable development of the country. Like other economic sectors, the building and construction sector contributes to a high amount of jobs but also to the negative effects of global climate change. However, this sector also has a very high potential for develop solutions working against the climate changes and to significantly reduce the GHG emissions. Recognizing its role in the joint effort to respond proactively to climate change, the Indonesian Ministry of Environment and Forestry issued the Action Plan to implement the Paris Agreement on Climate Change for the period 2020-2030 in 2020. Accordingly, this Plan provides key activities for the development of the construction industry to reduce GHG emissions and adapt to climate changes through these main tasks, including GHG emission reduction, climate change adaptation, resource preparation and establishment of a transparent Measurement, Reporting and Verification (MRV) system.

Government Regulation No. 79/2014 on National Energy Policy, sets out the ambition by 2025 and 2050 to transform the primary energy supply mix with shares as follows:

- New and renewable energy at least 23% in 2025 and at least 31% in 2050;
- Oil should be less than 25% in 2025 and less than 20% in 2050;
- Coal should be minimum 30% in 2025 and minimum 25% in 2050; and
- Gas should be minimum 22% in 2025 and minimum 24% in 2050.

<sup>1</sup> IEA world Energy outlook 2021

<sup>2</sup> IEA NZE Report

<sup>3</sup> International Energy Agency (IEA). The Future of Cooling. Opportunities for energy-efficient air conditioning. 2018, <https://webstore.iea.org/the-future-of-cooling>



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The distribution for 2020 was like this (thousand BOE):

Type of energy	Total consumption (thousand BOE)	Percentage
Fuel	222.820	26,4%
Bio Gasoil	179.300	21,2%
Electricity	162.161	19,2%
Coal	113.416	13,4%
Natural Gas	97.476	11,5%
LPG	69.623	8,2%
Biogas	177	0,0%
<b>Total</b>	<b>844.973</b>	<b>100,0%</b>

Table 1 Distribution of energy, Indonesia Statistic

The residential and commercial sector accounts for 21.6 % of the total energy consumption or 182,430 thousand BOE (or 310 GWh).

#### Nationally Determined Contribution (NDC)

In 2016, Indonesia issued its first Nationally Determined Contribution (NDC) with climate targets. The NDC has been updated and a new version has been issued by 21 July 2021. Here the targets for reducing the GHG emission are split into Unconditional Reductions and Conditional Reductions:

**Unconditional Reduction:** Indonesia has voluntarily committed to reduce unconditionally 29% of its greenhouse gases against the business as usual scenario by the year 2030. The commitment will be implemented through effective land use and spatial planning, sustainable forest management which include social forestry program, restoring functions of degraded ecosystems including wetland ecosystems, improved agriculture productivity, **energy conservation and the promotion of clean and renewable energy sources**, and improved waste management. The BAU scenario was projected to be approximately 2.87 GtCO<sub>2</sub>e in 2030, which is updated from the BAU scenario on the NDC due to existing condition on energy policy development in particular in coal-fired power plants.

**Conditional Reduction:** Indonesia could increase its contribution by up to 41% reduction of emissions by 2030, subject to availability of international support for finance, technology transfer and development and capacity building<sup>4</sup>.

In this context, this Roadmap on Energy Efficient Building and Construction Sector in Indonesia, has been developed based on the methodology of the Regional Roadmaps for Buildings and Construction 2020-2050<sup>5</sup> by the Global Alliance for Buildings and Construction (Global ABC). This Roadmap shows suggested pathways for the short, medium and long-term contribution of the building and construction sector to the achievement of the NDC targets of Indonesia.

The building and construction sector in Indonesia is key for meeting the climate mitigation targets set out in the Paris Agreement by 2050. This Roadmap identifies measures that can be taken in order to enable Indonesia's transition towards zero-emission, efficient and resilient buildings and construction.

<sup>4</sup> Updated Indonesian NDC:

<https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Indonesia%20First/Indonesia%20Updated%20NDC%202021.pdf>

<sup>5</sup> Global Alliance for Buildings and Construction (GlobalABC). Global Status Report 2019



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The roadmap aims at providing a holistic approach to transform the sector by covering eight activity areas that were identified by the Global Alliance for Buildings and Construction, through its Regional Roadmap for Buildings and Construction in Asia, as the key areas to consider for transforming the sector.

The eight areas are:

- Urban planning,
- New buildings (buildings under construction),
- Existing buildings,
- Appliances and systems,
- Building operations,
- Materials,
- Resilience and
- Renewable energy

In this report, each of the activities is structured in a similar manner, they can be read in isolation, or in conjunction with the other parts of the document.

This Roadmap has been developed by the **Danish Energy Agency - DEA** in close cooperation with the **Indonesian Ministry of Energy and Mineral Resources – Directorate General of New Renewable Energy and Energy Conservation (Direktorat Jenderal Energi Baru Terbarukan dan Konservasi Energi)** and a group of consultants (**Viegand Maagoe A/S from Denmark and Chakra Giri Energi Indonesia from Indonesia**). It is based on three stakeholder consultations that took place in the end of 2021 (see annex 1 with list of involved stakeholders). This Roadmap will provide orientation and guidance to public and private key stakeholders in the Indonesian buildings and construction sector as well as non-governmental organizations and civil society. The identified targets and actions build on consultations with the building and construction sector, experts at national level and recommendations from international experts.

By identifying and prioritizing **short-term**, **medium-term** and **long-term** actions, the Roadmap will help to guide the support and investments from government, development and private sector partners for buildings and construction in Indonesia – notably in light of COVID-19 recovery plans, as the sector is a strong contributor to the national economy and provider of jobs. The Roadmap aligns with the net zero emission climate goal for 2060, that Indonesia have set in the updated Nationally Determined Climate (NDC) goals submitted to the United Nation in July 2021.

## TARGETS AND TIMELINES

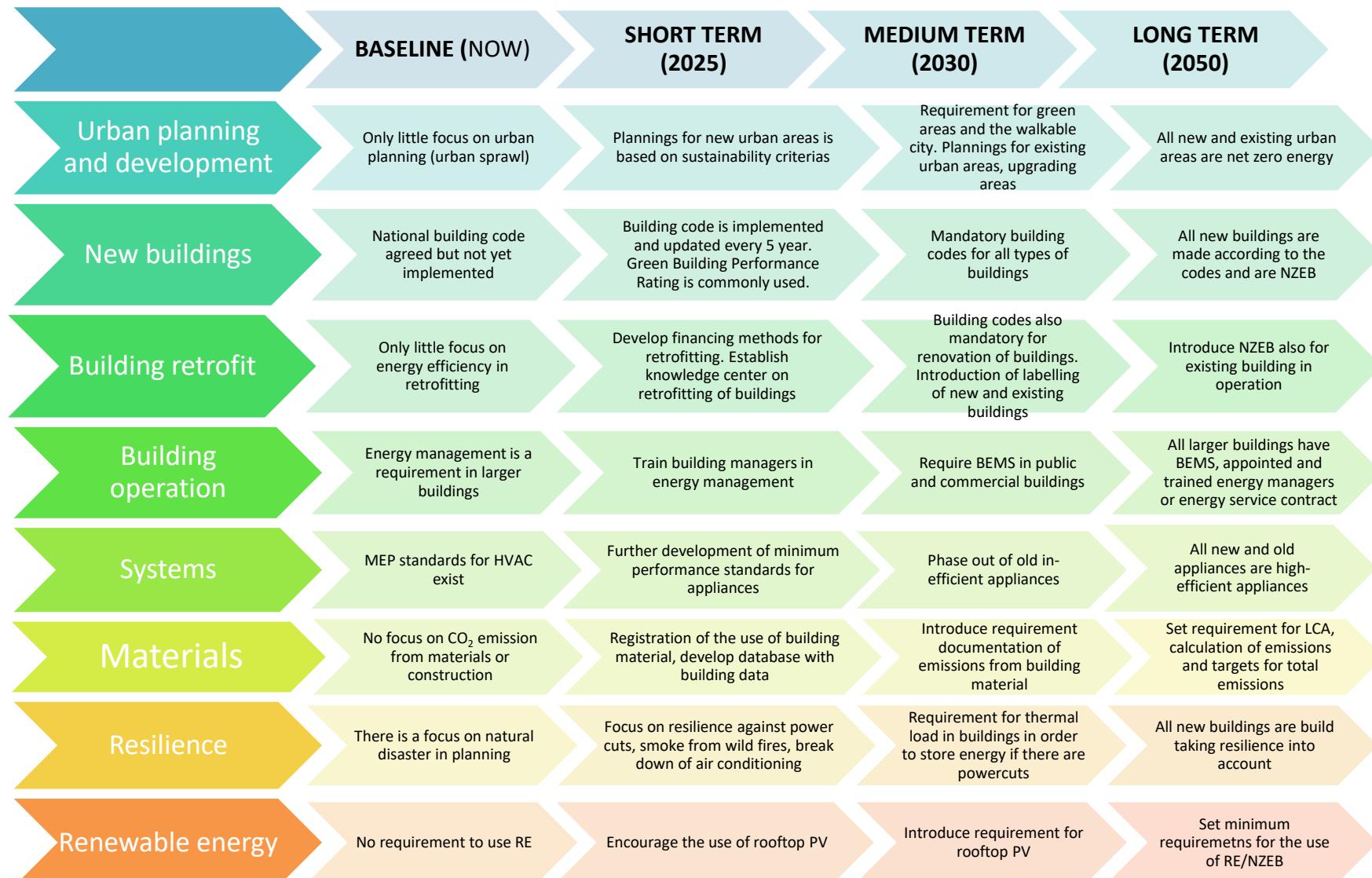
Targets and timelines are further described in the detailed Roadmap sections on each topic. The baseline, the suggested short term, medium term and long-term measurements are illustrated in the following figure for the eight action areas.

To move the building and construction sector in Indonesia towards more energy efficiency with zero-carbon emissions, effective policies are needed to address the current market barriers and to enable adoption of best practice technologies. With appropriately designed and consistently implemented policies, a range of cost-effective technologies can result in substantial energy savings and emission reductions in the building and construction sector.

Focusing on using highly efficient cooling, ventilation and lighting systems (and heating if needed, but there are only a few places in Indonesia that needs heating), locally adapted efficient building techniques, adopting efficient building envelope techniques and using either on-site renewables or off-site renewables can result in substantial energy savings and emission reductions, whilst meeting a growth in the building stock.



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## Short-term key activities (until 2025)

The following key activities are suggested for the short-term to support the Roadmap and contribute to achieve a sustainable buildings stock.

### **Activity 1 - Urban planning and development:**

Develop tools for integrated urban planning and development of regional and municipal policies in the planning activities for new buildings that take urban sustainability into account. Development of training programs for integrated planning for regions and cities.

### **Activity 2 - New buildings (buildings under construction):**

Building codes are enforced in all municipalities. Voluntary requirements are included in the building code for NZEB. Training programs developed. Development of MEPS for appliances especially cooling installations. Further development and support to Green Building Performance Rating scheme, many new buildings use the scheme voluntarily. Set a target that all public buildings are complying with codes. Set up one-stop shops at the municipalities where building owners, planners and architects can seek advice and can show compliance with the building code. Include voluntary targets for Net Zero Energy buildings (NZEB) in the building code. Train local staff to check for compliance with energy requirements in the building code. Ensure that the building code gives advantage to buildings where passive cooling is used. Develop incentives for the use of Green Rating Schemes such as BGH Performance Rating Tools (PUPR), LEED, EDGE, and GREENSHIP. Building certification for new buildings is to be introduced.

### **Activity 3 - Building retrofits:**

Ensure that the building code encourages deep energy renovation for existing buildings. Development of guidelines and awareness programs for energy retrofitting of buildings to encourage deep energy renovation of buildings. Develop and implement a scheme for Energy Performance Certificates (EPC) for existing buildings. Develop a database for the EPC's and for easy access for potential new house owners. Develop grants for low-income households for the retrofitting or upgrading of HVAC/air condition systems, upgrade of insulation system and replacement of lighting systems. For other types of homeowners, preferential or soft loans can be introduced. EPC's are made for most public buildings in order to assess the need for renovation. Establish a knowledge center on energy retrofitting of existing buildings with information for house owners and installers.

### **Activity 4 - Building operation:**

Increase the scope in the energy management regulation (70/2009) so that also smaller buildings are included. Ensure that there is sufficient number of trained energy auditors. All public building have implemented the scheme. Ensure that all governmental and public buildings are complying with the law on energy management.

### **Activity 5 - Systems:**

Continue to develop and enforce existing Minimum Energy Performance Standards (MEPS) that set product quality and performance requirements across the region. System for check of compliance is developed. Increase the awareness among consumers of Energy labeling of appliances. Introduce a system with labelling of appliances including testing facilities and a scheme for checking of compliance also with products from abroad. A requirement of a certain portion of public procurement of e.g. AC systems should be efficient or have energy label A.



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#### **Activity 6 - Materials:**

Develop a scheme for documentation of Life Cycle Analysis (LCA) for building projects and encourage the building industry to use this method. Developers, who make life-cycle-analysis (LCA) of the carbon content (embodied energy) may get other benefits (e.g. can include more space in the buildings). Development of an Indonesian LCA tool taking local conditions into account, support the development of. Increase research on embodied carbon in building materials and energy use during the production and transportation of building materials and the operation of the building.

#### **Activity 7 - Resilience:**

Develop resilience criteria to be included in the building code. The municipalities in the most vulnerable areas have developed plans for where further urbanization can take place with low risks for environmental disasters. The plans also include infrastructure and transport. Cities and urban areas (including residential housing and critical urban infrastructure) is planed using risks criteria, risk assessments, risk mapping, and resilience planning for emergency response to disasters and extreme weather. Prepare buildings for power cuts by usage of storage and passive technologies.

#### **Activity 8 - Renewable energy:**

Targets are set for the green transition and the use of renewable energy for electricity production. Develop and introduce voluntary requirement for renewable energy in buildings, favorite buildings with high energy efficiency. Financial support for the development of stand-alone RE installations for remote areas.

## **Medium term key activities (until 2030)**

#### **Activity 1 - Urban planning and development:**

Set target e.g. that 50% of all new developments are using tools for integrated planning and e.g. that integrated plans will be developed for the 10 largest cities.

#### **Activity 2 - New buildings (buildings under construction):**

All new buildings are constructed according to the building code. Building codes are changed to performance-based codes using simulation tools for showing compliance. NZEB requirements are made mandatory for public buildings. Sufficient amount of specialist are trained for checking of compliance. The principle of passive cooling is implemented in a large number of buildings. Green building rating scheme is widely used and mandatory for public buildings

#### **Activity 3 - Building retrofits:**

Energy saving measures have top priority when buildings are being retrofitted. Focus on building envelope renovation especially roof insulation. Set targets for the number of buildings with an EPC, e.g. half of all buildings that are being sold or rented out have an energy performance certification. Most of the larger governmental and public buildings have been energy renovated with efficient cooling and lighting systems. The national Knowledge Center on energy renovation is publishing information material to building owners and installers.

#### **Activity 4 - Building operation:**

Set targets for how many buildings that have had an energy audit and have introduced energy management, e.g. half of the largest energy consuming buildings have implemented energy management. There is a sufficient amount of energy auditors and the energy managers have been trained. Energy management is



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mandatory in all public and commercial buildings and the energy managers have received sufficient training to make energy renovation business cases and to implement suggested energy saving measures.

#### **Activity 5 - Systems:**

Mandatory MEPS for all appliances in new buildings (buildings under construction) and for major retrofitting in existing buildings. The requirements in the MEPS have been strengthened especially of cooling systems. Strengthening the labeling requirements. Ensure that all energy consuming appliances are included in the scheme. 50% of all public procurements are energy efficient.

#### **Activity 6 - Materials:**

A life cycle analysis must be carried out for all buildings and comply with CO<sub>2</sub> requirements in the building code. The limits are reduced at regular intervals. The limits should be set high for all building to achieve the target at this point. It is mandatory to use the LCA tool and all building materials producers must make and update EPD's. A national database has been developed containing the environmental information for building materials (EPDs) used in Indonesia. New development for planning and future land use zoning and classification regulation (where to build and where not to build).

#### **Activity 7 - Resilience:**

Buildings under construction take the requirements from the building code on resilience into account. Plans are made on the basis of simulation and modelling (flooding, sea level rising etc.) for all Indonesian cities.

#### **Activity 8 - Renewable energy:**

Targets are set for the green transition and the use of renewable energy for electricity production. There are mandatory requirements for the use of RE in buildings under construction. Benefits for existing buildings using RE. Mandatory to use PV in buildings under construction. Frameworks in place to support stand-alone systems that can interact with neighboring communities.

## **Long-term vision (until 2050)**

#### **Activity 1 - Urban planning and development:**

All new developments are using tools for integrated planning. Integrated plans are developed for all major cities.

#### **Activity 2 - New buildings (buildings under construction):**

All buildings are constructed according to the building code. The building code is revised and strengthened at regular intervals. NZEB requirements are strengthened and mandatory for all buildings (integrated into the building code). Training of municipal officials is upgraded and fits to the new building code. Green rating schemes are strengthened and mandatory for all buildings. Building codes are strengthened and all new are following the building codes. NZEB emission requirements implemented for all buildings. Enforcement mechanisms are further strengthen and training schemes are upgraded. A large number of buildings are implementing the principles of passive cooling and it is a requirement in the building code for certain types of buildings. Green Building Performance Rating Tools is further strengthened and mandatory for all larger commercial buildings.

#### **Activity 3 - Building retrofits:**

The majority of buildings is retrofitted with deep energy renovation. All existing buildings have an EPC. All governmental and public buildings have been retrofitted. The Knowledge Center is adapting training of installers to the current building code. NZEB requirements apply to existing buildings.



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#### **Activity 4 - Building operation:**

All larger building organizations in both public and commercial buildings have implemented energy management principles. All larger buildings have energy audits carried out on a regular basis. All energy managers have received training.

#### **Activity 5 - Systems:**

Regular Strengthening of the MEPS e.g. every 5 year. The MEPS are used for all installations and systems in both new and existing buildings. They are updated regularly and strengthened. 100% of public procurement is energy efficient.

#### **Activity 6 - Materials:**

All development projects must prepare a LCA and it is mandatory to use the national LCA tool. Targets for max. Co2 for construction, building material and operation must be followed. The tool has been updated according to the national database on Indonesian building materials.

#### **Activity 7 - Resilience:**

It is mandatory as an urban or building developer to develop a risk analysis for the building and the urban area. All municipalities have developed plans for where further urbanization can take place with low risks for environmental disasters.

#### **Activity 8 - Renewable energy:**

All buildings have on-site renewables (PV) or are supplied by electricity from off-site renewable energy using renewable energy sources. Local generated renewable energy is used in new developments and that the infrastructure is made ready for the use of renewable energy sources. Mandatory requirements for the use of RE in new buildings. Mandatory requirements for existing buildings using RE. Mandatory to use PV for all buildings.



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## 2. HOW TO USE THIS ROADMAP

This Roadmap for Energy Efficient Buildings and Construction in Indonesia builds on the methodology and structure of the Global Alliance for Buildings and Construction (GlobalABC) Regional Roadmap for Building and Construction in Asia 2020–2050 developed by the Global Alliance for Building and Construction and the International Energy Agency (IEA) published in 2018. This Roadmap for Energy Efficient Buildings and Construction in Indonesia shows a path for the transition towards low-emission, efficient and resilient buildings and construction. The Roadmap shows key steps and targets for achieving the NDC goals.

To achieve energy and GHG emissions savings in the buildings and construction sector, the Energy Outlook to 2050 of the International Energy Agency (IEA) shows significant energy savings in near/net zero energy buildings, in the area of deep renovations for buildings, low-GHG energy supply and the use of low-GHG materials for construction<sup>6</sup>. The emissions savings from these four components are broadly captured by the eight major activities in this Roadmap.

Building on the GlobalABC Global Roadmap from 2016<sup>7</sup>, the GlobalABC continued working on building Roadmaps for the three major regions Asia, Latin America and Africa. These Regional Roadmaps 2020 – 2050 aim to support countries in their ability to create common goals and ambitions towards achieving the Paris Agreement goals through the buildings and construction sector. They identify short-term, mid-term and long-term targets for eight strategic activities.

### 2.1. Structure of this Roadmap

This Roadmap identifies common goals, targets and timelines for key actions across eight activities. Each of these eight activities represents a segment of the buildings and construction sector and they are: *urban planning, new buildings(here using the term for buildings under construction), existing buildings, appliances and systems, building operations, materials, resilience and renewable energy*. The activities are all structured in a similar manner, illustrated by relevant examples and can be read alone, or in conjunction with the other parts of the document.

For each of the eight activities mentioned above the sections are structured as follows:

- **Current status:** a description of the current situation and challenges.
- **Key actions:** a summary of key actions and timelines identified for this activity
- **Stakeholders:** a map of the different stakeholders relevant to this activity and their relative importance
- **Recommended policy action:** a list of recommended policies with a description of the status of that policy in the region, and proposed targets for short, medium and long-term. The recommended policy actions are shown as a set of timelines, with a description of each below, followed by a series of local examples of current practice. See note below about how to read the timelines.
- **Recommended technology action:** a list of recommended actions related to particular technologies, with a description of the current status of that policy in the region, and proposed targets for short, medium and long-term. These are shown as a set of timelines, with a description of each below, followed by a series of local examples of current practice. See note below about how to read the timelines.

<sup>6</sup> The definition from the European Union of deep renovation is a saving of 60% compared to before the renovation

<sup>7</sup> <http://globalabc.org/resources/publications/global-roadmap-towards-low-ghg-and-resilient-buildings>



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- **Capacity building:** a list of recommended capacity building actions particularly relevant to this activity, followed by a series of local examples of current practice.

## 2.2. Roadmap development process

The targets and key actions were developed based on three large digital stakeholder-consultations that took place in October/November 2021 with the participation of a broad range of Indonesian stakeholders from the building sector, academia and ministries, as well as the expertise from the international and the national consultants connected to the development of this Roadmap. The stakeholder-consultation took the form of presentation, dialogues, and questionnaires. In total about 250 different stakeholders participated in the process. Annex 1 shows list of the different stakeholders and a short summary of the workshops.

## 2.3. Roadmap to guide Indonesia's NDC implementation

The purpose of this Roadmap is to set up an ambitious framework for the building and construction sector in Indonesia to contribute to the implementation of the Indonesian climate goals as indicated in the Indonesian NDC based on the global climate related objectives set out in the Paris Agreement for the world to stay well below 2°C and to be carbon neutral in the second half of this century.

It is the hope that the Government of Indonesia, based on this Roadmap, will provide orientation and guidance to public and private key stakeholders in the Indonesian buildings and construction sector as well as non-governmental organizations and civil society.



### 3. INDONESIA COUNTRY CONTEXT

#### 3.1. Geography

The Republic of Indonesia is the world's largest archipelago and consists of the six main islands Sumatra, Java, Sulawesi, Bali, Kalimantan (the Indonesian part of Borneo) and Irian Jaya (the Indonesian part of New Guinea), as well as 13,677 smaller islands. About 3,000 of the islands are inhabited and extend over a volcanic area of 1,904,569 km<sup>2</sup>. Indonesia has 270,625,568 (2019) [6] inhabitants. The capital is Jakarta, located on the island of Java. The country is a member of ASEAN.



Figure 1 Map of Indonesia with regions

#### 3.2. Climate

The climate of Indonesia is almost entirely tropical. The uniformly warm sea waters that make up 81% of Indonesia's area ensure that temperatures on land remain fairly constant, with the coastal plains averaging 28 °C (82 °F), the inland and mountain areas averaging 26 °C (79 °F), and the higher mountain regions, 23 °C (73 °F). Temperature varies little from season to season, and Indonesia experiences relatively little change in the length of daylight hours from one season to the next; the difference between the longest day and the shortest day of the year is only forty-eight minutes. This allows crops to be grown all year round.

The main variable of Indonesia's climate is not temperature or air pressure, but rainfall. The area's relative humidity ranges between 70 and 90%. Winds are moderate and generally predictable, with monsoons usually blowing in from the south and east in June through September and from the northwest in December through March. Typhoons and large-scale storms pose little hazard to mariners in Indonesian waters; the major danger comes from swift currents in channels, such as the Lombok and Sape straits. Indonesia experiences a number of climates, mostly tropical rainforest (highest precipitation), followed by tropical monsoon and tropical savannah (lowest precipitation).

However, oceanic climates and subtropical highland climates are found in a number of high-altitude regions in Indonesia, mostly between 1,500 and 3,500 meters (4,900 and 11,500 ft.) above sea level. Regions that are above this level (mostly in the Papuan highlands) fall into the tundra climate category and the subpolar oceanic category. Although air temperature changes little from season to season or from one region to the



next, cooler temperatures prevail at higher elevations. In general, temperatures drop approximately 1 °C per 90-meter increase in elevation from sea level with some high-altitude interior mountain regions experiencing night frosts. The highest mountain ranges in Papua are permanently capped with snow.

### 3.3. Population

According to the Handbook of Energy and Economic Statistics of Indonesia 2020, the Population in 2020 was 271,066.37 thousand people and the number of households was 69,438.89 thousand.

Indonesia's average population growth per year is about 1.1% for the decade ending in 2020, nearly having 13% population growth for that decade. At this rate, Indonesia's population is projected to surpass the population of the United States in the near future.

Indonesia has a relatively young population compared to Western nations, though it is ageing as the country's birth rate has slowed and its life expectancy has increased. The median age was 30.2 years in 2017.

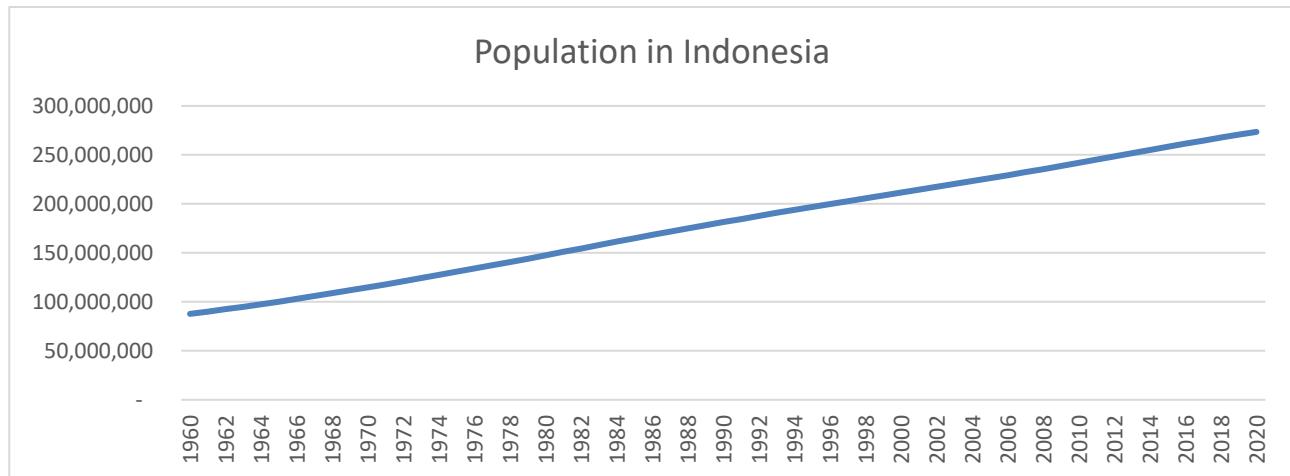


Figure 2 Population in Indonesia, 1960-2020, Source: The World Bank



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## 4. LEGAL FRAMEWORK FOR LOW CARBON BUILDINGS AND CONSTRUCTION

The global building and construction sector combined represented 38% of the global energy-related CO<sub>2</sub> emissions in 2018<sup>8</sup>. The strong growth in the buildings sector in the form of increased floor space both due to the rapidly growing population and due to increased space use per person, floor area growth is beginning to decouple from the energy demand, with floor area in 2018 having increased 3% from 2017 and 23% since 2010. In 2018, global emissions from buildings increased 2% for the second consecutive year to 9.7 gigatonnes of carbon dioxide (Gt CO<sub>2</sub>), suggesting a change in the trend from 2013 to 2016, when emissions had been levelling off. Growth is driven by a strong need for floor space and population expansions that has led to a 1% increase in energy consumption to around 125 exajoules (EJ).

A major source of energy in the global building stock is electricity, where the consumption on a global scale (still mainly generated from coal and natural gas) has increased by more than 19% since 2010. This indicates how crucial it is to make clean and renewable energy sources accessible and to use passive and low-carbon designs more frequently in building construction.

From 2017 to 2018, energy intensity continued to decrease for space heating (-2%) and lighting (-1.4%) but increased for space cooling (+2.7%) and remained steady for water heating, cooking and appliances. At an 8% increase in 2018, space cooling became the fastest-growing use of energy in buildings since 2010, though it accounted for only a small portion of total demand at 6%. The IEA estimates that the number of buildings in the world - and thus the demand for energy - will double by 2050<sup>9</sup>. Energy demand for space cooling is predicted to triple between 2016 and 2050. Nearly 70% of the increase will come from residential buildings, mostly in emerging economies driven by population growth and rising incomes<sup>10</sup>. Energy needs for cooling may in some countries account for about 60% and is therefore a large part of the buildings' total energy demand.

While buildings and construction are responsible for almost 40% of energy- and process-related emissions, climate mitigation measures in this sector are among the most cost-effective. It is therefore critical to increase the energy efficiency and decarbonize the buildings and construction sector to achieve the Paris Agreement commitment and the United Nations (UN) Sustainable Development Goals (SDGs).

### 4.1. Indonesia's Nationally Determined Contributions (NDC)

Indonesia is one of the largest emitters of greenhouse gases (GHG) in the world and also severely affected by the impacts of climate change. According to Indonesia's national reports on climate change, the main emission sources of carbon in Indonesia comes from land use and burning of peat (about 64% of the emissions), energy demand accounts for about 34% of the emissions. In this report, we are only looking at the CO<sub>2</sub> emissions from the use of energy connected with the building industry (not land use or peat burning).

<sup>8</sup> Global Alliance for Buildings and Construction (GlobalABC). Global Status Report 2019.

<sup>9</sup> Global Alliance for Buildings and Construction (GlobalABC). Global Status Report 2019.

<sup>10</sup> International Energy Agency (IEA). The Future of Cooling. Opportunities for energy-efficient air conditioning, 2018.



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The following illustration shows the total emission of CO<sub>2</sub> since 1889 (source: Our World in Data<sup>11</sup>)

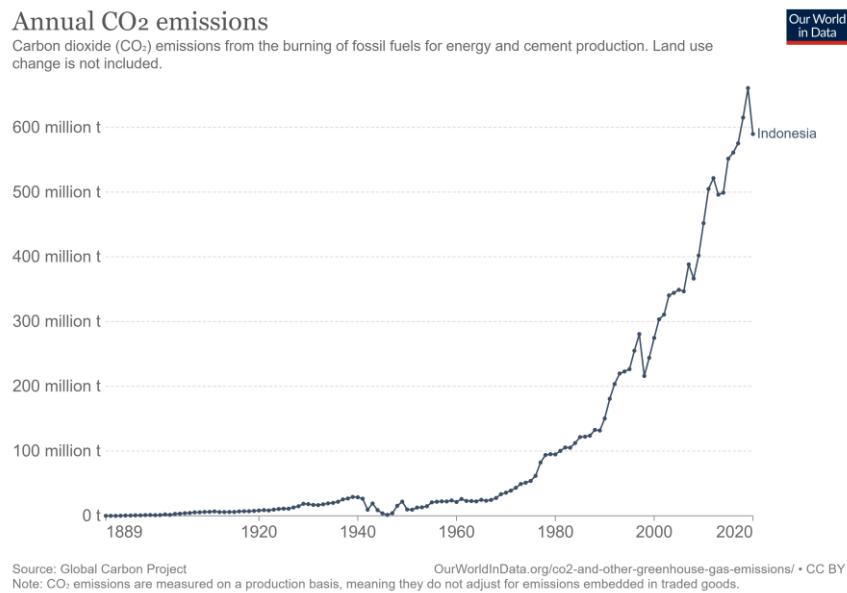


Figure 3 Total emission of CO<sub>2</sub> in Indonesia, Our World Data

In 2020, the total emission were at approx. 1,457 million tCO<sub>2</sub>emissions, of this the emissions from energy consumption were about 600 million T CO<sub>2</sub><sup>12</sup>. Indonesia's GHG emissions from energy demand are expected to increase significantly in the future. The updated Nationally Determined Contribution of Indonesia issued in July 2021 proposes a number of measures to reduce GHG emissions in key economic sectors such as energy, industry, agriculture and waste.

The Paris Agreement was signed by Indonesia in New York on April 22, 2016 by the Minister of Environment and Forestry, Mrs. Siti Nurbaya. The implementation of the Paris Agreement in the law in Indonesia is ratified in Law No. 16 of 2016 on the Ratification of the Paris Agreement to the United Nations Framework Convention on Climate Change (Paris Accord to the United Nations Framework Convention on Climate Change). The implementation of the Paris Agreement was undertaken on the basis of the NDC made by each country participating in the UNFCCC. The NDC has subsequently been submitted and the establishment of the National Registration System, as well as the development of the "Kampung Iklim (Climate Kampung)" program. Climate Kampung Program (ProKlim) is a nationwide scheme developed by the Ministry of Environment and Forestry (MOEF) to encourage the active participation of communities and all parties in carrying out local actions to improve resilience to climate change impacts and reducing GHG emissions through the implementation of ProKlim. The Government rewards communities in certain locations that have been implementing climate change adaptation and mitigation efforts in a sustainable way. The evidence of Paris Agreement implementation can be seen from the implementation of the NDC. The Indonesian ESDM ministry has prepared various policy tools, strategic programs and action plans to achieve the committed reduced emissions by 11% in 2030<sup>13</sup>.

<sup>11</sup> <https://ourworldindata.org/co2/country/indonesia#what-are-the-country-s-annual-co2-emissions>

<sup>12</sup> Updated Nationally Determined Declarations for Indonesia, 2021

<sup>13</sup> IESR Institute for Essential Services Reform, 2017



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Indonesia has committed to reduce unconditionally 29% of its greenhouse gasses emissions against the business as usual scenario by the year of 2030 (and 41% conditionally). The BAU scenario is projected approximately 2,869 Gt CO<sub>2</sub>e in 2030 which is updated from the BAU scenario on the NDC due to current condition on energy policy development in particular in coal fired power plants.<sup>14</sup>

## 4.2. Indonesia's Plan for the implementation of the Paris Agreement

The Indonesian Government has issued a Plan to implement the Paris Agreement on climate change in Law No. 16 of 2016. Accordingly, the Plan includes these five groups:

1. GHG mitigation
2. Climate change adaptation
3. Preparing resources
4. The establishing an open and transparent system (MRV systems)
5. The task of formulating and perfecting policies and institutions

Specifically, with the task of GHG mitigation, the Ministry of Energy and Mineral Resources, Ministry of Environment and Forestry, the Ministry of National Planning, the Ministry of Marine Affairs and Fisheries, the Ministries of Industry and Trade, the Ministry of Transportation, the Ministry of Public Works and Public Housing, the Ministry of Agriculture, the Ministry of Rural Development and other relevant entities have conducted periodic GHG inventory for the base years 2014, 2016, 2018 and assesses Indonesia's efforts in GHG mitigation to update the Nationally Determined Contribution (NDC) and participating in the UNFCCC global stocktaking. In order to reach the targets by 2030, Indonesia must continue to work on the implementation of GHG mitigation in the transport, construction, agriculture and rural development sectors in accordance with national conditions based on the UNFCCC global stocktaking. This needs involvement from Ministries, branches, localities and enterprises in implementing GHG mitigation activities suitable to national conditions.

## 4.3. The NDC targets for the building and construction sector

Construction of buildings and the operation of buildings accounted for 21.6% of total annual energy consumption (electricity, gas and LPG) in 2020<sup>15</sup>. Direct emissions from Indonesia's building sector constitute 4% of energy-related CO<sub>2</sub> emissions. Per capita, building related emissions are far below the G20 average, but on the rise. Therefore, buildings and construction plays an important role in the renewable energy transition.

In Indonesia, the building sector is one of the fastest growing sectors and the largest energy consumer, in which residential buildings are the most prominent energy users. The annual construction rate of residential and commercial buildings is about 5-6 % with the highest increase for residential buildings. The energy consumption from both new and existing buildings results in significant CO<sub>2</sub> emissions. Here the residential sector is by far the largest. New buildings have a lower energy consumption / level of CO<sub>2</sub> emission than older existing buildings.

Some of the major barriers in the implementation of GHG reducing technologies are: (a) Lack of energy efficiency policies and incentives for potential investors, (b) Lack of technical expertise and capacity to plan

<sup>14</sup> First Nationally Determined Contribution Republic of Indonesia Nov. 2016

<sup>15</sup> Statistics Indonesia, <https://www.bps.go.id/>



and design energy-efficient construction projects and financial issues for these projects and (c) lack of financing opportunities.

#### 4.4. Relevant regulation for EE in buildings:

The following regulations are relevant for the building and construction sector in Indonesia:

- Presidential Regulation No. 22 of 2017 concerning the General National Energy Plan
- Minister of Energy and Mineral Resources Regulation No. 14 of 2012 concerning Energy Management
- Regulation No. 70 of 2009: end-users with an annual consumption over 6,000 TOE must implement energy management (regular energy audit, preparation of an energy plan, implementation of energy saving measures)
- ESDM Regulation No. 13: public facilities must implement EE measures to achieve a 20% reduction target
- ESDM Regulation No. 7: minimum energy performance standards and labeling are required for air conditioning systems
- Governmental Regulation No.16/2021 on Buildings and Regulation No. 21/2021 on The Assessment of Green Building Performance
- Minister of Energy and Mineral Resources Regulation No. 18 of 2014 concerning minimum performance standards and energy saving label of Self-Based Lamps
- Minister of Energy and Mineral Resources Regulation No. 57 of 2017 concerning minimum performance standards and energy saving label of Air Conditioners

#### Indonesian Competency Standards

The Indonesian National Work Competency Standard (SKKNI) is a formulation of work ability that incorporates characteristics of knowledge, skills, and/or expertise, as well as work attitudes, that are important to the execution of assigned responsibilities and job requirements. The SKKNI on energy that applies in Indonesia is as follows:

- SKKNI 2018-053 Energy Audit
- SKKNI 2015-080 Energy Manager
- SKKNI 2020-223 Energy Monitoring and Verification

#### Indonesian National Standard (SNI)

According to PP No. 70/2009 on energy conservation, energy users with an annual consumption of at least 6,000 TOE are required to carry out energy management, which includes appointing energy managers, conducting periodic energy audits, implementing recommendations based on energy audit results, and reporting on energy conservation implementation every year. As a result, the application of SNI ISO 50001 as the execution of PP No.70/2009 is highly appropriate.

There are many additional SNIs that control energy demand, such as the ones listed below:

- SNI 6196:2011 Energy audit procedure for building
- SNI 6197:2020 Energy conservation for lighting system in building



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- SNI 6389:2020 Energy conservation for building envelope
- SNI 6390:2020 Energy conservation for air conditioning system in building
- SNI ISO 50001:2018 Energy management system – Requirements with usage guidelines
- SNI ISO 50002:2014 Energy audit – Requirements with guidelines for use
- SNI ISO 50006:2014 Energy management system – Measuring energy performance using Energy Baseline (EnB) and Energy Performance Indicator (EnPI) – General principles and guidelines
- SNI ISO 50015:2014 Energy management system – Measurement and verification of an organization's energy performance – General principles and guidelines
- SNI ISO 50021:2019 Energy management and energy saving – General guidelines for choosing an evaluator
- SNI ISO 50046 : 2019 General method for predicting energy saving
- SNI 6500:2018 Fixed Installation refrigeration system – Safety and environmental requirements
- SNI ISO 817:2018 Refrigerant naming and safety classification
- SNI 8476:2018 Method of assessment and testing on the performance of cool water coolers with vapor compression systems



## 5. OVERVIEW OF THE INDONESIAN BUILDING AND CONSTRUCTION SECTOR

In order to evaluate the potential for energy savings and reduction of CO<sub>2</sub> emissions it has been the ambition for this report to get an overview of the building stock in Indonesia and also to get a breakdown of this into types of buildings, year of construction and energy consumption per building type and per area. The team knew from the beginning that it would be difficult to obtain reliable data on this, therefore the following data analysis must be seen in the light of trying to identify the major trends in the building and construction sector in Indonesia and not to give exact numbers, since this for the time being is not possible. One recommendation, however, is to increase the availability of building stock data (number of buildings, year of construction, year of retrofitting, total area of the building stock with the possibility to split this into type, building year and geographical area).

### 5.1. Data quality and availability

The accessibility of data regarding both energy consumption and existing buildings in Indonesia is limited, which effects the data quality in this Roadmap. Data and information are identified by a variety of sources, in a variety of places, and in a variety of formats. Furthermore, the statistics and other information are often not accompanied by adequate explanations or clarifications. A critical issue is the standardization of energy and economic data. Furthermore, the data on e.g. the floor area for existing buildings in Indonesia varies from sources to sources. Building data sources in Indonesia are scattered across multiple sources and are inadequate. Minister of Public Works and Public Housing Regulation No. 17 of 2010, which was later revoked and replaced by Minister of Public Works and Public Housing Regulation No. 22 of 2021, govern building data collection.

It is hoped that following the publication of the above-mentioned regulation, Indonesia will continue to improve and eventually have a standardized and complete building database, allowing the data to be used in the interests of the nation and the welfare of the Indonesian people. For this report, the aim of the data collection and data analysis have been to get a realistic representation of the building sector and the energy consumption as well as to get an idea of the distribution between the different sectors in order to estimate saving potentials. However, the estimates for potential energy savings in the future are to some extent (due to the lack of reliable data) based on assumptions and may not necessarily be absolute correct, but are included here in order to make general recommendations for the building and construction industry.

### 5.2. Status of the buildings and construction sector in Indonesia

In order to make a baseline it is necessary to know the number of existing buildings, the use of the building, the floor area and when the buildings have been constructed. Here the definition of existing buildings is used for buildings, that are already in existence or constructed and officially authorized. As mentioned above this type of data is not directly available and the following method has therefore been used. The data related to existing buildings in Indonesia has been obtained by polygon data extraction using a tool "**Open Street Map (OSM)**", processed using QGIS and excel. OSM is a collaborative project to create a free editable geographic database of the world and can be accessed for open source. OSM is providing sufficient information to the



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representative levels of a building. Existing building data include name of provinces, number of buildings, footprint area, and image distribution for buildings area.

Currently, the building-area in Indonesia is estimated to be in the area of up to 3,600 million m<sup>2</sup> according to the Open Street Map (see example in Annex 2). This result is based on a digital mapping procedure, which could possibly cover the total area of surrounding building including parking lots and other open spaces, which could be defined as footprint area. From this total building area, it is necessary to define the net total building area according to the building types.

From the mapping shown in annex 2, buildings in Indonesia are mainly concentrated in the Java and Sumatra areas; more than half of the buildings are located here. Nevertheless, the mapping for the residential and non-residential building distribution is very uncertain. Therefore, an aerial mapping and satellite recognition is one of the methods that can be utilized as the starting point for further analyzing residential and other types of buildings spread across the provinces of Indonesia.

Another data source, Guidehouse Insight 2021, shows the proportion of the residential and commercial buildings. The discussed result points out that in 2021, residential buildings dominates the building area (89%) while the rest (11%) belongs to the commercial sector.

Sector	floor area, m <sup>2</sup>
<b>Public buildings, education, schools, community and cultural, sport and recreation</b>	84.825.753
<b>Industrial, infrastructure, military and transport</b>	70.804.746
<b>Offices</b>	85.227.719
<b>Hotels and retail</b>	137.519.806
<b>Residential</b>	3.061.422.191
<b>Total</b>	<b>3.439.800.215</b>

Table 1 Gross-Footprint Area of Existing Building, 2021, Data from Guidehouse Insights 2021

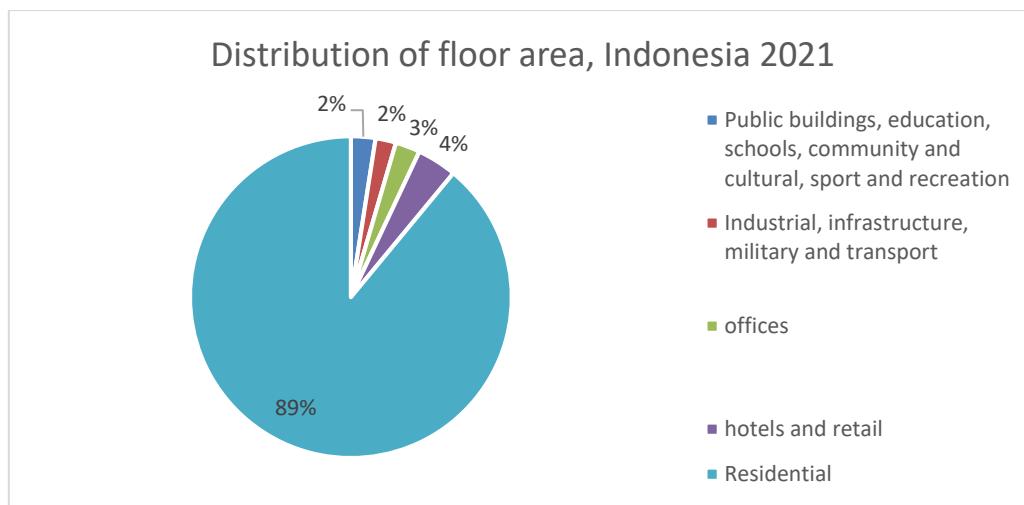


Figure 4 the distribution of the floor area of the different sectors



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The value of construction in Indonesia in 1990-2019 has increased. The value of construction decreased in 1997-1998 because of the Indonesian monetary crisis at the time. Based on the 2019 data update from Statistics Indonesia (BPS) on construction in Indonesia, the value of construction completed in Indonesia was 1,973.15 billion rupiah equal to a growth of 17.52% from 2018 from a value of 1,678.82 billion rupiah. The construction value in 2020 and 2021 are likely to decrease compared to 2019 due to the impact of the COVID-19 pandemic. In 2050, it is predicted that the construction value in Indonesia will increase by 126.36% compared to 2021 with a construction value of 2,661.45 billion rupiah.

The expected growth rate is estimated to be about 4% until 2030 and then go down to about 3-2.5% in the period 2030-2040 ending at 2% in 2050.

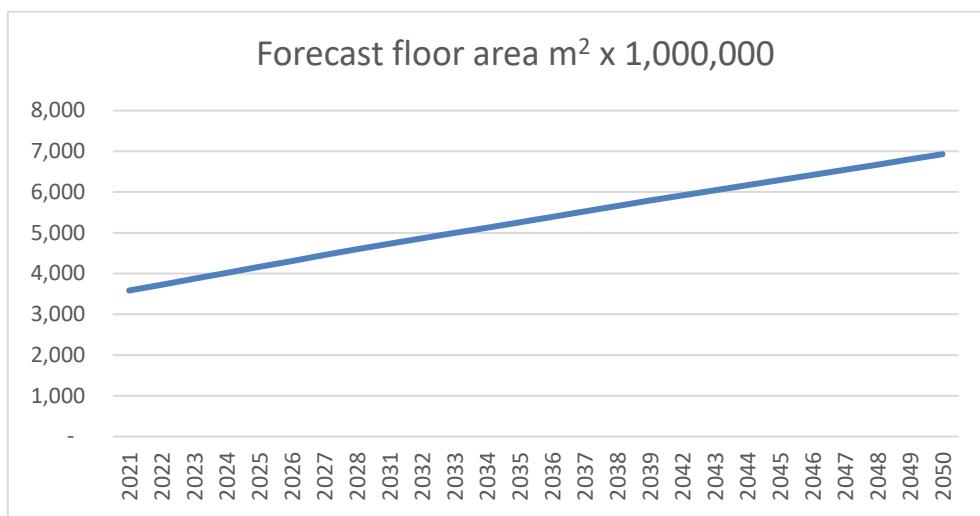


Figure 5 Forecast, floor area in the building sector Indonesia, Source: own data analysis

For commercial buildings, the highest annual growth rate comes from infrastructure sub-sectors, which is expected to increase with 8.5% annually. On the other side, community and cultural building has the lowest expected growth rate at about 2.6 % annually. Office buildings have the largest growth compared to other sectors, followed by retail and industrial. Those sectors are expected to grow 7.0% (office), 5.3% (retail), and 8.4% (industrial), respectively.

The residential building sector is expected to have an annual growth of about 3.7%. Single-Family detached buildings are the fastest growing group in the residential sector with an annual growth of 4.2%. According to the Indonesia Energy Outlook 2019 from the Ministry of Energy and Mineral Resources<sup>16</sup>, the number of households in 2020 is estimated to be about 67.5 million; this figure is expected to reach about 70.5 million by 2025 and 80 million in 2050, which gives an annual increase of households of about 0.5%. This means that about 600,000 new residential buildings are expected to be constructed every year.

<sup>16</sup> <https://www.esdm.go.id/assets/media/content/content-indonesia-energy-outlook-2019-english-version.pdf>



## 6. ENERGY CONSUMPTION IN THE BUILDING AND CONSTRUCTION SECTOR IN INDONESIA

Indonesia has large amounts of natural resources in the form of coal, oil and gas and this has made Indonesia a significant player in the international oil and gas industry.

The total final energy consumption in Indonesia in 2018 was around 114 MTOE derived from 40% transportation, 36% industry, 16% household, 6% commercial sector and 2% other sectors<sup>17</sup>.

For electricity consumption, the shares can be seen in fig. 5, where households make up 39,4% and commercial buildings 24,2%.

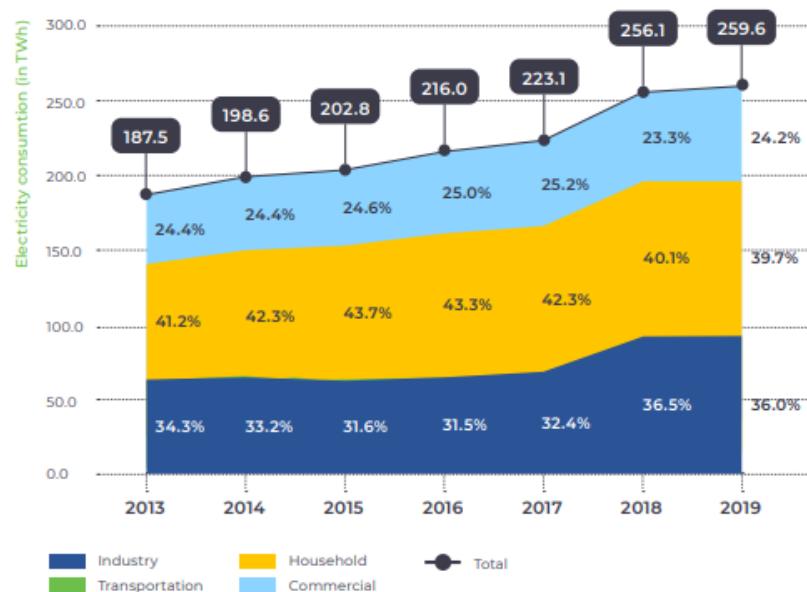


Figure 6 Electricity consumption for sectors 2013-2019, source: Handbook of Energy and Economics Statistics, MEMR, IESR analysis)

Energy consumption in the building sector can be divided into households and public and commercial buildings.

The demand for energy for households is influenced by the predicted increase in the number of household of about 70.6 million in 2025 and 80 million in 2050. Besides that, the urbanization rate also drives the increase of energy demand in the future. Based on Statistics Indonesia projection, the urbanization rate will reach 67% in 2035 from 49.8% in 2010 (Figure 6).

<sup>17</sup> Indonesia Energy Outlook 2019, <https://www.esdm.go.id/assets/media/content/content-indonesia-energy-outlook-2019-english-version.pdf>



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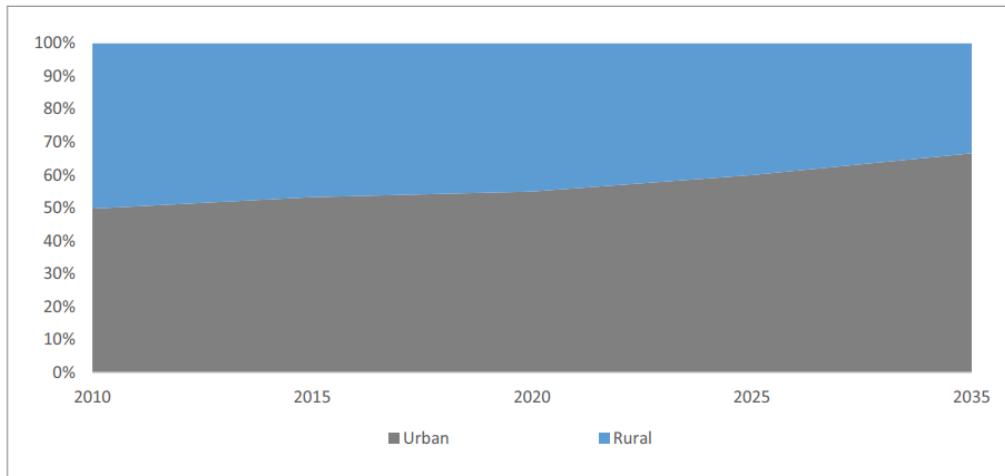


Figure 7 Projection of Rural and Urban People's Share until 2035 (source: Indonesia Energy Outlook 2019)

According to the Indonesian Energy Outlook (2019), the energy demand in household is in 2050 expected to reach 120 MTOE (Business as Usual scenario, BAU), 109 MTOE (Sustainable Development scenario, SD/PB in figure 6) and 94.7 MTOE (Low Carbon Scenario, LC/RK in figure 6)<sup>18</sup>. The different scenarios are if nothing is changed (BaU), if some measures are implemented (SD), and if very strict decarbonization regulation is implemented (LC).

The dominant type of energy consumption in household in 2050 is expected to be electricity. The electricity demand in households is forecasted to increase from 60% in 2018 to 90% in 2050. This increase is driven by the increasing use of electronic appliances in household such as air-conditioning installations, refrigerators, water pumps, rice cookers and induction stoves.

Gas is mainly used for cooking; the LPG demand in the BaU, SD and LC scenarios in 2050 will be 4.8 MTOE, 4.3 MTOE and 3.4 MTOE respectively, with an expected substitution from LPG to city gas, electricity and DME (Dimethyl Ether). The city gas for household program is expected to reach 4.7 million household connections. To meet the target of city gas development in the National Energy General Plan (RUEN) in 2025, there is a need to connect one million households per year. In the BaU scenario, it is assumed the same as in RUEN. In the SD scenario, the growth is also one million households connection/year. In the LC scenario, the growth is more than one million household connections/year. Based on the projection, gas demand in BaU, SD and LC in 2050 will reach 2.2 MTOE, 3.4 MTOE and 4.5 MTOE respectively. The energy demand projection in household is shown in Figure 7.

<sup>18</sup> Indonesia Energy Outlook 2019

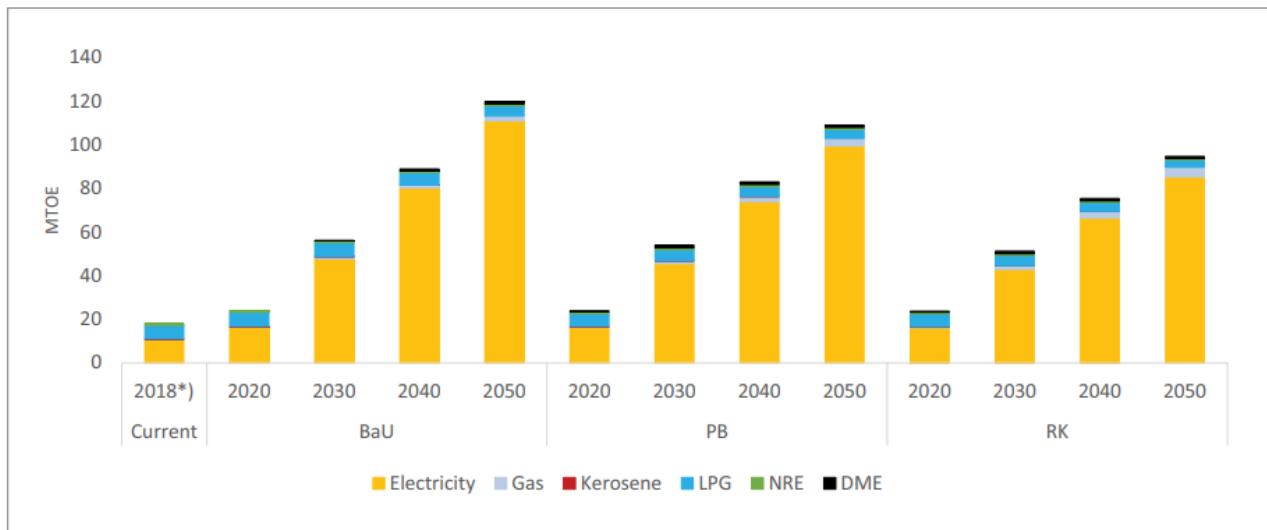


Figure 8 Energy Demand Projection in Household (source: Indonesia Energy Outlook 2019)

The share of Electricity demand from household is expected to increase from 49% in 2018 to 58% (BaU), 60% (SD) and 61% (LC) in 2050 despite of energy saving in several electronic appliances such as inverter in AC and energy saving lamp (LED). This condition is mainly influenced by the growth of household from 67 million in 2018 to more than 80 million in 2050. Furthermore, the increase in income also encourages an increased use of electronic appliances such as AC, refrigerator, washing machine, TV, and induction stove.

Energy demand for the commercial sector includes offices, hotels, restaurants, hospitals, and other services. Energy for these buildings is electricity, LPG, diesel, gas, biodiesel, and DME. Energy demand in the commercial sector is mainly for electricity with a share of about 60% to 70%. The electricity consumption in the commercial sector is mostly used for AC (cooling, ventilation, fans), production of hot water, water pumps, and electrical lights. Furthermore, LPG demand share is still high, about 22% from the total energy demand in commercial sector. LPG in the commercial sector is used for cooking especially in hotels and restaurant and in some places for the production of hot water. In 2050, the share of diesel and biodiesel demand in the commercial sector is expected to be around 5% and 2% respectively, used for generator as backup power supply. The total final energy demand in commercial sector in 2050 is expected to be 47.7 MTOE (BaU), 40.5 MTOE (SD) and 36.2 MTOE (LC). The growth of energy demand in commercial sector can be seen in Figure 8.

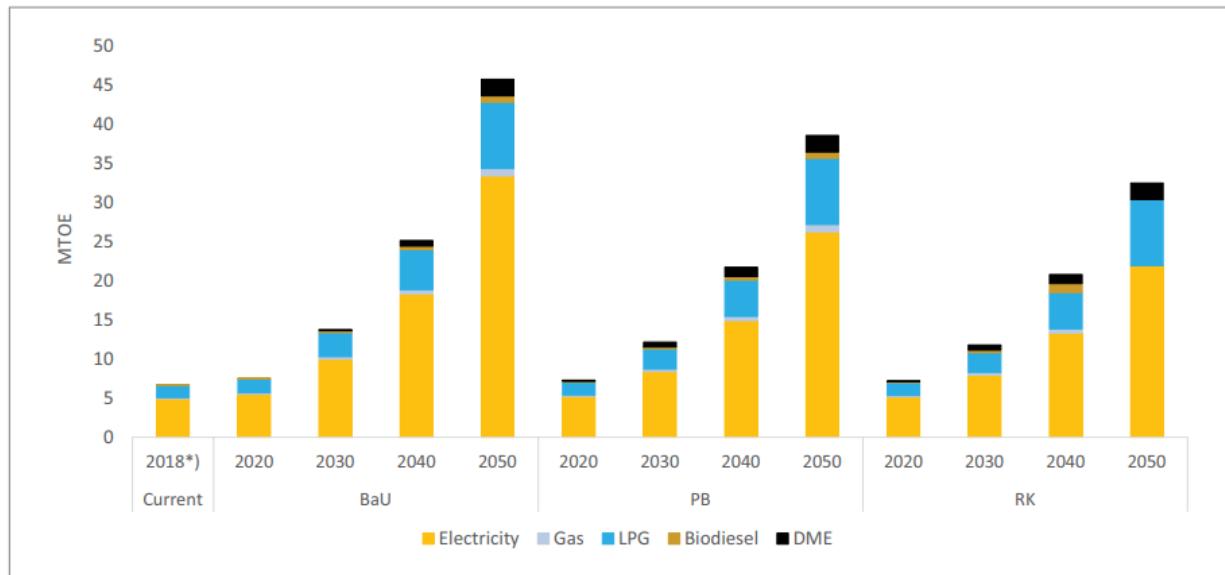


Figure 9 Energy Demand in the Commercial sector (source: Indonesia Energy Outlook 2019)

Energy demand in the commercial sector in all scenarios show similar trend. Almost 50% of energy demand is consumed by the trade, hotel and restaurant sub sectors. While the remaining 50% is consumed by the social services, communication services, financial services and offices sub sectors.

The overview of final energy demand per commercial sub sector can be seen in Figure 9.

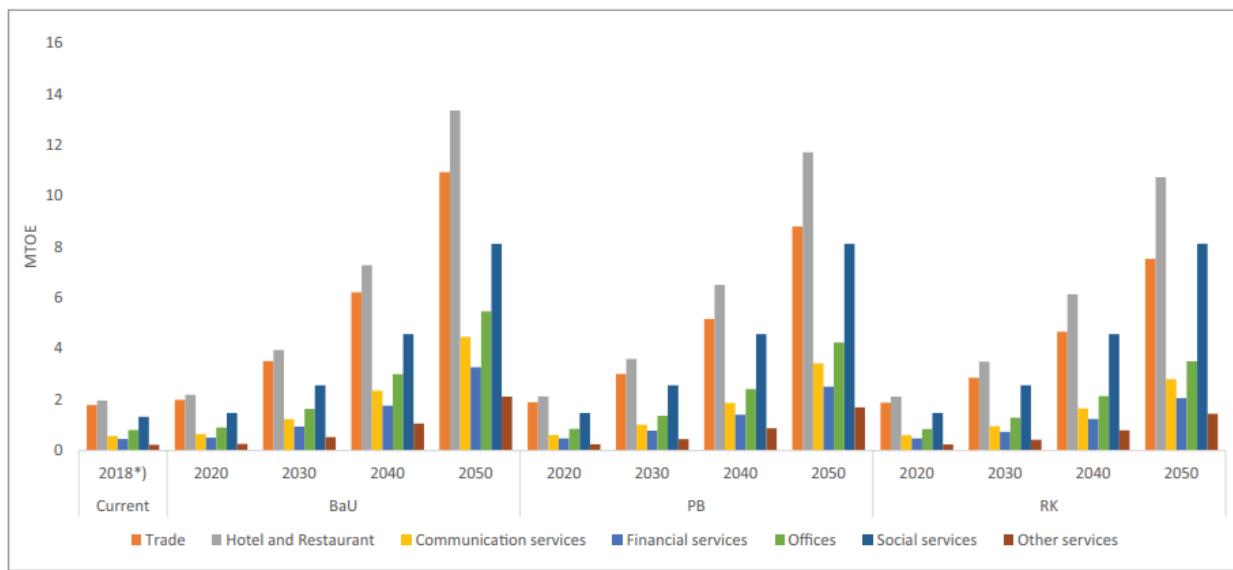


Figure 10 Final Energy Demand in Commercial Sector (Source: Indonesia Energy Outlook 2019)

Similar to household, the increase of electricity demand in commercial sector is driven by the increased demand for AC as well as LPG and electricity for cooking especially in hotels and restaurants. Electricity demand in commercial sector is expected to increase by seven times in 2050 to 389 TWh (BaU), 305 TWh (SD) and 255 TWh (LC).



## 7. FINANCIAL MEASURES AND CO-BENEFITS FOR EE IN BUILDINGS

### 7.1. Finance measures

In order to achieve the targets for low-emission, efficient and resilient buildings finance is needed. Some examples for specific finance models are outlined below:

**Urban development funds:** Dedicated funding for development projects, which can be directed toward sustainable urban development projects.

**Infrastructure funds:** Dedicated funding for projects (buildings, building retrofit and infra structure), which can be directed toward sustainable projects.

**Dedicated credit lines:** funding delivered through banks for a specific purpose, such as sustainable buildings or development projects.

**Risk-sharing loan / loan guarantee:** Large organization, such as a government, international bank or aid organization, covering the risk of payment default to allow banks to fund a project with lower costs and better loan terms.

**Green bonds:** Bonds that can be used to bundle funding associated with sustainable projects.

**Preferential tax:** Direct funding from the government to reduce or eliminate the tax for sustainable products and services.

**Grants and rebates:** Direct funding provided by the government, organization or program during or after the purchase of a sustainable product or service.

**Energy performance / energy service contracts:** Contracts for services or delivered savings from an Energy Services Company (ESCO), can include a range of energy efficiency services and products. These contracts normally last for a longer period of time like 5 or 10 years.

**Procurement purchase and lease:** The purchase or lease of sustainable products and services. Leasing enables the ability to use energy efficient products on a rental basis to reduce a capital expenditure.

**On-bill / tax repayment:** An approach where any recurring bill, such as utility bills, insurance bills or home improvement store bills, can collect small amounts of money over a long period of time to pay for energy efficiency purchases in smaller payments. A tax-finance is where tax authority uses recurring tax payments as a means for collecting money over time. The most common of these is called PACE (Property Assessed Renewable energy) and is able to use low interest loan repayments on the property tax bill until the purchase is full paid.

**Community finance and crowdfunding:** Collective funding from a large number of people connected either locally or through a call for funding.

### 7.2. Co-benefits

Many co-benefits can be achieved through sustainable building and urban planning. The following describe some of the benefits. Many of these are difficult to quantify but still relevant to include in the analysis of the feasibility of projects.

**Emissions savings:** By reducing the energy consumption, emissions from the production of energy are also reduced. By introducing NZEB for buildings there will be no emissions at all from new buildings. Renovating existing buildings will reduce the emissions significantly.



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**Air quality:** The air quality can be improved by reducing the amount of local fuel used for supplying buildings with energy (gas, oil and coal). Also the use of integrated urban planning and the use of e.g. more green spaces and inducing walking and biking commutes can reduce the local pollution.

**Resource efficiency:** Reduction of the energy consumption and improvement in the efficiency means an overall improvement of the resource efficiency.

**Security of supply:** By using less energy and using it more efficient it is possible to increase the security of supply and to reduce peak load in the grid system. This puts less strain on energy markets.

**Better societal Economy:** Energy efficiency in the building sector creates employment for sustainability services and reduces the cost of operation of a building, thereby improving the economy.

**Improved productivity:** Better buildings and better urban planning can significant improve the productivity of the occupants and users.

**Higher employment:** By supporting the need for renovation and retrofitting the need for skilled labor is likely also to increase. This is the case in the whole building chain from the production of building materials to the construction of buildings and to the operation and maintenance of the building.

**Improved asset value:** The construction of sustainable buildings and the renovation of existing building will increase the value of the buildings and the neighborhoods.

**Poverty alleviation:** By reducing the need for energy, the building owners and the users will pay a lot less for the operation of the buildings.

**Improved health and well-being:** Sustainable buildings generally have a better indoor climate and this will improve the health of the occupants. Sustainable urban planning delivering increased physical and mental health through improved access to green spaces and other urban amenities.

**Safety and security:** Sustainable new buildings and sustainable urban planning can increase the felling of safety and thereby reduce crime in a neighborhood or a building area.



## 8. ENERGY EFFICIENCY IN THE BUILDING AND CONSTRUCTION SECTOR IN INDONESIA

In the following, the eight Roadmap activities are analyzed in order to establish a baseline. Recommendations are given for the short term (2025), medium term (2030) and the long term (2050). Suggested action and targets are indicated for each activity.

### 8.1. Activity 1: Urban planning and development

Indonesia is among the largest contributors to urbanization globally. According to estimates from the United Nations, Indonesia's urban population increased by nearly 59 million people from 2010 to 2018, behind only China and India. When the independence of Indonesia was proclaimed in 1945, only one in eight Indonesians lived in towns and cities. At present, 137 million people live in urban areas of Indonesia or 54 percent of the population. The urban population of Indonesia increased at an average rate of 4.1 percent per year between 2000 and 2010, faster than in any other country in Asia. The share of urban residents is expected to grow to 68 percent of the population by 2025. Because of persistent gaps in infrastructure and low attention to spatial prioritization of infrastructure investments, Indonesia has not fully benefitted from the positive effects of urbanization.

Indonesia has experienced urbanized sustained growth in population, urban spatial expansion, construction, and built infrastructure development. The largest city of Indonesia is Jakarta with a population of 10.6 Million inhabitants. Eleven of the country's cities have populations that have surpassed the one million resident milestone.

City	Inhabitants, millions
Jakarta	10.6
Surabaya	2.87
Bekasi	2.54
Medan	2.45
Bandung	2.44
Depok	2.06
Tangerang	1.89
Palembang	1.67
Semarang	1.65
Makassar	1.42
South Tangerang	1.29
Batam	1.20
Bandar Lampung	1.17
Bogor	1.04

Table 2 Cities with more than one million inhabitants in Indonesia, 2020

Many cities are based on urban sprawl and not on sustainable planning. It is recommended that cities and municipalities will work on integrated sectoral plans and strategies including master plans for transportation, housing, economic strategies and environment. Capacity building for this is needed.



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Development of national urban institutional and policy component to support the strengthening of inter-ministerial coordination on cross-sectoral urban issues is also needed at the national level. Also development of national policies, guidelines and strategies to promote efficient, sustainable and climate-resilient urban development. Support integrated planning for urban development component in order to strengthen the quality, strategic approach and implementation of integrated spatial planning in the large cities, and links spatial planning with the prioritization of capital investments. Development of an annually rolling capital investment planning and budgeting framework. Capacity building activities on urban planning and development and on how to integrate sustainable criteria in the city plans and support of necessary systems, equipment and tools for local governments to address constraints to effective implementation of prioritized capital investments, including demand side constraints to accessing alternative sources of finance beyond national government transfers.

#### **National Urban Development Project (NUDP)**

An example of such activities can be found in the World Bank Project: National Urban Development Project (NUDP) running from 2016 to 2022. This Project (NUDP) will give technical assistance and ensure capacity-building to meet pressing needs in urban planning and management, urban infrastructure financing and strategic project by preparing a platform for coordination of the urban planning and infrastructure development at the city level with the aim to increase city capacity to be able to access multi-year financing. This platform also aims to facilitate various sectoral programs financed by various funding sources, including the National Budget (APBN), loans and grants. The NUDP project will develop a platform that brings together sectoral infrastructure investment programs in three ways:

- (1) *Development of national level infrastructure development guidelines and improving cross-sector coordination through strengthening inter-ministerial platforms for urban development;*
- (2) *provide guidance on regional investment priorities through the spatial development framework approach;*
- (3) *Introducing and building a system of prioritizing development programs through capital investment planning (CIP) to be adapted within the framework of regional planning and development towards investment efficiency and effectiveness.*

As a part of this project, a report has been made in 2019<sup>19</sup> where these three arguments are the base of the report (ACT):

*Augment the coverage and quality of basic services and urban infrastructure to better manage congestion forces and address large disparities in human capital outcomes both across and within places*

*Connect urban areas of different sizes with each other, with surrounding rural areas, and with international markets—and to connect people with jobs and basic services within urban areas—to enhance inclusiveness both within and among areas.*

*Target places and people that may be left behind by the urbanization process to ensure that they share in the prosperity benefits of urbanization and that urban areas are livable for everyone.*

<sup>19</sup> Time to ACT Realizing Indonesia's Urban Potential, World Bank 2019, also available in Bahasa)  
<https://openknowledge.worldbank.org/handle/10986/31304>



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Improvements involves reforming the ways urban areas are governed and financed, with a focus on expanding options for financing infrastructure and basic services, as well as improving coordination between different levels and sectors of government and between districts that belong to a common metropolitan area. It also involves building stronger capacities to plan, implement, and finance urban development.

### **Action and Targets for 2030-2050 for urban planning and development**

**Integrate energy and environment in urban policy plans.** Take into account the long-term goal of reducing carbon emissions in the building sector in urban planning and development policies.

**Integrated planning for the regions and cities.** Allows for a systematic, planned approach that integrates energy supply and demand at the regional and city level to provide less carbon-efficient and efficient solutions. Focus on linking new residential areas with high density areas using energy networks (district cooling), transport and renewable energy systems.

**Institutional coordination.** Ensure cooperation between ministries, provinces and cities, and across sectors including transport, urban planning, housing, society and energy supply.

**Public transport-oriented design.** Develop a land use plan that prioritizes public transport infrastructure together with sustainable urban growth.

	Key actions Baseline (2020)	Short term (2025)	Medium term (2030)	Long term (2050)
1 Integrated planning for the regions and cities	Only little focus on sustainable urban planning and development for new areas (urban Sprawl)	Development of tools for sustainable city development plans, development of training programs for professionals	Integrated plans developed for 10 largest cities in Indonesia taking transport and sustainable living into account	Integrated plans developed for the majority of the large cities in Indonesia taking transport and sustainable living into account
2 Integrate energy and environment in urban Policy Plans for new developments	Current land use plan do not consider low carbon buildings and living	Development of tools for integrated planning for new developments	50% of new urban development are using tools for integrated planning	All new urban developments are using tools for integrated planning

Table 2 Key Actions and Targets for Urban Planning and Development

### **Stakeholders for urban planning and development**

The key stakeholders for sustainable urban planning are the regional planning authorities and the municipalities. In addition, architects and planners play a big role in this working on efficient and resilient buildings through urban planning. Further stakeholders include professionals from research, funding, training, and making technologies available.



### **Policies for urban planning and development**

Urban planning policy can support goals for low-emission, efficient and resilient buildings by enabling a local environment that has sustainable resources and where designers, developers and owners have the support to invest in the broader sustainable development goals. The following sub-targets and timelines offer more details:

Urban planning policy target details:

**District planning:** Local jurisdictions should increasingly plan for interactions between buildings and connections with district energy resources that can enable zero emission communities with renewable energy and sustainable buildings.

**Space planning:** Planners, developers and designers can work together to increase the mixed-use nature of dense urban districts that have easy access to transit, retail, employment, entertainment and residences to limit unnecessary energy use and emissions from transport and increased quality of life.

**Urban ecology:** Landscaping and vegetation services can support improved resilience and reduced need for heating and cooling if properly designed to support sustainable communities.

**Incentives:** Non-fiscal incentives, such as expedited permits or increased floor area allowances, should be the priority to encourage sustainable buildings and communities. Fiscal incentives should be used to enable the very best sustainable buildings, while finance support, such as loan guarantees, should enable private investment.

### **Technology for urban planning and development**

Technology can enable increased action toward low-emission, efficient and resilient buildings when coupled with urban planning. Specific targets and timelines for sustainable urban planning technologies are outlined below:

Urban planning technology target details include:

**Digital tools:** Support the increased use of tools that use data and information, such as satellite images, cost data, benefits analysis and lifecycle analysis to make science-based decision making in the urban planning process.

**Energy network:** Planning of local energy networks e.g. using district cooling. District cooling may have a high investment energy has a low lifecycle cost compared to other energy solutions, support the increased use of district energy technologies that can transition district energy networks to be efficient and use renewable energy sources, such as co-generation, industrial waste heat, biomass, geothermal, wind or solar energy.

**Exterior lighting:** Support the increased use of smart and efficient lighting in the exterior of buildings and streets. Smart lighting includes sensors, controls and can be integrated with other environmental and site conditions information, such as traffic.

**Water management:** Support the increased use of water management technologies that reduce water runoff, increase landscape permeability and rainwater retention. This can support resilience against floods and improved health of soil and underground aquifers.

**Waste management:** Support the increased use of waste and wastewater storage and treatment technologies that can reduce energy use for waste from buildings.

**Vegetation:** Increase vegetation in, on and around the building to improve shading, air quality, management of storm water, the urban heat island effect, and human physiology.



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### **Capacity building and training for urban planning and development**

Information combined with capacity building activities is needed in order to facilitate the use of integrated planning for regions and municipalities. Training for professionals working directly with the built environment is also needed to deliver sustainable urban planning. Specific capacity building targets include:

Sustainable urban planning capacity-building target details include:

**Training within government:** Build capacity and awareness in all levels of government on the implementation of sustainable urban planning, and their benefits and impacts on transport, infrastructure, public health and wellbeing, the energy sector, and the environment.

**Training of professionals:** Provide training programs for service and product providers of buildings and construction (architects, developers, contractors, vendors, etc.) and building owners are aware of sustainable urban policies, programs or incentives to implement sustainable buildings and construction.

**Educational training:** Develop educational programs including primary, secondary, vocational, university and adult education, to enable increased knowledge of sustainable urban planning. Provide certification or accreditation for professionals in the urban planning sector.

**Awareness and information:** Develop information tools for people to have increased awareness, improved decision-making and to promote more sustainable choices. Methods of increasing information to consumers include benchmarking programs, certification programs, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programs.

**Institutional coordination:** Coordination and shared goals between relevant government and non-government organizations can enable improved policy coherence. Urban planning in particular is a field that cuts across many different disciplines including environmental, infrastructure, energy, transport, and buildings. Technical, financial and human capacity and resource in each of the organizations can improve the implementation and enforcement of urban planning policies.

## **8.2. Activity 2: New buildings (buildings under construction)**

The value of construction in Indonesia is steadily increasing. The value of construction decreased a bit in 1997-1998 because of the Indonesian monetary crisis at the time. Based on the 2019 data from BPS regarding construction statistics in Indonesia, the value of construction completed in Indonesia was 1,973.15 billion rupiah or an increase from 17.52% from 2018 from a value of 1,678.82 billion rupiah. The construction value in 2020 and for 2021 are likely to decrease compared to 2019 due to the impact of the COVID-19 pandemic. After the pandemic is over the building market in Indonesia is expected to rise again.



## CONSTRUCTION TRENDS IN INDONESIA

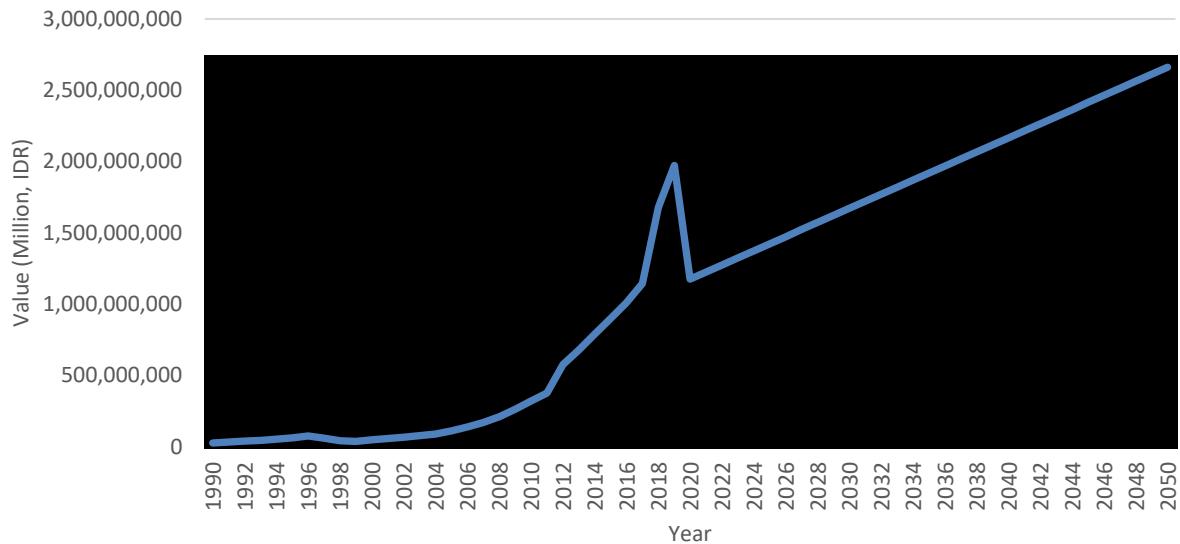


Figure 11 Value of the construction sector in Indonesia (new constructions) Source: BPS Indonesia

The building rate for buildings being constructed in Indonesia has been about 10-20 percent since 2000

### Growth Rate for new constructions in indonesia, %

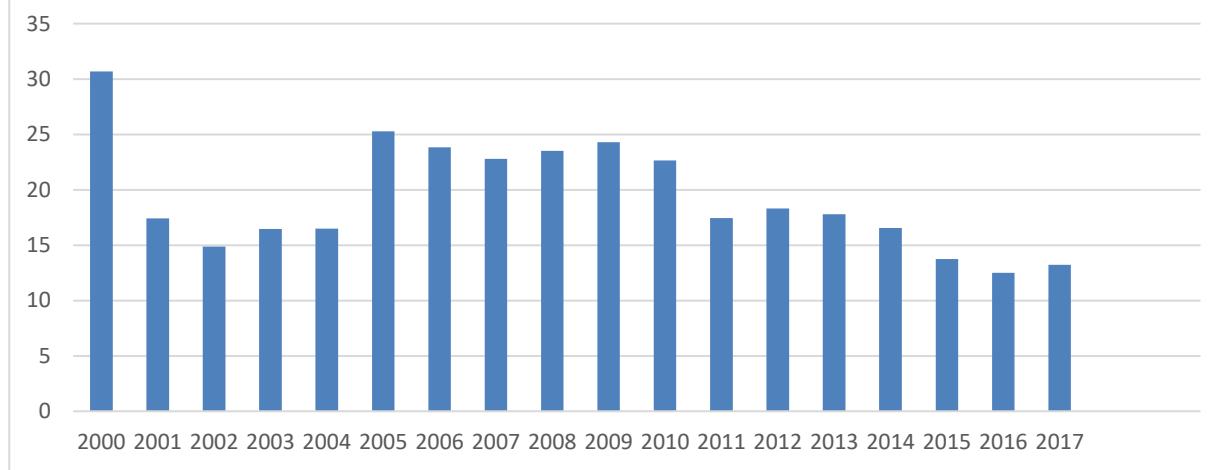


Figure 12 Growth rate 2000-2017, Source: BPS Indonesia

The expected growth rate for the construction of new buildings is expected to be somewhat reduced in the future and in 2050 to be about 2% per year. If we look at the different sectors, we see this picture in relation to the growth rates. From figure 12 we can see that the sector with the highest growth has been the education sector, followed by the health sector, the hotel sector and the industrial sector.

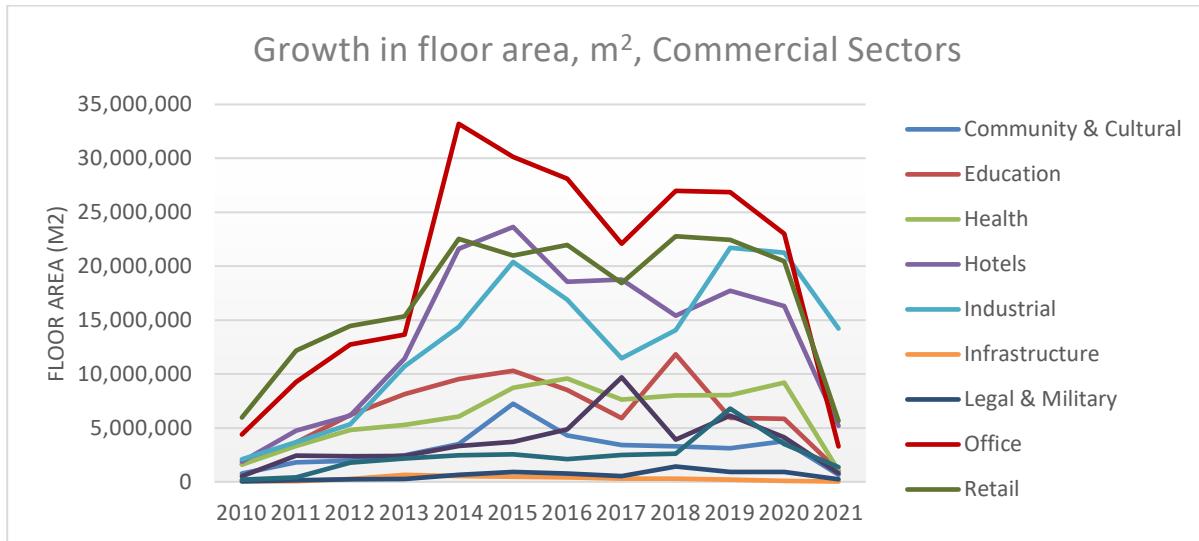


Figure 13 Increase in floor Area in Commercial Sectors, 2010-2021

The forecasts from the construction sector indicates that the biggest growth will be in the office sector.

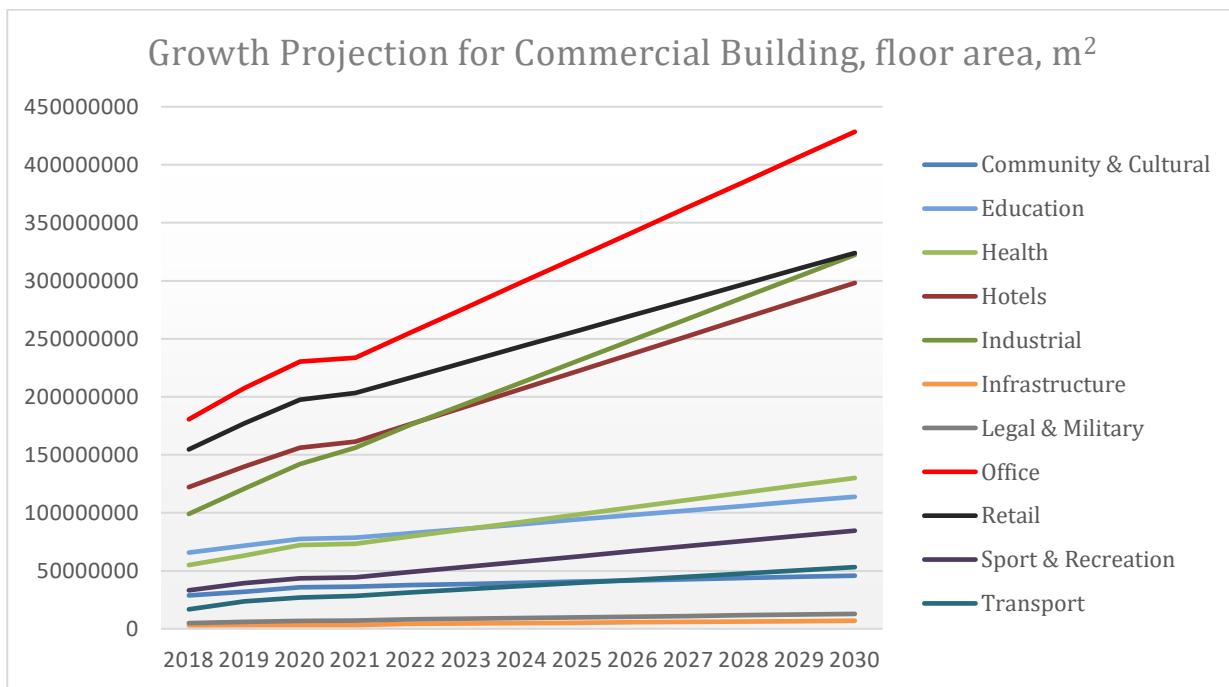


Figure 14 Expected growth rates for commercial buildings, Source. BCI Asia, 2021

For residential buildings the picture looks like this. Single-family detached buildings are the fastest growing sector in the residential sector with an annual growth of 4,21%. According to the Indonesia Energy Outlook 2019, households are projected to reach 80 million in 2050 (current number of households - single family houses and apartments - is 67.5 million according to the Handbook of Energy & Economy Statistics of Indonesia 2020).



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## Growth Projection for Residential Buildings, floor area, m<sup>2</sup>

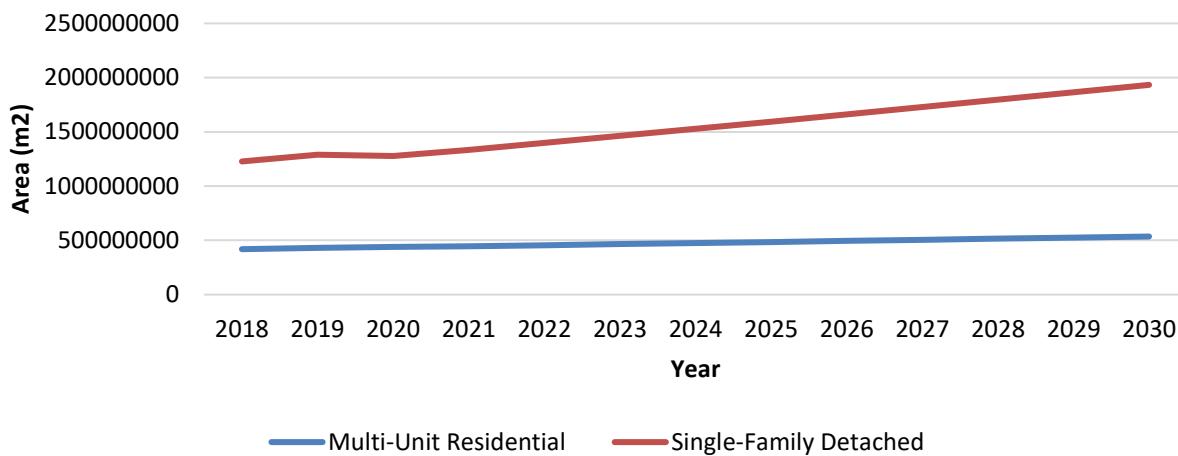


Figure 15 Growth projection residential buildings, m<sup>2</sup>, Source: Guidehouse Insight, 2021

From the statistics and projections, it is estimated that every year, this amount of floor area will be constructed in Indonesia:

	Existing buildings 2020, Floor area, m <sup>2</sup>	Projection total area in 2030, floor area, m <sup>2</sup>	New buildings being build every year, floor area, m <sup>2</sup>
<b>Public buildings, education, schools, community and cultural, sport and recreation</b>	84.825.753	185.000.000	10.000.000
<b>Industrial, infrastructure, military and transport</b>	70.804.746	245.000.000	17.500.000
<b>Offices</b>	85.227.719	285.000.000	20.000.000
<b>Hotels and retail</b>	137.519.806	412.500.000	27.500.000
<b>Residential</b>	3.061.422.191	3.236.000.000	17.500.000
<b>Total</b>	<b>3.439.800.215</b>	<b>4.363.500.000</b>	<b>92.500.000</b>

Table 3, existing building area and projection of new constructions by 2030, floor area, m<sup>2</sup>, Source: BCI Asia, 2021 and Guidehouse 2021.

Most of these new buildings will be built in metropolitan areas. In-efficient buildings built today will be responsible for carbon emissions in the next decades. Integrated policies for new buildings can avoid this locking-in emissions scenario for Indonesia's construction sector. Mandatory Building Codes and Green Rating schemes are therefore of great importance both to be developed and to be implemented.

### Energy regulations in Indonesia

Indonesia has four energy standards for buildings (Standar Nasional Indonesia/SNI), which were introduced in 2000 and are now commonly used as a reference to build commercial buildings and offices and cover the building envelope, air conditioning, lighting and building energy auditing:



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- SNI 03-6389-2011 - Energy conservation for building envelope - Overall Thermal Transfer Value (OTTV should be under 45 Watt/m<sup>2</sup>)
- SNI 03-6390-2011 - Energy conservation for air conditioning system in building
- SNI 03-6197-2011 - Energy conservation for lighting system in building
- SNI 03-6196-2011 - Energy audit procedure for building

The General Plan for National Energy through Presidential Regulation No. 22/2017, developed by the Ministry of Energy and Mineral Resources (MEMR), states the framework for energy efficiency and conservation. The Plan aims to promote EE through four primary activities:

1. Developing the Energy Service Company (ESCO) to implement energy efficiency projects
2. Implementing energy audit and management programs
3. Restructuring of industrial machinery and the issuance of incentive schemes (monetary and nonmonetary) for industries that have implemented energy efficiency measures
4. Implementing socialization and education measures via electronic and social media to increase awareness on the part of project developers and the public regarding energy efficiency.

The National Master Plan for Energy Conservation (RIKEN) was first passed in 1995, establishing the need for further implementation of specific energy conservation programs and energy audits and reports. In 2005, Indonesia launched an update to the RIKEN, which set the goal of decreasing energy intensity by at least 1% per year until 2025. RIKEN 2011 was developed based on the Government Regulation No.70/2009 and the Presidential Regulation No. 22/2017 among others, to include strategies, programs, and Roadmap on energy conservation to reach the energy intensity reduction target as well as sectoral energy consumption reduction targets. This document acts as a guideline for stakeholders to implement EE&C in Indonesia and stipulates the obligation to implement EE labelling to energy appliances.

Furthermore, the Government Regulation No. 36/2005 on Buildings mandates new buildings to implement energy conservation measures. The law requires residential buildings of more than 500 m<sup>2</sup> and commercial buildings of more than 5,000 m<sup>2</sup> to meet minimum energy performance requirements. However, compliance with the Government Regulation No. 36/2005 has not been strictly enforced. Ministerial Regulation No. 13/2012 on Electricity Saving targets 20 percent electricity saving through improvement of air conditioning, lighting, and supporting equipment. The regulation mandates all government buildings, including official residences to comply with the technical specifications for air conditioners, lamps, and other electronic equipment. The green building codes were introduced in on a municipal level in Jakarta, Bandung and Semarang.

#### **The Green building codes in Indonesia:**

Green building codes have been implemented in Jakarta since 2013 with support from the International Finance Cooperation (IFC). The code includes Minimum Energy Performance standards (MEPS). The use of the green building codes only applies for buildings larger than 50,000 square meters<sup>20</sup> and the number of new buildings this big is rather limited. The experience regarding energy efficient building techniques among the panel of experts checking the construction details before a building permit is issued, is therefore also rather limited.

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<sup>20</sup> A revised version of the Green Building code is being launched in august 2019 including also smaller buildings. For residential and commercial buildings



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Since stipulated in 2013, Governor Regulation on Green Building implementation in Jakarta has been experiencing some challenges. One of the challenges is due to limited resource to enforce its implementation. Administration of building permit in Jakarta is administered by DPMPTSP (Dinas Penanaman Modal Pelayanan Terpadu Satu Pintu), which serve as one stop service for all permits, including for building, in Jakarta.

Based on the discussion with IFC on required support of Green Building Regulation, there is an update for the regulation in order to improve implementation rate. Currently aiming not only for large buildings, medium size buildings are also required to conform to the requirement to implement Green building principles. To support the implementation, the Jakarta Government through DPMPTSP would require competent building inspector to conduct due diligence / checking of conformity. In Jakarta, implementation of green building is relying on the assessment conducted by Architectural Experts Pool (TABG-AP) who are being hired by the Jakarta Government.

As part of the whole building permit process, the experts looks at architectural, structural and MEP aspects as show in the illustration below:

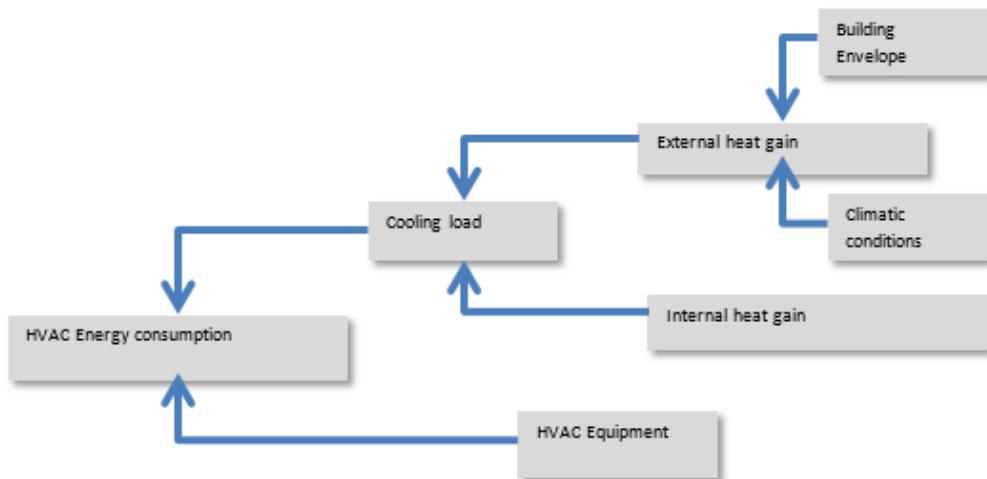


Figure 16 Illustration of the compliance process for the building code

**From the stakeholder consultations:**

*"In terms of building and preceding construction regulations, 509 regencies and cities, particularly IMB, have its own set of rules. However, as of August 2021, The Consolidation of all of these requirements has been made into a single directive. The only rule that must be followed is Government Regulation No. 16. SimBG (submission, reporting, monitoring, and evaluation in the building sector), laws and standards, and others have all helped PUPR improve the implementation process."*

*"Green construction is directly linked to integrated design, resulting in a low Energy Consumption Index when in use. Starting with maximizing the passive design, implementation can then go on to the active design of the connected building."*



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### Green Rating schemes:

#### Green Building Rating Tools – Ministry of Public Works and Housing

In 2015, the Ministry of Public Works and Housing introduced the Ministerial Regulation No. 02/PRT/M/2015 on Green Buildings which then in 2021 is being replaced by the Ministry of Public Works and Housing Ministerial Regulation No. 21 regarding Green Building Performance Assessment to assist in green building certification and implementation in Indonesia. The regulation classifies green building requirements as mandatory, recommended, and voluntary based on specific building size, criteria, as well as energy and water consumption. To be certified as a Green Building according to this mandate, compliance needs to be met in all these five phases:

1. Program phase,
2. Technical planning phase,
3. Construction phase,
4. Usage phase, and
5. Demolition phase.

The energy efficiency component is contained within the technical planning phase, which includes building envelope, ventilation and air conditioning, lighting, transportation within the building premises, and electricity.

There has been an increased awareness on Green Building concept, as large cities such as Jakarta and Bandung have implemented local green building codes with energy efficiency requirements as an important component. Large buildings in Jakarta are required to follow mandatory compliance whereas buildings in Bandung are required to include energy performance and incentives for smaller buildings. Even though a rating tool has been published, organizational infrastructure still needs to be further developed to include human capacity building for design and construction assessment.

The Green Building Council of Indonesia (GBCI)<sup>21</sup> is an independent not for profit organization founded in 2009 by leading professionals and companies in the building industry in Indonesia. The main mission is to transform market and industry players to be more responsible and sustainable. There are four main programs: 1. Ranking Development, 2. Training and Education, 3. Green Building Certification and 4. Stakeholder Engagement.

#### **Action and Targets for 2030-2050 new buildings (Buildings under construction)**

It is recommended that Indonesia prioritize the development of energy efficiency requirements for new buildings and make them mandatory as first priority. Effective enforcement mechanisms are required and relevant agencies and actors must be trained on enforcement. The green building certifications can be implemented with financial or non-financial incentives as a voluntary scheme in the beginning. Making it mandatory for public and other buildings at a later stage will ensure the transformation of the sector towards full decarbonization.

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<sup>21</sup> <https://www.gbcindonesia.org/>



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By 2050, cumulative floor area of buildings to be constructed is projected to be at 617 million square meters. This is four times higher than the baseline of 2016. Meanwhile, single family buildings are believed to be dominantly driven by a 250% increase of floor area from 10.3 m<sup>2</sup> per capita in 2016 to 27 m<sup>2</sup> per capita in 2050. EE requirements for single-family buildings should therefore be adopted as soon as possible.

To achieve sustainable (low-emission, efficient and resilient) new buildings, a series of key actions for policies, investment and design are recommended.

**Improving existing building energy standards.** Ensure that building standards are periodically enhanced to improve performance requirements every 5 years with the expectation of moving towards zero-emission and zero-energy standards over the period of 2040- 2050.

**Encourage further developers to use the building codes.** A new building code has been introduced in 2021 but is still not fully implemented. Priority should be given to the adaption and enforcement of the code and encourage building owners and developers to use this e.g. by giving advantages to developers following the buildings codes.

**Encourage the use of Green rating tools.** Give rewards to outstanding buildings and developers going significantly beyond the building code.

**Government takes the lead.** Develop policies to ensure that all new public buildings follows the building code and targets are set to go beyond the codes e.g. NZEB.

**Ensure funding for sustainable construction.** Ensuring access to and use of financial resources to encourage private investment in sustainable buildings. Link these efforts to new and emerging consumer loan models.

**Increased use of building design tools.** Use integrated design processes and simulation or modelling tools such as BIM and energy model for ensuring high performance at cost savings. For new buildings, use of BIM and energy model may be required in the design task.

**Reducing embodied carbon in materials in buildings.** Include requirements for low-carbon materials in buildings regulations and focus on design that use suitable materials (see Activity 6: Materials) and reduce the amount of carbon in building operations through providing renewable energy (see Activity 8: Renewable energy).

**Increase awareness and information.** Increase the understanding of the benefits of sustainable buildings of consumers in decision-making; use the labelling system to promote energy-efficient properties.



	Key actions Baseline (2020)	Short term (2025)	Medium term (2030)	Long term (2050)
<b>1 Strengthen and further develop Energy Requirements in the Building Codes</b>	EE requirements for buildings (calculation of OTTV) but not enforced	Building codes are strengthening and enforced in all municipalities. Set target that all public buildings are complying with codes. Set up one-stop shops at the municipalities where building owners, planners and architects can seek advice and can show compliance with the building code.	All new buildings are constructed according to the building code. Building codes are changed to performance-based codes using simulation tools for showing compliance.	Building codes are strengthened and all new are following the building codes
<b>2 NZEB requirements</b>	Some work is being done on this	Voluntary targets are included in the building code for NZEB	NZEB requirements Developed and made mandatory for public buildings	NZEB emission requirements implemented for all buildings
<b>2 Capacity building for enforcement of Energy requirements in Building Codes</b>	Great lack of experience among technical experts	Training programs developed	Sufficient amount of specialist are trained for checking of compliance	Enforcement mechanisms further strengthen and training schemes are upgraded
<b>3 Promote efficient and passive cooling</b>	Some buildings are using the principles of passive cooling	Ensure that the building code also takes passive cooling into consideration and requirement for documentation of the efficiency of mechanical cooling	A large number of buildings are implementing the principles of passive cooling and it is a requirement in the building code for certain types of buildings	A large number of buildings are implementing the principles of passive cooling and it is a requirement in the building code for certain types of buildings



<b>4 Develop, implement and incentivize National Green Building Certification,</b>	Green Building Rating schemes exist but only few developers follow the schemes	Further development and support to Green Building Rating scheme, many new buildings use the scheme voluntarily	Green Building Rating Scheme is widely used and mandatory for public buildings	Green Building Rating Scheme is further strengthened and mandatory for all larger commercial buildings
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Table 4 Key Actions and Targets for New Buildings (buildings under construction)

#### **Stakeholders for sustainable new buildings**

The key stakeholders for sustainable new buildings is the Ministry of Public Works and Housing, who is responsible for the development of the building code. Local government play an important role since they are the ones issuing building and occupancy permits and also have to check for compliance with the building code.. Additional stakeholders include those that can support the process through research, funding, training, and making technologies available, like property and project developers, financial institutions, architects and construction engineers, manufacturers and suppliers\*, workers and installers, building owners and occupants, Civil society \*\*

\* For both equipment and material

\*\* including academia, non-governmental organizations, research institutions, social networks and community associations/professional

#### **Policies for sustainable new buildings**

New buildings policy can be developed to enable each new building to be low-emission, efficient and resilient. With new buildings, many policies are highly effective as there are clear approval and permit processes that enable improved enforcement. Within the targets for sustainable new buildings, the following sub-targets and timelines offer more details:

Sustainable new buildings policy target details:

**Building certification:** Building energy or sustainability certification and labelling can be used to verify and enforce performance requirements to enable increased information sharing and documentation for consumers and financial decisions.

**Building passports:** Building passports can be used to track information about the building, materials, systems, energy use, renovations and other real estate information to improve decision making processes with improved data that is tracked and stored.

**Incentives:** Non-fiscal incentives, such as expedited permits or increased floor area allowances, should be the priority to encourage sustainable buildings and communities. Fiscal incentives should be used to enable the very best sustainable buildings, while finance support, such as loan guarantees, should enable private investment.

#### **Technology for sustainable new buildings**

The energy use and emissions from new buildings are influenced by the design of the building, choice of technologies and materials. Through careful building design, it is possible to reduce the amount of energy the building requires during the operation phase.

Sustainable new building technology include:



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**Insulation:** The building envelope is one of the components of the OTTV calculation. The level of insulation is determined by the thermal conductivity of the material [W/mK], or the “R-value”, where the higher the R-value, the more thermal resistance the material has and the better are the insulating properties. “U-value” express how much heat is lost through a given thickness of a particular material, where the lower the U-value, the better the material is as an insulator.

**Cooling:** Cooling technology can enable more efficient delivery of thermal comfort through improved peak demand efficiency (EER) and seasonal efficiency (SEER). This is discussed in more detail in the Activity System.

**Daylighting:** Access to views and to daylight are essential for building occupant wellbeing, health and productivity. Building design should ensure that all spaces have access to natural light and views, and have glare-free, adequate daylight levels for large portions of the day through improved control.

### ***Capacity building for sustainable new buildings***

Information combined with capacity building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable new buildings. Specific capacity building targets for new buildings include:

**Training within government:** Build capacity and awareness in all levels of government on the implementation of sustainable new building and their benefits, including for infrastructure, public health and wellbeing, the energy sector, and the environment.

**Training of professionals:** Provide training programs for service and product providers of buildings and construction (architects, developers, contractors, vendors, etc.) and building owners are aware of sustainable new building policies, programs or incentives to implement sustainable buildings and construction.

**Educational training:** Develop educational programs including primary, secondary, vocational, university and adult education, to enable increased knowledge of sustainable new buildings.

Provide certification or accreditation for professionals in the sustainable construction sector.

**Awareness and information:** Develop information tools for people to have increased awareness, improved decision-making and to promote more sustainable choices. Methods of increasing information to consumers include benchmarking programs, certification programs, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programs.

**Institutional coordination:** Coordination and shared goals between relevant government and non-government organizations can enable improved policy coherence. Enable technical, financial and human capacity for the implementation and enforcement of sustainable new buildings policies.

Other capacity building efforts can include:

**Awareness of procurement models:** Promote the use of alternative procurement models such as bulk procurement, energy performance contracting, benchmarking, green leasing and incentives to reduce the cost of new efficient and sustainable buildings. Increase the capacity of financial service providers to implement the range of innovative financing models.



### 8.3. Activity 3: Building retrofits

In this section, the potential for existing buildings is analyzed. As described under the data section, the majority of the building stock in Indonesia are existing buildings, where only few have been constructed taking energy consumption into account.

#### Baseline on existing residential buildings

The number of households in Indonesia in 2020 is estimated to be 69,438.89 thousand (Handbook of Energy & Economic Statistics of Indonesia, 2020). It is not known how many of the households that are occupied and how many are not occupied. It is also not known when these buildings were constructed and how long the remaining lifetime of the buildings is. Assuming that the data for residential floor area is correct (3,061 million m<sup>2</sup>), the average floor area per household is about 45 m<sup>2</sup>. This figure has many deviations with household being both much smaller and much bigger. However, it is estimated that the number of households being more than 150 m<sup>2</sup> now is less than 5% but that this figure is most likely to increase in the future, when the middle class is growing in Indonesia and the requirement for space is growing. Newly constructed single-family houses are in the area of 100-120 m<sup>2</sup>.

There are no reliable data on the renovation rate for residential buildings, since most of the renovations take place without being registered. However, the GlobalABC's Global Status Report for 2019, states that renovation rate in developing countries is in the area of 1% at the moment and could reach 1.5% by 2025 and 2% by 2040.

One of the important areas is to get an overview of the buildings, that have reached their end-of-life-time and are ready to be demolished (they have no value, or are dangerous to the inhabitants, or the costs of needed renovation is higher than the value of the building), the buildings, that have a very poor energy performance and need energy renovation in the near future. Finally the buildings, that have a better energy performance, assuming that the newest buildings have the best energy performance (not always the case, but most of the time).

The task for the ministries is to encourage the building-owners with houses of good value to renovate or retrofit their buildings. The best time for this is always when other renovations measures are being carried out (new kitchen, new roof etc.) but also when a building is being sold or rented to a new building owner.

#### Building codes for existing buildings

The current building code No. 16/2021 in Indonesia is only valid for new buildings and not for retrofitting of existing buildings and the current method for showing compliance does not evaluate the total energy consumption of the buildings since it is an evaluation of the thermal transfer through the building envelope and the windows (the OTTV method). It is recommended that new building codes in the future are based on the performance of buildings developed and implemented for existing buildings.

#### EPC

Introducing Energy Performance Certificates (EPC) or Energy Labeling of the buildings can help assess the status of a building. However, a system like this can also be rather expensive to administrate, since it requires a large amount of energy experts, to evaluate the performance of the buildings. This can on the other hand also be a very good job opportunity.



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### Baseline on existing commercial buildings

The majority of the commercial buildings is no more than 40-50 years old, only few buildings like old city centers, public buildings etc. are from before this period. From the data analysis, we have the following split of commercial buildings (also including public buildings):

Type of commercial buildings	Total area m <sup>2</sup>	Percentage
Public buildings, education, schools, community and cultural, sport and recreation	84.825.753	22%
Industrial, infrastructure, military and transport	70.804.746	19%
Offices	85.227.719	23%
Hotels and retail	137.519.806	36%
<b>Total</b>	<b>378.378.024</b>	<b>100%</b>

Table 5 Type of commercial buildings, Source: Lighthouse.

### ESCO

The Establishment of ESCO through Ministerial Regulation No. 14/2016 was intended to accelerate the implementation of energy efficiency projects. [41] The Regulation states that ESCOs' activities consist of planning of concept for energy efficiency projects, investment grade energy audits, financing of energy efficiency projects, installation or construction work for energy efficiency projects, monitoring and maintenance of energy installations, and measurement and verification of energy efficiency projects performance.

### Conclusions from stakeholder consultation 2:

*"The building code must also include energy requirements for renovation of existing buildings. It is important to register the energy consumption of buildings in order to get a baseline; to be able to compare KPI's and to make plans for implementation of energy saving measures. Data collection must be made mandatory.*

*In many buildings, the main consumer of energy is the HVAC systems. Minimum Energy Performance requirements for replacing HVAC installations must be implemented. Building operation is important since a building will be in operation for maybe 40-50 years. There is a need for special training of HVAC installers and maintenance companies so that they know where to look for energy saving opportunities.*

*There is also a significant need for information to both residential and non-residential building owners on how to upgrade a building in an energy efficient way. Incentives in the form of financing, loans etc. is needed for the building owners to start energy retrofitting."*

### Action and Targets for 2030-2050 building retrofit

Key steps to improving the performance of existing buildings include both increasing the number of buildings that are improved and increasing the amount of improvement that is achieved.

**Encourage deep renovation of existing buildings.** Depending on the energy performance of existing buildings, deep renovation should be encouraged. According to the European Union deep renovation means that the energy consumption is reduced significantly (30-50%) and that the technical installations (especially cooling and heating) are updated to Best Available Technology (BAT) level. This is to avoid smaller works being carried out and to ensure that everything is done when the opportunity is there.



**Finance for energy renovation of buildings.** Provide public support for building owners for energy renovation of their buildings and ensure the possibility for easy access to bank loans for energy renovation of buildings.

**Energy labeling scheme for existing buildings.** The labelling scheme show the energy performance of a building and suggest energy renovation measures. The labeling system help building buyers to make a selected choice when buying a building

**Government leads by example.** Develop policies to ensure that existing public buildings are being retrofitted in an efficient way.

**Knowledge center for energy renovation of buildings.** Establish a knowledge center with specialist knowledge on Indonesian building technologies and how to renovate buildings in an energy efficient way still securing a good indoor environment. The knowledge center shall also deliver training for installers and craftsmen on the installation of energy efficient technologies like cooling.

	Key actions Baseline, (2020)	Short term (2025)	Medium term (2030)	Long term (2050)
<b>1 Encourage deep renovation of existing buildings</b>	Mainly smaller renovation and no focus on energy renovation	Ensure that the building code encourages deep energy renovation for existing buildings.	Energy saving measures have top priority when buildings are being retrofitted	The majority of building renovations have focus on deep energy renovation and NZEB
<b>2 Finance for energy renovation of buildings</b>	There are some systems in place for economic support for house-owners for retrofitting homes.	Development of guidelines and awareness programs for energy retrofitting of buildings to encourage deep energy renovation of buildings	Funding schemes for energy renovation are being implemented	The funding schemes have ensured that most of the buildings in Indonesia have been energy renovated.
<b>3 labeling scheme for existing buildings</b>	No system exist today	Develop and implement a scheme for Energy Performance Certificates (EPC) for existing buildings.	Half of all buildings have an energy label or EPC. All public buildings have an EPC.	All existing buildings have an energy label or and EPC.
<b>4 Energy renovation of public buildings</b>	Many public buildings have a very poor energy performance	EPC's are made for most public buildings in order to assess the need for renovation.	The worst performing public buildings have been energy retrofitted	All public buildings have been energy retrofitted, energy management is used in all public buildings
<b>5 Establishment of a knowledge center on energy renovation of existing buildings</b>	Some NGO organizations exists (MASKEEI GBCI)	A knowledge center is established with professionals and knowledge on renovation of existing buildings in Indonesia	The knowledge center is publishing information material for installers and for building owners on energy renovation of buildings	The knowledge center is training a large amount of installers in the installation of energy efficient appliances like cooling systems

Table 6 Key Actions and Targets for Retrofit of Existing Buildings



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### ***Stakeholders for sustainable building retrofits***

Ministry of Construction, municipalities, Property and project developers, Financial institutions, Architects and construction engineers, Manufacturers and Suppliers\*, Workers and installers, Building owners and occupants, Civil society \*\*

\* For both equipment and material

\*\* including academia, non-governmental organizations, research institutions, social networks and community associations/professional.

### ***Policy for sustainable building retrofits***

Existing buildings are a challenge, since it is difficult to enforce laws on buildings that are built many years ago, or where someone else is responsible for the development and construction of the building. Building retrofit policies must be developed to encourage the building owners to carry out energy retrofitting in the form of information and economical support.

**Energy Performance Certification (EPC):** Building energy or sustainability certification and labelling can be used to show the energy performance of an existing building and encourage to carry out energy saving measures on the building and/or the installation. Should also include mandatory disclosure of energy and carbon performance data when buildings is leased or sold

**Building information/building passport:** Building passports can be used to track information about the building, materials, systems, energy use, renovations and other real estate information to improve decision making processes with improved data that is tracked and stored.

**Incentives:** Non-financial incentives, such as expedited permits or increased floor area allowances, should be the priority to encourage sustainable buildings and communities.

Financial incentives should be used to enable the very best sustainable buildings, while finance support, such as loan guarantees, should enable private investment.

### ***Technology for sustainable building retrofits***

The energy use and emission from existing buildings is influenced by whether the building has undergone a building retrofit and the quality of that retrofit with respect to design, choice of technologies and materials.

**The building envelope:** The thermal resistance in existing buildings is often poor compared to new buildings and most buildings will benefit from the installation of insulation at least in the roof. The use of insulation in roof will delay the heat up of a building during the day and reduce the need for cooling.

**Windows:** Old windows allow a large amount of heat to go through the window and requires more cooling. By replacing them with windows with a better thermal value, a solar reflecting surface and a low solar heat gain coefficient (SHGC), the amount cooling need can be reduced and the indoor air quality can be improved. These windows also provide noise protection and improve thermal comfort.

**Shading:** Heat transfer through windows shall be reduced by using of shading of the windows.

**Air tightness:** Airflow into buildings through uncontrolled openings will increase the need for cooling. Air barriers can be created using membranes, foams, liquid coatings, and properly sealed windows.

**Ventilation:** To improve indoor air quality, controllable ventilation is essential. The three primary ventilation types include mechanical, natural and hybrid. To increase both the ventilation efficiency and energy recovery efficiency, buildings can shift increasingly to hybrid ventilation, which uses natural ventilation when feasible and mechanical ventilation when natural ventilation is not effective. To further improve the efficiency, when



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in mechanical ventilation mode, the system should include energy recovery ventilation technology to enable air exchange with minimal heat and humidity transfer.

**Cooling:** While cooling is the fastest growing end-use in buildings globally, cooling technology can enable more efficient delivery of thermal comfort through improved peak demand efficiency (EER) and seasonal efficiency (SEER). This is discussed in more detail in Activity 5.

**Heating:** Heating technology can enable more efficient delivery of thermal comfort through improved system efficiency (COP). This is discussed in more detail in Activity 5.

**Lighting:** Lighting technology can enable more efficient delivery of visual comfort through improved lumens per watt efficiency (lm/w). This is discussed in more detail in Activity 5.

**Daylighting:** Access to views and to daylight are essential for building occupant wellbeing, health and productivity. Building design should ensure that all spaces have access to natural light and views, and have glare-free, adequate daylight levels for large portions of the day through improved control.

### ***Finance for sustainable building retrofits***

The following finance mechanisms can be used for increasing the rate of renovation:

- **Development of energy performance contracting** and finance schemes for energy service companies (ESCOs).
- **Concessional loans** from banks for building-specific retrofit programs including energy savings.
- **Public procurement programs:** Setting minimum energy performance requirements (green leases) for leased government offices and facilities.
- **Incentives such as fiscal, grants and subsidies** linked to energy efficient retrofits of apartments and office buildings.

### ***Capacity building for sustainable building retrofits***

Information combined with capacity building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable building retrofits. Specific capacity building targets for building retrofits include:

Sustainable building retrofits capacity-building target details include:

**Training within government:** Build capacity and awareness in all levels of government on the implementation of sustainable building retrofits and their benefits, including for infrastructure, public health and wellbeing, the energy sector, and the environment.

**Training of professionals:** Provide training programs for service and product providers of buildings and construction (architects, developers, contractors, vendors, etc.) and building owners are aware of sustainable building retrofit policies, programs or incentives to implement sustainable buildings and construction.

**Educational training:** Develop educational programs including primary, secondary, vocational, university and adult education, to enable increased knowledge of sustainable building retrofits. Provide certification or accreditation for professionals in the retrofit sector.

**Awareness and information:** Develop information tools for people to have increased awareness, improved decision-making and to promote more sustainable choices. Methods of increasing information to consumers include benchmarking programs, certification programs, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programs.

**Institutional coordination:** Coordination and shared goals between relevant government and non-government organizations can enable improved policy coherence for sustainable buildings and construction.



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Technical, financial and human capacity in each of the organizations can improve the implementation and enforcement of sustainable building policies.

Other capacity building efforts can include:

**Awareness of procurement models:** Promote the use of alternative procurement models such as bulk procurement, energy performance contracting, benchmarking, green leasing and incentives to reduce the cost of existing building retrofits. Increase the capacity of financial service providers to implement the range of innovative financing models.

**Utility building retrofit programs:** Promote the implementation of building retrofitting programs by utilities, highlighting the role of smart and energy efficient buildings in the transition to a cleaner and more sustainable energy sector.

## 8.4. Activity 4: Building operation

Building operation and energy management of existing buildings can help a building to keep the energy performance and on ensuring a good indoor environment for the users. The more installations and the more complicated the use of the building is the more important is the building operation and management of the building, meaning that especially for commercial and large public buildings this is relevant and important.

Building Energy Management Systems (BEMS) are often only used in newer buildings, where the buildings are equipped with automatic control systems for the management and use of electrical equipment, water supply systems, fire alarms and firefighting systems, etc. in the building. These systems can also be combined with energy use monitoring systems.

### Energy Management scheme for larger consumers

The Government Regulation No.70/2009 on Energy Conservation states the obligation for large energy users (with energy consumption more than 6,000 toe per annum) to implement energy conservation measures through energy management. The energy management system includes appointing an energy manager, formulating energy conservation programs, carrying out periodical energy audits, implementing recommendations based on the energy audit, and publishing an annual report of the energy conservation measures to the authoritative government bodies such as the ministry or governor. In 2019, there were 304 large energy consumers/ energy-intensive companies subject to the energy management program. However, only 148 companies reported their energy management programs in that year. The perceived intangible benefits, rewards, and retributions of reporting to national database for reporting energy consumption - POME - are assumed to be some of main reasons behind the low participation of this program (IESR, 2019).

The government has signalled to revise the Regulation No. 70/2009 on energy conservation to expand the mandatory energy management program from energy consumers with energy consumption larger or equal to 6,000 TOE per year to consumers with energy consumption larger or equal to 4,000 TOE per year (in the industrial, transportation, and power sectors) and to consumers with energy consumption of 500 TOE per year in the building sector. In early 2020, the MEMR expressed its intention to significantly increase the number of energy audits and surveys, to develop financing models for energy efficiency programs, and to continuously monitor and evaluate the programs. Aligned with this target, the ministry recently upgraded the Energy Management Online Reporting System (POME) and will integrate it into the Energy Conservation Information System (SINERGI) (MEMR, 2020). The new POME system added some new features such as Energy Consumption Intensity, emission reduction and energy saving calculator, making consumers easier to benchmark their energy consumption against that in similar industry.



### Action and Targets for 2030-2050 building operation

**Energy management system.** Provide tools and training for energy management systems and apply energy management processes in all buildings, especially non-residential buildings. The Government Regulation No. 70 / 2009 on Energy Conservation from 2009 indicated that the national government, regional governments, private sectors and society in general are all responsible for energy conservation.

**Audits.** A strong part of the energy management program is the use of energy audits to determine operational inefficiencies and potentials for energy saving measures.

**Smart controls.** The use of digital sensors and controls is critical for better management of building operations, such as the control of temperature, lighting, and ventilation. The installation of energy metering systems linked to energy management systems and buildings will also enable better management. Across the region, smart controls are being applied to home appliances, such as air conditioning systems. All new building with air-condition should have smart controls.

	Key actions Baseline (2020)	Short term (2025)	Medium term (2030)	Long term (2050)
<b>1 Energy management in public and commercial buildings</b>	Law no. 70/2009 where all organizations with a consumption over 6,000 TOE per year must report energy consumption and implement energy management	Increase the scope in the energy management regulation (70/2009) so that also smaller buildings are included. Ensure that there is sufficient number of trained energy auditors	Half of the largest energy consuming commercial buildings are reporting on their energy consumption and have implemented energy management	All larger energy consuming public and commercial buildings are reporting on their energy consumption and have implemented energy management
<b>2 Training of energy auditors and energy managers</b>	There are not a sufficient number of qualified energy auditors	Develop training system for training of energy auditors and energy managers	There is a sufficient amount of energy auditors and the energy managers have been trained	All larger buildings have energy audits carried out on a regular basis
<b>3 Training of energy managers in public buildings</b>	Energy managers do not have the sufficient training	Energy managers in larger public buildings have received training	Energy managers in most public and larger commercial buildings have received training	Energy managers for all buildings have received training
<b>4. Public buildings</b>	The regulation is relevant for buildings with a consumption over 6,000 TOE	Ensure that all larger governmental and public buildings are complying with the law	Energy management is mandatory in all public and commercial	Energy management is a natural part of the management of any public building



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		on energy management.	buildings and the energy managers have received sufficient training to make energy renovation business cases and to implement suggested energy saving measures	
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Table 7 Key Actions and Targets for Building Operation

#### **Stakeholders for sustainable building operations**

In Indonesia, the key stakeholders for existing building operations include Ministry of Public Works and Public Housing, energy managers of public and commercial building and those that can influence existing buildings and those that can deliver the results of audits and low-emissions, efficient and resilient buildings through operations. Additional stakeholders include those that can support the process through research, funding, training, and making technologies available. Banks and ESCO service companies, Property and project developers, Financial institutions, Architects and construction engineers, Manufacturers and suppliers\*, Laborers and installers, Building owners and occupants, Civil society \*\*

\* For both equipment and material

\*\* including academia, non-governmental organizations, research institutions, social networks and community associations/professional.

#### **Policy for sustainable building operations**

Building operations policy can be developed to enable improved management of building to be low-emission, efficient and resilient. With existing building operations, new enforcement rules are needed to enable similar permit processes to require increased building sustainability through operations. Within the targets for sustainable building operations, the following sub-targets and timelines offer more details:

##### **Key message**

**Supporting detailed targets can enable the broader sustainable development goals.**

Sustainable building operations policy target details:

**Energy Performance Certification:** The EPC's are used actively by the building management to improve the building operation and the performance of the building.

**Energy Audits:** Mandatory inspection of installed equipment and energy disclosure of buildings can support improved data collection and decision making.

**Incentives:** Non-financial incentives, such as expedited permits or increased floor area allowances, should be the priority to encourage sustainable buildings and communities. Financial incentives should be used to enable the very best sustainable buildings, while finance support, such as loan guarantees, should enable private investment.

#### **Technology for sustainable building operations**

The energy use and emissions from buildings is influenced by the quality of building operations.

Specific targets and timelines for the sustainable building operation technologies are outlined below:



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**Maintenance tools:** Digital operations and maintenance (O&M) tools can support timely and active maintenance for the building energy manager with schedules of specific periodic maintenance actions (e.g. cleaning or replacement of air intake filters). O&M manuals should increasingly be provided at the handover of a system after a retrofit or new installation and be actively used by building managers or operators. Active fault detection is a digital method for identifying maintenance needs and can increasingly be included in system installations and in building management systems.

**Audit tools:** Building sustainability audits provide an opportunity to systematically check the optimization of system configurations and to identify priority retrofit measures. Audit tools (e.g. software, sensors and thermal cameras) can reduce the cost to conduct an audit and improve the rate of annual building audits.

**Building management systems:** Building management systems can range from full-scale building software to simple controls that manage individual technologies within a building. Increasingly digital tools are connecting multiple systems within a building with learning and fault detection to improve the overall management of the building system controls.

**Energy management systems:** Energy management systems enable monitoring of energy consumption of systems, components, and/or the building as a whole to identify anomalies and understand energy consumption trends. A network of digital energy meters, sensors, or smart meter can form the basis of an energy management system.

**Sensors and controls:** Sensors and controls are fundamental to smart maintenance, audit, energy management and building management. Control systems can range from fully centralized systems to simpler systems such as programmable thermostats. Sensors and controls are increasingly starting to incorporate machine learning to understand occupant preferences and optimize system settings based on internal and external conditions.

### ***Capacity building for sustainable building operations***

Information combined with capacity building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable building operations. Specific capacity building targets for improved building operations include:

#### **Key message**

Sustainable building operations capacity building target details include:

**Training within government:** Build capacity and awareness in all levels of government on the benefits, implementation and planning of efficient building operation, and the benefits to other systems such as infrastructure, public health and wellbeing, the energy sector and the environment.

**Training of professionals:** Provide training programs for service and product providers of buildings and construction (architects, developers, contractors, vendors, etc.) and building owners are aware of sustainable building operations policies, programs or incentives to implement sustainable buildings and construction.

**Educational training:** Develop educational programs including primary, secondary, vocational, university and adult education, to enable increased knowledge of efficient operation of buildings. Provide certification or accreditation for professionals in the building operations sector.

**Information and awareness:** Develop information tools for people to have increased awareness, improved decision-making and to promote more sustainable choices. Methods of increasing information to consumers include benchmarking programs, certification programs, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programs.

**Institutional coordination:** Coordination and shared goals between relevant government and non-government organizations can enable improved policy coherence. Technical, financial and human capacity



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and resource in each of the organizations can improve the implementation and enforcement of urban planning policies.

Other capacity building efforts can include:

**Awareness of procurement models:** Promote the use of alternative procurement models such as bulk procurement, energy performance contracting, benchmarking, green leasing and incentives to reduce the cost of existing building retrofits. Increase the capacity of financial service providers to implement the range of innovative financing models.

**Utility building operations programs:** Promote the implementation of efficient building operations programs by utilities, highlighting the role of smart and energy efficient buildings in the transition to a cleaner and more sustainable energy sector.

## 8.5. Activity 5: Systems

Indonesia has already worked extensively on the development of standards for installations and systems. For the purpose of this Roadmap baseline concerning systems and appliances, focus is limited to the most significant energy appliances such as room air conditioners (ACs), refrigerators-freezers, electric motors as well as cooking stove, rice cookers and their estimated GHG emissions by consolidating the findings from the existing data.

There are many types of systems and appliances used in buildings including electric and electronic appliances (lighting, fridges, ACs, washing machines, TVs, fans, computers...), pumping systems using electric motors (e.g. for water supply, drainage and wastewater treatment), fire protection systems and other equipment such as elevators.

Construction engineering system includes: (a) Water supply system; (b) Drainage and wastewater treatment systems; (c) Power supply and lighting systems; (d) Fire protection system; (d) Ventilation and air conditioning system; (e) Waste collection system; (g) Other equipment of the construction such as elevators, information and communication, etc.

With the increase of middle-class income households and living standards in smaller household sizes, demand for appliances and equipment is expected to rise (especially for air conditioners and refrigerators). Air conditioners are expected to dominate the energy consumption in both residential and non-residential buildings, reaching almost 40% of total energy consumption from systems and appliances in 2050 and accounting for 43% of total energy related emissions from systems and appliances. Refrigerators and freezers in private households come second representing 25% of the energy consumption and 35% of the emission from systems and appliances in 2050, followed by LPG use.

The lifetime of appliances and installations is normally much shorter than the lifetime of a building, and most installations will have to be replaced two-three times in the building's life if not more. This also means that the appliances and installations offer a significant opportunity to reduce emissions in new but especially in existing buildings.

Details on the policy targets for appliances and systems are outlined below.

### Minimum Energy performance standards MEPS

The Ministry of Energy and Mineral Resources (MEMR or KESDM), through its Directorate General of New Renewable Energy and Energy Conservation (EBTKE), aims to reduce national energy consumption across all sectors by 17% in 2025 relative to BAU through various policies, including energy efficiency standards and



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labelling for household electric appliances. Energy efficiency regulations for air conditioners and compact fluorescent lamps are already in place, and MEMR plans to issue additional Ministerial Regulations to further reduce household energy consumption. In 2021 the Minimum Energy Performance Standard for air-conditioners was updated it is recommended to update this on a regular basis and to announce the update in sufficient time before the update comes into force in order to allow the industry to adapt (MEMR Regulation 57/2017).

High-performance AC units are available on the market today. The average efficiency rating of air conditioners installed has increased, however a large amount of the air-conditioning systems sold today are still far behind the performance of more efficient options commercially available.

In fact, the typical efficiency rating of units being sold in major cooling markets is 10-30% better than the worst-performing products<sup>22</sup>. Yet recent market trends show that substantial energy efficiency gains could be realised quickly. Products available in some markets - often at comparable prices - can be 30-70% more efficient, and best available technologies are often twice as efficient, if not more.

An end-use survey and market studies carried out by the organization CLASP<sup>23</sup> reported that maximum only 66% home appliances, namely fan, refrigerator, and rice cooker, meet MEPS proposed by CLASP. This means, that there is still at least 34% of all appliances from these three types of appliances that are not very efficient. By adopting the proposed MEPS by the organization CLASP, Indonesia would gain a significant energy savings of at least 18.3 TWh from 2020 to 2030 and mitigate GHG emissions of at least 16.3 Mt CO<sub>2</sub> in the same period.

It is recommended, that Indonesia continue to implement Minimum Energy Performance Standards (MEPS) for all technical installations e.g. cooling installations and refrigerators/freezers. According to an IEA study (the Future of Cooling in South Asia, 2019), air-conditioning units sold in Indonesia have an average seasonal efficiency ratio (SEER) typically under 3 although products are available with much higher efficiencies often at comparable prices.

It is also recommended that appliances cooking shall have MEPS as they also consume a significant share of energy.

### **Labels for appliances**

The energy performance of appliance/systems energy shall be displayed for the consumers. Awareness shall be generated about the labels so that the information on the labels will help supply required information for first-time purchasers to compare the cost and benefit of the product before making the decision.

This kind of information enables consumers to make choices on a life-cycle basis, but also facilitates the implementation of incentives, MEPS and phase-out programs.

### **Public procurement**

By including a life-cycle-cost criterion in public procurement of appliances and electrical installations goods, the focus on investment costs versus life-time-costs will be easier to assess.

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<sup>22</sup> <https://www.iea.org/reports/the-future-of-cooling-in-southeast-asia>

<sup>23</sup> Indonesia Refrigerator Market Study and Policy Analysis. file:///C:/Users/B046249/Downloads/Indonesia-Refrigerator-Market-Study\_FINAL.pdf



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### Action and Targets for 2030-2050 systems

Key actions to enable increased sustainability of systems in buildings include:

- **Developing a Minimum Energy Performance Standard (MEPS).** Develop a schedule, enforce regulations on product/equipment quality and performance requirements in the building. Mandatory MEPS is currently in place for lighting system, air-conditioning and a wide range of equipment.
- **Labelling of installations.** Many systems already exist like EnergyStar from the USA or EcoDesign from the European Union where appliances are labeled according to energy performance and other parameters
- **Public procurement.** Develop policies to ensure that all public buildings invest in efficient and low emission systems. Local or national statutory procurement mechanisms for high-performance equipment and systems can secure demand for manufacturers and facilitate market transformation.

	Key actions Baseline (2020)	Short term (2025)	Medium term (2030)	Long term (2050)
<b>1. Minimum performance standards, MEPS</b>	Some standards are already developed (e.g. MEMR Regulation 57/2017)	Continue to develop and enforce existing Minimum Energy Performance Standards (MEPS). System for check of compliance is developed.	Mandatory MEPS for all appliances in new buildings and for major retrofitting in existing buildings	Regular Strengthening of the MEPS e.g. every 5 year
<b>2. Product Labels</b>	Consumer awareness is low and no mandatory labels for key appliances	Increase the awareness among consumers of Energy labeling of appliances. Introduce a system with labelling of appliances including testing facilities and a scheme for checking of compliance also with products from abroad	Strengthening the labeling requirements. Ensure that all energy consuming appliances are included in the scheme	Further strengthening of energy requirements for labeling of appliances
<b>3 Public procurement of energy efficient installations (government lead by example)</b>	At moment no specific focus on energy efficient public procurement	A requirement of a certain portion of public procurement of e.g. AC systems should be efficient or have energy label A	50% of all public procurements are energy efficient or label A	100% of all public procurements are energy efficient or label A

Table 8 Key Actions and Targets for Appliances and Systems



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### **Stakeholders for sustainable systems**

In Indonesia, the key stakeholders for sustainable systems include those that can influence technologies and those that can deliver the results of low-emissions, efficient and resilient buildings through the use of sustainable systems. Ministry of Construction, Sub-national government, Utility companies, Property and project developers, financial institutions, Architects and construction engineers, Manufacturers and suppliers\*, Workers and installers, Building owners and occupants, Civil society \*\*

\* For both equipment and material

\*\* including academia, non-governmental organizations, research institutions, social networks and community associations/professional

### **Policy for sustainable systems**

Sustainable systems policy can support low-emission, efficient and resilient buildings goals by enabling market transformation that increases the availability of sustainable products. Within the targets for sustainable systems, the following sub-targets and timelines offer more details:

#### **Key message supporting detailed targets can enable the broader sustainable development goals.**

Sustainable systems policy target details:

- **Information and awareness:** Combining information and capacity building activities can increase the overall awareness of people to improve their decision-making process. Product labels on all systems sold can provide information on the sustainability of the products including their embodied energy and carbon and their lifecycle energy and carbon performance. Supporting the information roll-out with educational efforts to increase the capacity for people to make better design, purchase and operational decisions.
- **Research and development:** Increasing research funding can enable the invention of new products and services while also increasing the ability to get improved technologies to the market cost effectively.
- **Procurement and phase-out:** Purchasing sustainable products and services can support the effort to phase-out the use of unsustainable products and services. This effort should be done by both public and private entities and can include bulk procurement or minimum performance specifications for procurement rules.
- **Incentives:** Non-financial incentives, such as expedited product approvals, should be the priority to encourage sustainable systems. Financial incentives should be used to enable the very best sustainable systems, while finance support, such as loan guarantees, should enable private investment in sustainable systems.

### **Technology for sustainable systems**

The energy use and emissions from buildings are influenced by the systems used in the buildings. Specific targets and timelines for the sustainable system technologies are outlined below:

#### **Key message**

Sustainable systems technology target details include:

**Space cooling systems:** Space cooling appliances represent a large proportion (up to 60%) of electricity demand in the residential and commercial sectors in ASEAN economies. The market for room air conditioners (AC) in ASEAN economies is expected to grow by at least 10% annually over the next 5 years, and this AC growth will drive electricity demand, particularly during peak hours of the day<sup>24</sup>.

The types of ACs available in the Indonesian market include wall mount (80%), floor standing/corner type (7%) and cassette units (6%). A very small amount of window-units is also available for sale.

<sup>24</sup> Promotion of higher efficiency air conditioner in ASEAN: A regional policy roadmap, 2015.



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Most of the ACs available in the Indonesian market are of the non-inverter type and use R-22 refrigerant; while the inverter units available in the market use R-410A. Non-inverter AC's are currently dominating the Indonesian market with over 95% of market share.

While cooling is the fastest growing end-use in buildings globally, cooling technology can enable more efficient delivery of thermal comfort through improved peak demand efficiency (EER) and seasonal efficiency (SEER). Adoption of hybrid cooling methods, such as evaporative cooling, natural ventilation and other "free cooling" that uses ground or water temperatures, can support the increased overall efficiency. Overall system efficiency will also increase with the use of variable speed drives and improved thermal distribution efficiency. Cooling system sustainability can also be improved through the use of low global warming potential (GWP) refrigerants. Overall performance of the space cooling system is based on the efficiency of the cooling equipment and the thermal distribution system, such as ducts or pipes, to deliver the cooling within the building.

**Ventilation:** To improve indoor air quality, controllable ventilation is essential. The three primary ventilation types include mechanical, natural and hybrid. To increase both the ventilation efficiency and energy retention efficiency, buildings can shift increasingly to hybrid ventilation, which uses natural ventilation when feasible and mechanical ventilation when natural ventilation is not effective. To further improve the efficiency, when in mechanical ventilation mode the system should include energy recovery ventilation technology to enable air exchange with minimal heat and humidity transfer. Energy recovery ventilation efficiency will also need to improve from low efficiency systems near 50% efficiency to high efficiency in the 80-90% efficiency range.

**Water heating systems:** By targeting an increasing water heating efficiency (the COP), the energy needed for the production of hot water can be reduced., as most highly efficient systems are electrical, renewable energy, the use of waste heat or cogeneration.

**Lighting:** Lighting technology can enable more efficient delivery of visual comfort through improved lumens per watt efficiency (lm/w). Lighting technology developments in more efficient solid-state lighting (SSL) is improving the quality of light, efficiency, maintenance and reducing costs. Daylight harvesting systems with intelligent controls, sensors, and shading devices can also support the target for increased lumens per watt.

**Refrigerators:** Refrigerator technology improvements have resulted significant energy savings over recent decades and future energy savings are possible through variable speed compressors, improved insulation and heat pump technologies.

**Cooking:** Going away from using gas for cooking is an important focus area. Here the introduction of electrical/induction stoves is an area of importance.

**Sensors and controls:** Sensors and controls are fundamental to energy efficient operation of buildings, energy management and building maintenance. Control systems can range from fully centralized systems, building energy management to simpler systems like smart and programmable thermostats. Sensors and controls are increasingly starting to incorporate machine learning to understand occupant preferences and optimize system settings based on internal and external conditions.

**Appliances:** Large and small appliances both have opportunities for increased sustainability. Development in appliance efficiency is needed to counter the surge in appliance usage from rising wealth and ownership. The most significant gains have been in refrigerators, with specific targets noted above, where increased efficiency continues through variable speed compressors, improved insulation and heat pump technologies. Other appliances such as dishwashers, clothes washers and dryers, televisions, and digital appliances will need to become more efficient, reduce standby losses and connectivity energy use through the use of sensors, controls and automation to enable low power modes, load balancing, demand response, and remote programming.

### ***Capacity building for sustainable systems***



Information combined with capacity building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable systems. Specific capacity building targets for systems include:

Sustainable systems capacity building target details include:

**Training within government:** Build capacity and awareness in all levels of government on the benefits, implementation and planning of efficient buildings, and their benefits to other systems such as infrastructure, public health and wellbeing, the energy sector and the environment.

**Training of professionals:** Provide training programs for service and product providers of buildings and construction (architects, developers, contractors, vendors, etc.) and building owners are aware of sustainable system policies, programs or incentives to implement sustainable buildings and construction.

**Educational training:** Develop educational programs including primary, secondary, vocational, university and adult education, to enable increased knowledge of sustainable and efficient building systems. Provide certification or accreditation for professionals in the buildings services sector.

**Information and awareness:** Develop information tools for people to have increased awareness, improved decision-making and to promote more sustainable choices. Methods of increasing information to consumers include benchmarking programs, certification programs, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programs.

**Institutional coordination:** Coordination and shared goals between relevant government and non-government organizations can enable improved policy coherence. Technical, financial and human capacity and resource in each of the organizations can improve the implementation and enforcement of urban planning policies.

Other capacity building efforts can include:

**Awareness of procurement models:** Promote the use of alternative procurement models such as bulk procurement, energy performance contracting, benchmarking, green leasing and incentives to reduce the cost of existing building retrofits. Increase the capacity of financial service providers to implement the range of innovative financing models.

**Utility programs:** Promote the implementation of efficient systems programs by utilities, highlighting the role of smart and energy efficient buildings in the transition to a cleaner and more sustainable energy sector.

## 8.6. Activity 6: Materials

The construction sector is the third-largest contributor to Indonesia's GDP, and the investments in the construction sector in Indonesia are among the largest out of all construction investments in Asia. The industry has been growing as it is supported by the government's target to develop the archipelago's infrastructure to increase its connectivity. Over eight million people were working in the construction industry in Indonesia and it is expected that the number of workers will also increase accordingly.

The building material market in Indonesia has increased significantly over the last years and is expected to rise further in order to fulfil the need for new buildings. In this chapter, materials refer to those materials used in the construction industry in Indonesia. These include materials produced, extracted or harvested in the country and those being imported from neighboring countries to fulfill the increasing demand for construction in the country.

The construction industry in Indonesia is expected to record a growth of 7.2% in real terms in 2022, surpassing the pre-pandemic output levels. The growth rate in 2021 was 3.1% recorded in 2021, due to large-



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scale social restrictions and pandemic-related<sup>25</sup>. The construction sector has overtaken Indonesian GDP growth in recent years and plays an increasingly important role in the country's economy. This trend is set to continue as a strong economy and rising personal incomes drive demand for commercial and residential buildings. In addition, the government has embarked on a massive long-term infrastructure development program that includes projects worth hundreds of billions of US dollars. Rising private investment and government spending can be expected to make Indonesia one of the largest construction markets in the world.

Moreover, the country is still catching up on infrastructure development after long years of neglect. Also the economic slowdown from the COVID-19 pandemic is expected to threaten long-term demand for building materials, because it is expected that many of the building projects will resume once inflation and GDP growth stabilize again.

### **Cement**

In 2020 the CO<sub>2</sub> emissions from cement production in Indonesia was about 33.8 million tons CO<sub>2e</sub> which was about 5.7% of the total CO<sub>2</sub> emission in Indonesia<sup>26</sup>. This makes the cement industry a key sector to target in Indonesia's quest to reduce its emissions. The cement industry mainly consumes fuel in the clinker burning process.

State-controlled cement company Semen Indonesia dominates the cement production with a market share of more than 40% and is expanding into other ASEAN markets. The company has build new plants in Central Java and West Sumatra. Another big Cement producer, Indocement Tunggal Perkasa, is also building new plant. Holcim Indonesia, the country's third largest cement producer has also established a new plant in East Java.

Indonesia's total cement production capacity has significantly increased over the last years. However, Indonesia still relies on imports of cement products. Moreover, at 225 kg per-capita cement consumption in Indonesia is less than half that of Thailand or Malaysia.

### **Iron, Steel and Aluminum**

Indonesian steelworks are set to be among the main beneficiaries of rising construction activity, while aluminum is becoming an increasingly popular building material. Ample deposits of iron ore, bauxite and nickel provide easy access to raw materials. Domestic steel use has increased significantly. Crude steel production, meanwhile, has stagnated in recent years. As a result, Indonesia relies increasingly on shipments from abroad. Imports of semi-finished and finished steel products has increased.

The domestic production gap presents opportunities for companies operating within the country. Indonesia needs to improve overall volumes as well as diversify its steel products from what is currently a limited range. An assertive policy to add value to Indonesia's metal industries by forcing mining companies to process their ores domestically aims to expedite investment in smelting and processing facilities. Most bauxite, for example, is still exported to China, but in the future, the mineral is likely to be more easily available for domestic aluminum producers.

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<sup>25</sup> Indonesia Construction Market Size, Trends and Forecasts by Sector – Commercial, Industrial, Infrastructure, Energy and Utilities, Institutional and Residential Market Analysis, 2022-2026'

<sup>26</sup> <https://ourworldindata.org/co2/country/indonesia?country=~IDN>



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State-controlled Krakatau Steel is the largest steelmaker. The integrated company is partnering with South Korea's POSCO on a new steel plant in Banten. Other Indonesian steelmakers are also cooperating with foreign companies to boost capacity and efficiency.

### **Ceramics, Glass, Plastics and Paints**

Apart from the cement and steel industries, makers of glass, ceramics, plastics and paints are also expecting increases in demand in the future. In 2012, Indonesia was the world's 6th largest ceramics producer, with more than three quarters of output going to the local market. Readily available deposits of clays, feldspar and silica sand support the industry, while low per-capita consumption leaves ample space for expansion. The ceramics business has enjoyed double-digit growth since 2011, according to industry association ASAHI. The construction sector, where ceramic tiles are used for floors, walls and roofs, should secure strong demand going forward. Glass and plastics producers are similarly reaping the benefits of growing demand from the construction sector, which could help them overcome a slowdown in the food and beverages and automobile sectors. Finally, manufacturers of protective paints and coatings can expect rising sales to property and public infrastructure projects, after decorative paintings are already enjoying strong growth thanks to Indonesia's expanding middle class.

### **Use of different building materials**

The Building and Construction Industry Asia (BCIA) list the use of preferred building materials in Indonesia divided in residential and non-residential constructions as shown below. This gives some indications on the architectural style and construction methods used in Indonesia.

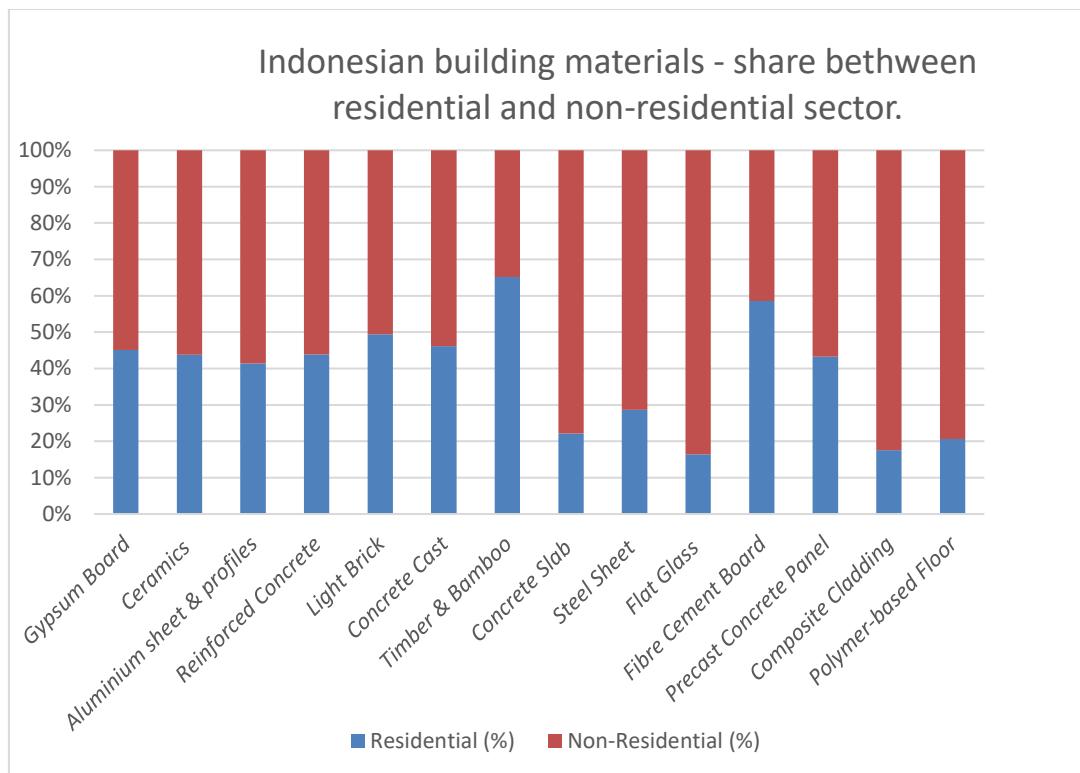


Figure 17 Building materials – share between residential and non-residential sector, the materials are listed with the highest consumption to the left, Source: BCI Asia, 2021



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The flooring and walls of tropical houses are often made of ceramics and concrete, with varying roof materials, commonly ceramics tiles and zinc plates. Materials that are light, has a thickness, and does not store huge amounts of heat is often used for structures in an area with no extreme outside temperatures (tropical zone).

Gypsum boards and ceramics and its derivatives are one of the most used building materials in Indonesia, owing to their strength and low heat conductivity capabilities, which result in a cool temperature in hot weather and the storage of room heat in cold weather. Wood fiber gypsum board is a derivative material consisting of cement combined with bark, giving it a wood-like look.

### **Embodied carbon emission for building materials**

The production of building materials for the building and construction sector has a high energy consumption both in the manufacturing process and for transport. As a result, energy consumption in the construction industry considers three factors:

1. Energy required for the production of the building materials;
2. Energy needed for transportation of raw materials and ready to use building materials and
3. Energy used for operational purposes.

All the energy relating to materials is called Embodied Energy. Energy and energy inputs such as electrical energy, fuel, and raw materials are used in the manufacturing of building materials and products. Direct (energy intake) and indirect energy (energy output) are both used as energy sources and raw materials in the primary manufacturing stage. Direct energy use includes all on-site and off-site transportation associated to manufacturing. This comprises the energy used to transport raw materials to linked sectors and to distribute ready-to-use goods from industrial plants to end customers e.g. the building site.

In both the commercial and residential sectors of Indonesia, some building materials, such as cement/concrete and ceramics, continue to dominate in terms of proportion of material composition. Because the production process requires energy, the embodied energy in the materials as glass and cement has a relatively significant value. Cement and glass are regarded as energy-intensive building materials.

The table in annex 3 provides a list of popular building materials as well as the CO<sub>2</sub> emissions produced by each material per unit of each substance. These figures show that different construction materials emit varied quantities of CO<sub>2</sub>, resulting in a high overall quantity of CO<sub>2</sub> emissions when evaluated as one building unit.

For the share of emissions from the buildings and construction industry, the embodied carbon makes up for almost 10% of the emissions from the building and construction sector globally. Technical regulations and environmental performance standards should aim to reduce embodied carbon by reducing construction material imports and encouraging local production of sustainably sourced materials (e.g. bricks, bamboo, sustainable timber, materials from recycled construction waste or other waste streams). In addition, eco-labels for construction materials could be introduced to raise awareness of consumers, building owners and developers.

Collecting data on building materials used and introducing life cycle assessment for buildings will help addressing the embodied carbon of buildings in Indonesia.



### Action and Targets for 2030-2050 material

Key actions to enable increased sustainability of materials in buildings and buildings products include:

**Life Cycle Cost analysis.** Implement a requirement for LCA with the focus on CO<sub>2</sub> emissions for the materials, transport, and the construction of the building and the operation of the building.

**Encourage the use of alternative building materials, circular economy and recycling of building materials.** Develop a one-time or renewable material-based life cycle approach in the construction sector to implement business models and approaches based on recycling, zero-emission materials, and high-efficiency systems. Support the development of material recycling processes for products and materials that can reduce energy consumption and emissions. This should be considered cautiously since some materials can only be reused if proper procedures and documentation are performed during the demolition phase.

**Information and awareness.** Promote information on low carbon materials and technologies (e.g., wood and earth constructions, technologically improved concrete) to energy experts, green buildings are involved design and construction process.

**Government leads by example.** Develop policies to ensure all public buildings invest in low-cost and high-performance materials based on life cycle analysis.

	Key actions Baseline, (2020)	Short term (2025)	Medium term (2030)	Long term (2050)
<b>1 Introduce LCA as a requirement with focus on emissions from building materials</b>	No experience on this today, no focus on CO <sub>2</sub> in building materials. No KPI for CO <sub>2</sub> per tons/m <sup>3</sup> material	Develop a scheme for documentation of Life Cycle Analysis (LCA) for building projects and encourage the building industry to use this method. Developers, who make life-cycle-analysis (LCA) of the carbon content (embodied energy) may get other benefits	Develop requirements for public buildings to carry out life-cycle-analysis with a limit on CO <sub>2</sub> . The limits should be set high for all building to achieve the target at this point.	A life cycle analysis must be carried out for all buildings and comply with CO <sub>2</sub> requirements in the building code. The limits are reduced at regular intervals.
<b>2 Develop a National LCA tool</b>	Different international tools are used	Development of an Indonesian LCA tool taking local conditions into account, support the development of EPD's	Most developers are using the Indonesian LCA tool	It is mandatory to use the LCA tool and all building materials producers must make and update EPD's
<b>3 Research in alternative building materials, circular economy</b>	Not a big topic in the research area today	Increase research on embodied carbon in building materials and	Develop a database system for the collection of	A national database has been developed con-



<b>and recycling of building materials</b>		energy use during the production and transportation of building materials and the operation of the building.	data on CO <sub>2</sub> content of building material	taining the environmental information for building materials (EPDs) used in Indonesia
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Table 9 Key Actions and Targets for Materials

#### **Stakeholders for sustainable materials**

In Indonesia, the key stakeholders for sustainable materials include those that can influence materials and those that can deliver the results of low-emissions, efficient and resilient buildings through the use of sustainable materials. Ministry of Construction, Sub-national government, Utility companies, Property and project developers, Financial institutions, Architects and construction engineers, Manufacturers and suppliers\*, Laborers and installers, Building owners and occupants, Civil society \*\*

\* For both equipment and material

\*\* including academia, non-governmental organizations, research institutions, social networks and community associations/professional

#### **Policy for sustainable materials**

Sustainable systems policy can support low-emission, efficient and resilient buildings goals by enabling market transformation that increases the availability of sustainable products. Within the targets for sustainable materials, the following sub-targets and timelines offer more details:

**Key message** Introducing specific CO<sub>2</sub> targets for building materials is necessary for reducing the emissions.

Sustainable materials policy target details:

**Research and development:** Increasing research funding can enable the invention of new products and services while also increasing the ability to get improved technologies to the market cost effectively.

**Circular economy:** Policies should be evaluated on the basis of circular economy thinking by using lifecycle analysis that accounts for energy, emissions and the multiple benefits of sustainable materials.

**Incentives:** Non-financial incentives, such as expedited product approvals and permits, should be the priority to encourage sustainable materials. Financial incentives should be used to enable the very best sustainable materials, while finance support, such as loan guarantees, should enable private investment in sustainable materials.

#### **Technology for sustainable materials**

The energy use and emissions from buildings are influenced by the materials used in the buildings.

Specific targets and timelines for the sustainable materials are outlined below:

**Key message.** Introduce LCA requirements.

Sustainable systems technology target details include:

**Envelope materials:** Traditionally materials with low thermal storage is used in the construction sector in Indonesia, however there can be an advantage in introducing materials with a higher thermal storage. The energy consumption for producing materials with better thermal storage capacity may, however, require more energy for the production. Introduction of LCA calculation can facilitate decision making in this area.



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**Insulation:** Insulation is one of the components of the building material where the effect of using insulation can reduce the operational energy demand, but where the need for energy for producing the material is high. Again, an LCA calculation can make the decision making easier.

**Window glass:** Heat transfer by conduction through windows can be reduced through a transition to double and triple pane low-emissivity windows, that when produced at scale are highly cost effective. These windows also provide noise protection, improve thermal comfort and can enable passive architecture and natural ventilation. As above, glass is also a material with a high energy consumption need for the production, but with a saving on the energy demand of the operation of the buildings.

### ***Capacity building for sustainable materials***

Information combined with capacity building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable materials. Specific capacity building targets for materials include:

#### **Key message**

Sustainable materials capacity building target details include:

**Training within government:** Build capacity and awareness in all levels of government on the benefits of sustainable building materials including on systems including infrastructure, public health and wellbeing, and the environment.

**Training of professionals:** Provide training programs for service and product providers of buildings and construction (architects, developers, contractors, vendors, etc.) and building owners are aware of sustainable building materials policies, programs or incentives to implement sustainable buildings and construction.

**Educational training:** Develop educational programs including primary, secondary, vocational, university and adult education, to enable increased knowledge of sustainable and efficient building materials. Provide certification or accreditation for professionals in the sustainable materials, material reuse, and building maintenance sector.

**Information and awareness:** Develop information tools for people to have increased awareness, improved decision-making and to promote more sustainable choices. Methods of increasing information to consumers include benchmarking programs, certification programs, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programs.

**Institutional coordination:** Coordination and shared goals between relevant government and non-government organizations can enable improved policy coherence. Technical, financial and human capacity and resource in each of the organizations can improve the implementation and enforcement of urban planning policies.

Other capacity building efforts can include:

**Awareness of procurement models:** Promote the use of alternative procurement models such as bulk procurement, energy performance contracting, benchmarking, green leasing and incentives to reduce the cost of existing building retrofits. Increase the capacity of financial service providers to implement the range of innovative financing models.

## **8.7. Activity 7: Resilience**

Indonesia is very exposed to both flooding and sea level rise as an archipelagic country with extensive low-lying and small island areas; Indonesia is therefore highly vulnerable to the adverse impacts of climate change. Expected sea level rise, changing precipitation patterns, and more intense storms and typhoons will increase disaster risks across Indonesian metro and urban areas. Sea level rise could threaten 42 million Indonesians who live less than 10 meters above sea level. A 50-centimeter sea level rise, combined with land



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subsidence in Jakarta Bay, could permanently flood densely populated areas of Bekasi and Jakarta that house more than 270,000 residents.

Indonesia has already experienced extreme climate events such as floods and drought, and is anticipating long-term impacts from sea level rise. As the Indonesian population grows, climate change induced natural disasters will affect a greater number of people and their assets, making it more difficult for them to escape poverty. Climate change is believed to increase the risk for hydro-meteorological disasters, which make up to 80% of disaster occurrences in Indonesia. The poorest and most marginalized populations tend to live in high-risk areas that are likely to be flooded, experience landslides and sea level rise, as well as water shortages during drought.

So apart from Indonesia being vulnerable from a geographical point of view (risk of typhoons, each quakes and tsunamis to mention a few risks) the urbanization processes and the urban development also increase the exposure of people and assets to disaster risk. It is estimated that some 110 million people or 42 percent of the population, across some 60 Indonesian cities are at some point exposed to natural hazards. The number is expected to increase because of urban population growth and associated transformation of the built and natural environment, changes in the climate, and more widespread land subsidence.

Urbanization, linked mainly to natural population growth and rural-urban transformation, has increased the exposure of cities to natural hazards. Large-scale urban development - often poorly planned and inadequately regulated - also increases the vulnerability of cities to natural hazards. New urban migrants and assets are often pushed toward vulnerable areas. In addition, poor-quality infrastructure is constructed in hazard-prone areas with inadequate consideration of, or compliance with, risk-informed planning regulations and urban design codes. As a result, buildings and urban infrastructure are unable to withstand damaging geotechnical and hydro-meteorological forces.

Taking the risks into consideration for the planning and constraining of buildings and urban areas can have a significant influence on reducing the risks and reducing the impact on buildings and people. Building design and material standards must be made to withstand the new weather conditions caused by climate changes. Consequently, the durability of buildings is getting more in focus.

### **Action and Targets for 2030-2050 Resilience**

Key actions to enable increased resilience of buildings include:

#### **Include resilience criteria in the building code.**

**Identification of risks areas and development of local zoning plans.** Use data and information to document the potential risk exposure by location to enable improved decision making during the building and infrastructure design process. **Wind and seismic resistant construction.** Implement policies and use best practice design and strong materials to enable buildings to be resistant to natural disasters and extreme weather events. **Storm water management.** Require improved retention of storm water within properties to reduce the negative impact of water flowing to other properties and to surging waterways.

#### **Risk-informed spatial planning and urban design and building codes that incorporate risk reduction standards.**

**Thermal resistant construction.** Implement policies and use best practice design to increase the resistance of buildings extreme temperature.

**Developing integrated assessment.** Governments and stakeholders work together to develop assessment plans to ensure comprehensive resilience plans for all regions.



	Key actions Baseline, (2020)	Short term (2025)	Medium term (2030)	Long term (2050)
<b>1 Building code includes resilience criteria</b>	Resilience is not included as a separate subject in the current building code	Develop resilience requirements to be included in the building code	New buildings take the requirements from the building code on resilience into account.	It is mandatory as an urban or building developer to develop a risk analysis for the building and the urban area
<b>2 Identification of risk areas and development of zoning plans</b>	Some focus on this area	The municipalities in the most vulnerable areas have developed plans for where further urbanization can take place with low risks for environmental disasters. The plans shall also include infrastructure and transport	New development for planning and future land use zoning and classification regulation (where to build and where not to build).	All municipalities have developed plans for where further urbanization can take place with low risks for environmental disasters
<b>3 Risk-informed spatial planning and urban design</b>	Some municipalities are working with this area	Cities and urban areas (including residential housing and critical urban infrastructure) is planed using risks criteria	Plans are made on the basis of simulation and modelling (flooding, sea level rising etc.) for most Indonesian cities	Plans are made on the basis of simulation and modelling (flooding, sea level rising etc.) for all Indonesian cities

Table 10 Key Actions and Targets for Resilience

### Stakeholders for resilience

In Indonesia, the key stakeholders for resilience include those that can influence the ability to make technologies and design approaches available to increase resilience of buildings and those that can deliver the results of resilient buildings. Ministry of Construction, Sub-national government, Utility companies, Property and project developers, Financial institutions, Architects and construction engineers, Manufacturers and suppliers\*, Laborers and installers, Building owners and occupants, Civil society \*\*

\* For both equipment and material

\*\* including academia, non-governmental organizations, research institutions, social networks and community associations/professional



## **Policy for resilience**

Sustainable building resilience policy can support low-emission, efficient and resilient buildings goals by enabling market transformation that increases the usefulness and life of sustainable buildings. Within the targets for sustainable building resilience, the following sub-targets and timelines offer more details:

### **Key message Municipalities shall require developers to prepare plans for resilience.**

Sustainable building resilience policy target details:

**Resilience strategy:** Building developers shall develop a resilience strategy that identifies the list of policies and measures that can support increased resilience and addresses the potential for re-location and crisis plans for high risk settlements.

**Building codes:** It is recommended to include resilience requirements in the building code. This can be requirements for structural and thermal resilience including passive measures that enable occupants to use the building when energy services are not available due to an extreme weather event or a natural disaster. This includes among others insulating of the building, shading, earth crack resistant load bearing structure, wind and seismic proof walls and water drainage and storage systems.

**Building zoning laws:** Develop and enforce zoning laws accounting for weather patterns, climatic conditions and geological characteristics to support the goals of the resilience strategy.

**Circular economy:** Policies should be evaluated on the basis of circular economy thinking by using lifecycle analysis that accounts for energy, emissions and the multiple benefits of resilient buildings.

**Resilient building insurance:** Regulations to prevent financial, system or human losses from catastrophe. Regulations on insurance and re-insurance risks for resilient real estate. Available de-risking benefit to owners of resilient buildings.

**Impact assessment:** Requirement for climate change impact assessments, regarding changes in typical and extreme weather events (storms, cloud patterns, precipitation and temperatures).

## **Technology for resilience**

### **Key message**

Sustainable systems technology target details include:

**Protection from extreme temperatures:** Building envelope efficiency and thermal comfort systems can reduce the impact of extreme climate conditions like very hot weather. This includes achieving the targets for envelope thermal resistance, air sealing, heating, cooling and ventilation in other activities.

**Resistance to wind and earth movement:** Structurally sound buildings are more likely to withstand natural disasters and function as a building for more years into the future. Winds from hurricanes, tornados and other naturally occurring events destroy buildings every year; however, buildings that are built to higher standards can often withstand some of the most powerful storms. Movement from earthquakes, landslides, soil erosion and avalanche also causes damage to buildings every year; however, buildings and neighborhoods can be developed to increase resistance to damage from these events.

**Resistance to humidity and water damage:** Floods, rain and ground water can all cause water damage, mold and mildew and render a building unusable or unhealthy for occupants. Improved design and materials for the building and landscaping the grounds surrounding the building can protect the building from water based damage. Systems can be used to remove humidity when water does enter the building, such as is common in basement and underground spaces. This also includes achieving the air sealing targets in other activities.

**Resistance to pest infestation:** Small cracks or weak materials can be susceptible to providing access, food or shelter for pests such as rodents, insects or birds. Improved design, materials and construction standards can all improve the resistance to pest infestation. This also includes achieving the air sealing targets in other activities.



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### **Capacity building for resilience**

Information combined with capacity building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver resilient buildings. Specific capacity building targets for resilience include:

#### **Key message .**

Resilient building capacity building target details include:

**Training within government:** Build capacity and awareness in all levels of government on the benefits, implementation and planning of resilient buildings, and their benefits to other systems such as infrastructure, public health and wellbeing, the energy sector and the environment.

**Training of professionals:** Provide training programs for service and product providers for buildings and construction (architects, developers, contractors, vendors, etc.) and building owners are aware of resilient building policies, programs or incentives for sustainable buildings and construction.

**Educational training:** Develop educational programs including primary, secondary, vocational, university and adult education, to enable increased knowledge of resilient buildings and infrastructure.

**Information and awareness:** Develop information tools for people to have increased awareness, improved decision-making and to promote more sustainable choices. Methods of increasing information to consumers include benchmarking programs, certification programs, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programs.

**Institutional coordination:** Coordination and shared goals between relevant government and non-government organizations can enable improved policy coherence. Technical, financial and human capacity and resource in each of the organizations can improve the implementation and enforcement of urban planning policies.

Other capacity building efforts can include:

**Utility programs:** Promote the implementation of building resilience programs by utilities, highlighting the role of smart and energy efficient buildings in the transition to a cleaner and more sustainable energy sector.

## **8.8. Activity 8: Renewable energy**

The NDC has a climate target of the reduction of GHG by 27% by 2030. Since the building and construction sector accounts for about 28% of the total energy consumption in Indonesia, renewable energy plays a significant role for achieving this target.

While reliance on domestic coal and imported petroleum products has grown, Indonesia has started adding more renewables to its energy mix. The country has set out to achieve 23% renewable energy use by 2025, and 31% by 2050.

Ambitious government plans to extend electricity access have yielded fruit in Indonesia, where the number of people without access declined from around 100 million in 2000 to around 23 million in 2016 even with a population increase of almost one-quarter.

Electricity is mainly produced using coal and fuel. A large part of the fuel is imported although Indonesia is an oil producing country itself. Renewable energy sources are in the form of geothermal energy, wind energy and solar energy.



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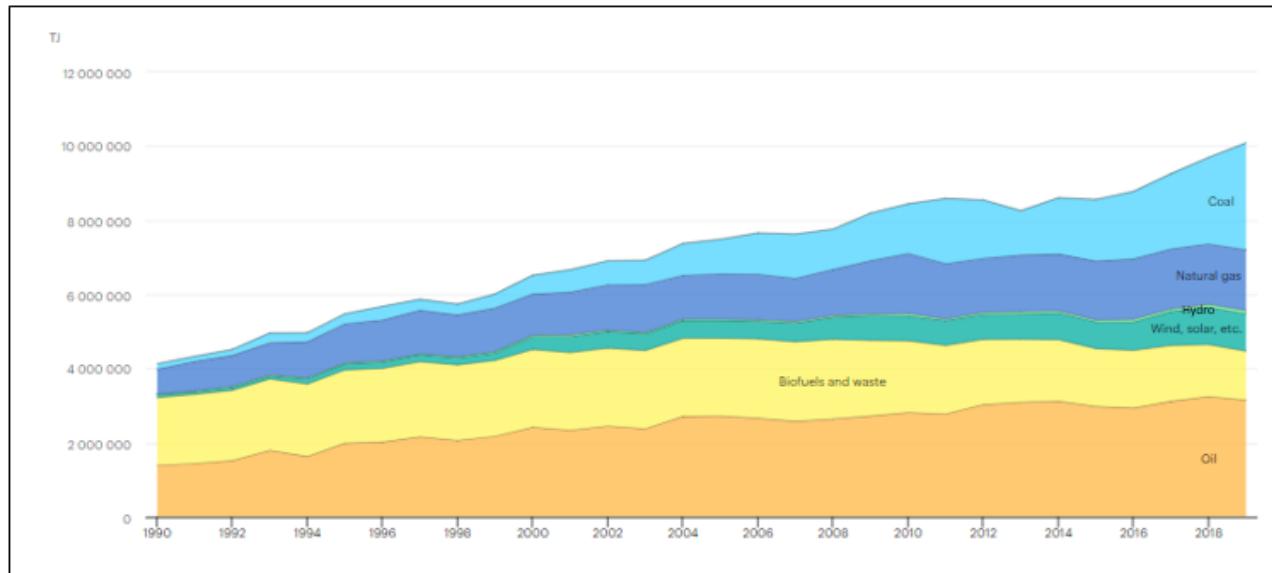


Figure 18 Total energy supply (TES) by source, Indonesia 1990-2019, source: IEA 2021.

### Action and Targets for 2030-2050 Renewable Energy

Key actions to increase the use of renewable energy (here understood as wind, solar and hydro) for buildings include:

**Integration of on-site renewable energy.** Include building integrated photovoltaic (BIPV), solar thermal and micro-wind renewable energy projects in the planning and design of buildings and neighborhoods.

**Eliminate on-site fossil fuel burning equipment.** Replace systems with equipment that use renewable energy, including heat pump technology (assuming that the heat pumps eventually will be on zero emission electricity).

**Connect buildings to low-emission district energy systems.** Support the renewable energy transition for district energy systems by connecting buildings when districts commit to systems upgrades with renewable energy.

**Green power.** Ensure that the electricity transfer to using renewable energy and not coal or oil.

**Zero carbon policies.** Implement energy policies that support the renewable energy transition based on the lifecycle benefit of the measures.



	Key actions Baseline (2020)	Short term (2025)	Medium term (2030)	Long term (2050)
<b>1 Decarbonization of electricity grid (not for the building industry but for the whole country)</b>	Target in the NDC is set to 23% RE in 2025 and 31% RE in 2050.	Targets are set for the green transition and the use of renewable energy for electricity production.	Targets are set for the green transition and the use of renewable energy for electricity production.	All buildings have on-site renewables (PV) or are supplied by electricity from off-site renewable energy using renewable energy sources.
<b>2 Requirement of RE in the building code</b>	No requirements for renewable energy integration in buildings	Develop and introduce voluntary requirement for renewable energy in buildings, favorite buildings with high energy efficiency. New buildings shall be PV prepared	There are mandatory requirements for the use of RE in new buildings. Benefits for existing buildings using RE. Mandatory to use PV for new buildings	Mandatory requirements for the use of RE in new buildings. Mandatory requirements for existing buildings using RE. Mandatory to use PV for all buildings
<b>3 Buildings in remote areas or areas without electricity build stand alone RE systems</b>	Some examples exists	Financial support for the development of stand-alone RE installations for remote areas	Frameworks in place to Support stand-alone systems that can interact with neighboring communities	All remote buildings are supplied with renewable energy

Table 11 Key Actions and Targets for renewable Energy

#### **Stakeholders for renewable energy**

In Indonesia, the key stakeholders for renewable energy include those that can influence the availability of renewable energy technology and services and those that can deliver the results of renewable energy supply to buildings, Ministry of Construction, Sub-national government, Utility companies, Property and project developers, Financial institutions, Architects and construction engineers, Manufacturers and suppliers\*. Laborers and installers, Building owners and occupants, Civil society \*\*.

\* For both equipment and material

\*\* including academia, non-governmental organizations, research institutions, social networks and community associations/professional



### **Policy for renewable energy**

Renewable energy policy can support low-emission, efficient and resilient buildings goals by enabling market transformation that reduces the carbon intensity of sustainable buildings. Within the targets for renewable energy, the following sub-targets and timelines offer more details:

#### **Key message Introducing requirements for the use of RE in buildings.**

**Renewable energy:** The share of renewable energy used in buildings to be increased.

**Building codes:** Incorporate measures, such as energy storage or dedicated space for renewable energy systems, in building codes to increase the readiness of buildings to use renewable energy onsite and through green power purchase.

**Information and awareness:** Combining information and capacity building activities can increase the overall awareness of people to improve their decision-making process regarding the purchase and use of renewable energy.

**Clean district energy:** District energy systems are common on campuses and in urban communities, however they commonly still use fossil-fuel based energy to supply energy (heating, cooling and electricity) to energy uses in the district. The transition to renewable energy within these networks can provide more sustainable district energy.

**Incentives:** Non-financial incentives, such as expedited product approvals and permits, should be the priority to encourage the use of renewable energy. Financial incentives should be used to enable full adoption of renewable energy, while finance support, such as loan guarantees, should enable private investment in renewable energy.

### **Technology for renewable energy**

The lifecycle energy and emissions for buildings are influenced by the energy used in buildings. Specific targets and timelines for renewable energy are outlined below:

#### **Key message: Make the buildings as efficient as possible and then Increase share of solar PV, hydro and wind to reduce the carbon emissions**

Renewable energy technology target details include:

**Solar thermal:** On-site building solar thermal collectors can be used to provide heating or hot water directly or provide heat for a thermal driven process that can be used for cooling (heat pump/absorption cooling).

**Solar electricity:** On-site building integrated photovoltaic or roof-mounted photovoltaic can generate electricity for use directly in buildings, to be stored in batteries for later use or delivered to the grid for other electricity customers.

**Wind electricity:** On-site building integrated wind turbines can generate electricity for use directly in buildings, to be stored in batteries for later use or delivered to the grid for other electricity customers.

**Renewable combined heat and power:** Larger facilities and campuses can use renewable energy directly in a co-generation or tri-generation power, heating and cooling plant through the use of heat recovery, heat pumps, biomass, biogas, hydrogen and other renewable energy.

**Heat pumps:** While heat pumps are an energy efficient technology, they can also be classified as renewable energy technology if they are supplied with electricity produced from renewable energy.

**Biomass:** Modern and efficient biomass can provide a low-impact fuel source for on-site production of hot water, cooking and production of power in larger facilities.

**Biogas:** Modern and efficient biogas can provide a low-impact fuel source for on-site heating, cooking and be a replacement for oil and natural gas fuel. While biogas still has on-site emissions, some organizations document biogas as low-carbon or carbon neutral when the source of the biogas is renewable and harvested and produced with sustainable standards.



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**Hydrogen:** Hydrogen can be used either in combustion or chemical fuel cell processes. When produced and used sustainably, Hydrogen can be a zero emission fuel.

**Energy storage:** Thermal and electricity storage are both important enablers of renewable energy to enable energy to be produced when it is freely available and to be used when it is needed.

**Controls and sensors:** Use of renewable energy, including using smart meters and other controls and sensors, can be optimized based on available renewable resources (i.e. sun, wind, etc.), available storage (i.e. thermal or electric storage), and demand for energy.

Other renewable energy technologies that do not have specific targets above include:

**Small-scale hydro:** Historically, small-scale hydro was an important energy source in Indonesia. Currently, most small-scale hydro is directly fed into the power grid and not used on-site.

**Green power purchase:** Buildings can be fed directly with renewable energy through the power grid by purchasing green power from the utilities to support the investment in the power sector renewable energy transition.

### **Capacity building for renewable energy**

Information combined with capacity building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver renewable energy. Specific capacity building targets for renewable energy include:

#### **Key message Train skilled people in RE for buildings**

Renewable energy capacity building target details include:

**Training within government:** Build capacity and awareness in all levels of government on the benefits, implementation and planning of renewable energy production, and the benefits to other systems such as infrastructure, public health and wellbeing, the energy sector and the environment.

**Training of professionals:** Provide training programs for service and product providers for buildings and construction (architects, developers, contractors, vendors, etc.) and building owners are aware of renewable energy policies, programs or incentives for sustainable buildings and construction.

**Educational training:** Develop educational programs including primary, secondary, vocational, university and adult education, to enable increased knowledge of renewable energy in buildings. Provide certification or accreditation for professionals in the buildings renewable energy sector.

**Information and awareness:** Develop information tools for people to have increased awareness, improved decision-making and to promote more sustainable choices. Methods of increasing information to consumers include benchmarking programs, certification programs, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programs.

**Institutional coordination:** Coordination and shared goals between relevant government and non-government organizations can enable improved policy coherence. Technical, financial and human capacity and resource in each of the organizations can improve the implementation and enforcement of urban planning policies.

Other capacity building efforts can include:

**Awareness of procurement models:** Promote the use of alternative procurement models such as bulk procurement, energy performance contracting, benchmarking, green leasing and incentives to reduce the cost of existing building retrofits. Increase the capacity of financial service providers to implement the range of innovative financing models.

**Utility programs:** Promote the implementation of renewable energy programs by utilities, highlighting the role of smart and energy efficient buildings in the transition to a cleaner and more sustainable energy sector.



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## 9. KEY STAKEHOLDERS

This section will provide a brief overview on key stakeholders in Indonesia and their responsibilities in this Roadmap.

### 9.1. Stakeholder Mapping

In Indonesia, the Ministry of Public Works and Housing and the Ministry of Energy and Mineral Resources are the main ministries that deal with energy efficiency in buildings. The Ministry of Public Works and Housing (MPWH) has developed building energy codes and made them mandatory for cities like Jakarta on a provincial level. Mandatory codes specific to city are being introduced in the cities of Bandung and Surabaya.

#### Governmental stakeholders

##### The Ministry of Public Works and Housing (PUPR)

The Ministry of Public Works and Housing formulated policy, spatial planning, and public infrastructure among others. In general, standards for building constructions, including the regulation on Green Building guideline, are under the supervision of the MPWH.

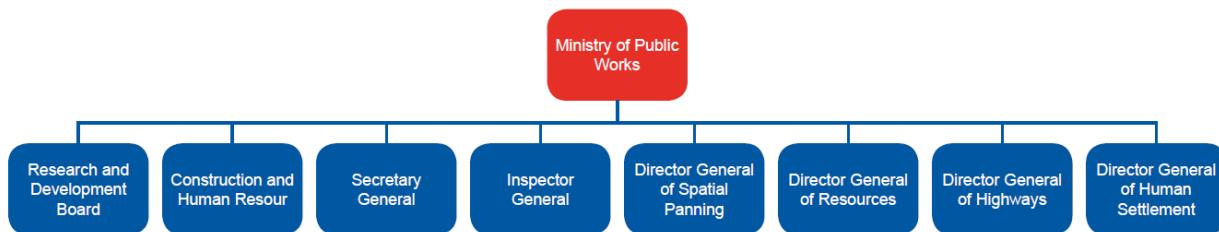


Figure 19 Organization of Ministry of Public Works and Housing, Indonesia, Source: Desk Research Report: Mapping of Green Building Codes and Building Energy 2018

##### The Ministry of Energy and Mineral Resources (ESDM)

The Ministry of Energy and Mineral Resources (ESDM) are tasked with administering government affairs in the field of energy and mineral resources. The MEMR's main functions consist of formulating, determining and implementing policies and technical guidance in the field of training, controlling and supervising of oil and gas, electricity, minerals and coal, new energy, renewable energy, energy conservation, and geology. They also provide support and implementation of research and development in the field of energy and mineral resources.

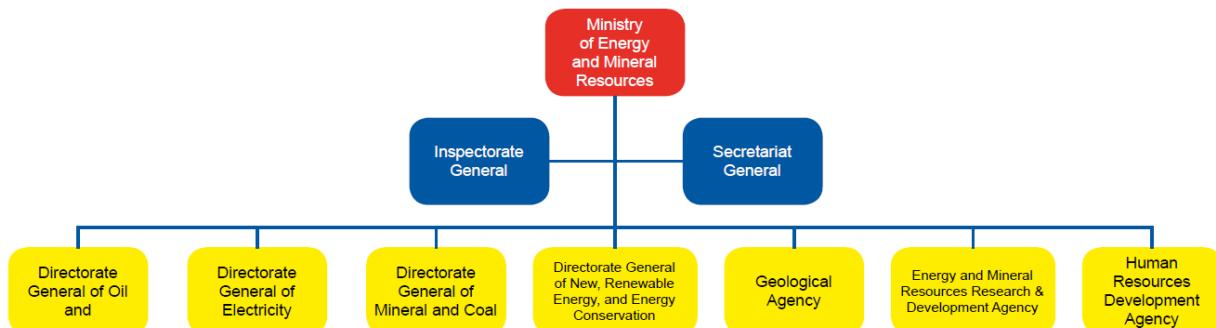


Figure 20 Organization of Ministry of Energy and Mineral Resources, Indonesia, Source: Desk Research Report: Mapping of Green Building Codes and Building Energy 2018



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### Non-governmental stakeholders:

#### The Green Building Council of Indonesia (GBC Indonesia)

The Green Building Council of Indonesia (GBC Indonesia) is an independent and private organization established in 2009 by professionals in the Indonesian design and construction industries. GBC Indonesia collaborate with stakeholders such as architects, buildings designers, building professionals, governments, and private sectors. GBC Indonesia has four main programs: market transformation, training & education, green building certification, and stakeholder engagement.

The majority of energy efficiency measures are controlled by MEMR whilst the MPWH are responsible specifically for the building and residential sectors as well as the national guidelines on Green Buildings. Within the standards and regulations for Green Buildings developed by the MPWH, the energy efficiency components are prepared by the MEMR. The Green Building Council Indonesia has been playing an important role in introducing the GREENSHIP Rating Tools scheme and is recognized by the government. The certification procedure is conducted through a third party and is on a voluntary basis. In addition to the national stakeholders, the local governments also play an important part in implementing energy efficiency measures in buildings. For example, the Governor of Jakarta initiated the development of Governor Decree No. 38/2012 and the Mayor of Bandung enacted the Mayor Decree no. 1023/2016, both on Green Building guidelines to reduce energy consumption, water consumption, and carbon emissions from buildings. The Green Building Council of Indonesia is promoting the Excellence in Design for Greater Efficiencies (EDGE), a rating tool developed by the International Finance Corporation (IFC).

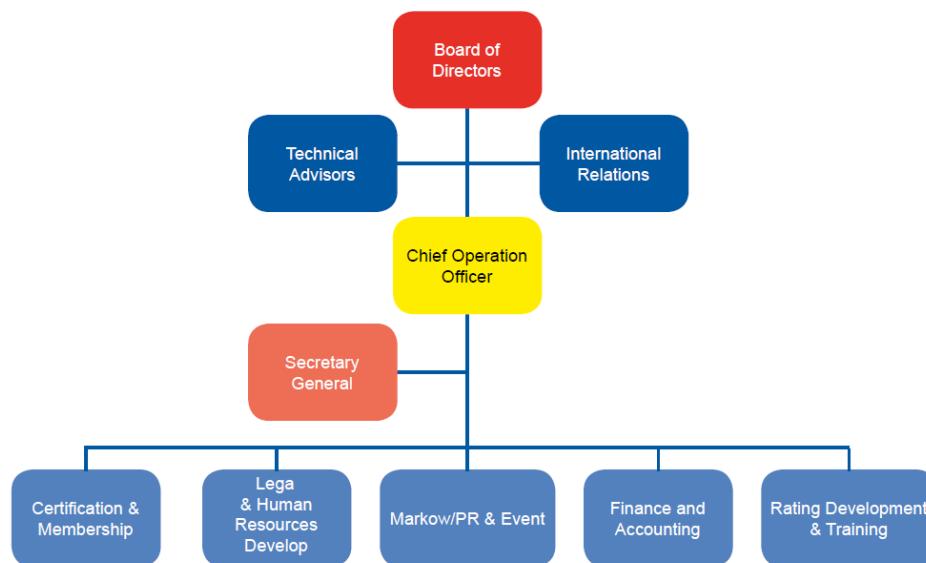


Figure 21 Organization of the Green Building Council Indonesia, Source: Desk Research Report: Mapping of Green Building Codes and Building Energy 2018



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## 10. KEY BARRIERS FOR IMPLEMENTATION OF THE ROADMAP

### 10.1. Regulatory and institutional barriers

The main obstacles to low-carbon and climate-resilient buildings in Indonesia are, first of all, the lack of legal regulations and - in the case there are legal regulation - the check of compliance and keeping compliance with regulation. The challenge with lack of experience on showing compliance and checking for compliance means that for Indonesia it makes sense not only to work on developing the legal framework for Energy Efficiency in buildings, but also to work on the use of voluntary sustainability schemes (where energy optimization is a part of the requirements).

Until recently there were no national adopted building code, however the Governmental Regulation No.16/2021 on Buildings and Regulation No. 21/2021 on The Assessment of Green Building Performance has in 2021 been adopted by the Ministry of Public Works and Housing. The regulation has mandatory energy performance requirements for certain building types. The code is, however, not fully implemented yet (April 2022).

### 10.2. Technology and capacity barriers

Advanced technological and digital solutions for development of cities, buildings and other structures as well as efficient management of existing buildings are needed in order to reach some of the sustainability goals. In the building sector, most of the technologies are readily available (insulation, high efficiency windows and air-conditioning systems) and can be implemented now.

However, a key technical barrier is the need for in-depth trainings of professionals in sustainable design, construction, operation and maintenance of buildings. Another barrier is the lack of capacity of government officials to verify compliance and third barrier is the lack of resources and capacity of market participants.

The pace of urbanisation is high in Indonesia and requires new constructions at a very high pace. This requires skilled workforces to build the buildings. It is difficult to get sufficiently skilled workpeople for the construction of new buildings; it is also difficult to get skilled craftsmen to carry out renovation and retrofitting of existing buildings in cities and urban areas.

The need for specialised and focused education and training is existing in both academia (architects, engineers, planners, landscape architects, environmental designers etc.) and among entrepreneurs, workmen and installers and the need will increase significantly in the future both due to new sustainable requirements being introduced for new buildings and due to the growing building stock in need of renovation or retrofitting.

There is a limited capacity and experience of construction professionals in the preparation of regulations, standards and technical guidelines for planning, infrastructure, energy-efficient buildings and resource-efficient works, environmental protection, climate change response and natural disaster prevention and this is likely to be a major obstacle for many years to come. It is therefore important to start already now to



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prepare the supply chain for skilled people by planning educations, upskilling activities etc. in order to be prepared for the future.

### 10.3. Financial barriers

Financial barriers to energy efficient, low carbon and climate resilient buildings are closely related to legal barriers, so formal mobilization of financing sources for sustainable buildings is mostly not yet part of the eligibility criteria, unlike buildings part of social development goals (social housing, etc.), so green financing and green bonds are needed to adapt.

There is a lack of incentive mechanisms and policies for the development of green cities, eco-cities, green buildings and energy efficient buildings including financial and non-financial incentives. This hinders the process of mobilising social resources for these activities.

Especially low-income households may not have the possibility to retrofit their homes and may benefit from grant schemes. Other households could be motivated to do energy efficiency retrofitting by soft loans or loan with state guarantee.

The ESCO concept, where a third party comes with finance and a guaranteed energy saving, may be interesting for commercial and public building and could be developed further.

The building and construction sector in Indonesia are still facing some constraints/barriers as follow:

Lack of incentive financial mechanisms and policies for green city, eco-city, green buildings, and Energy Efficiency Buildings. That hinders the process of mobilizing social resources for the above activities. Economic and technical norms of works (investment rate, construction unit price, and consultancy cost norms) have become outdated in the face of requirements for energy, resource and environmental protection. Although the construction cost is determined by the market, construction investment activities still use these economic and technical norms as a common method, especially for projects using the state budget.

### 10.4. Legal barriers

There are many different regulations on energy efficiency in buildings and construction. There may also be differences in national and local laws.

### 10.5. Technological barriers

Standards and technical guidelines for design and construction of energy saving projects, responding to climate change and natural disasters (storms, floods, etc.) are lacking; there are no specific and clear criteria for green urban areas or ecological cities. Lack of energy management and energy labelling for construction works; assessment and certification of green buildings, green cities, ecological cities, etc.

### 10.6. Capacity barriers



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The limitation of capacity and awareness of state management officials on construction is a significant barrier in proposing, drafting and implementing legal provisions to promote planning and technical floors, building energy-saving works, sustainable development, responding to climate change.

The limited capacity and experience of construction experts in drafting regulations, standards, technical guidelines for planning, infrastructure and building energy-saving, natural resources, Environmental protection, climate change response and natural disaster prevention are quite big barriers for many years.

## 10.7. Social barriers

Some of the social barriers are:

- Lack of interest and undervaluing EE
- Lack of trusted information and experience
- Lack of knowledge about the multiple benefits of energy efficiency projects. This may require developing a system of assigning value to non-economic benefits, so that it can be taken into account when making investment decisions.



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### Units of measure

EJ	exajoule
GtCO <sub>2</sub>	gigatonnes of carbon dioxide
MtCO <sub>2</sub>	megaton of carbon dioxide
kg/m <sub>2</sub>	kilograms per square meter
kWh	kilowatt hour
kWh/m <sub>2</sub>	kilowatt hour per square meter
m <sub>2</sub>	square meter
tCO <sub>2</sub>	tons of carbon dioxide
TWh	terawatt hour
W	watt
W/mK	watt per meter per degree kelvin
Mtoe	megatons of oil equivalent



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## ANNEXES

### Annex 1: List of stakeholders from stakeholder consultations

Three virtual stakeholder consultations were carried out in November 2021 in connection with this Roadmap.

The stakeholder consultations were divided into these subjects:

**Workshop I:** New Building and Building Materials, date: Tuesday, 4 November 2021

Panelists:

- Ir. Sulton Sahara (Director of Ministry of Housing & Residential, PUPR)
- Tirta Mazli (Senior Vice President Biro QSHE, PT. PP Tbk. )
- R.M. Soedjono Respati (General Director of MASKEEI)
- Surendro (Executive Director of GBCI)
- Irwan Sendjaja (President of BOMA)

Total participants: 50 persons

**Workshop 2:** Existing Building, Building Operations & Appliances, date: Thursday, November 18, 2021

Panelist:

- Ir. Sulton Sahara (Director of Ministry of Housing & Residential, PUPR)
- Mardi Utomo (Building Engineers Association)
- Prof. Dr. H. Kamin Sukardi (Indonesian Association of HVAC )
- Dr. Joko Tri Haryanto (PKPPIM BKF Ministry of Finance)
- Irwan Sendjaja (President of BOMA)

Total participants; 104 persons

**Workshop 3:** Urban Planning, Resilience, & Renewable energy, date: Tuesday, November 30, 2021

Panelist:

- **Chrisnawan Anditya, S.T., M.T.**, Director of Various New and Renewable Energy, Ministry of Energy and Mineral Resources
- **Drs. Sumedi Andono Mulyo, MA, Ph.D** Director of Spatial Planning and Land Affairs, Ministry of National Development Planning
- **Anita Puspita Sari**, VP of Bioenergy PLN
- **Ir. Iwan Prijanto, MM., GP.** Chairperson of Green Building Council Indonesia
- **Dr. Phil. Hendricus Andy Simarmata, ST, M.Si**, Chairperson of Indonesian Urban Planning Expert

Participants: 61 persons

The participants in the stakeholder consultations come from these organizations:

1	<b>Kementerian ESDM</b>	Ministry of Energy and Mineral Resources of the Republic of Indonesia
2	<b>Kementerian PUPR</b>	Ministry of Public Works and Public Housing of the Republic of Indonesia
3	<b>Kementerian Keuangan</b>	Ministry of Finance of the Republic of Indonesia
4	<b>Kementerian ATR/BPN</b>	Ministry of Agrarian Affairs and Spatial Planning
5	<b>Kementerian PPN/Bappenas</b>	Ministry of National Development Planning
6	<b>GBCI</b>	Green Building Council Indonesia
7	<b>MASKEEI</b>	Indonesia Energy Conservation and Efficiency Society
8	<b>BOMA</b>	Building Owners and Managers Association



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9	<b>ASHRAE Indonesia Chapter</b>	American Society of Heating, Refrigerating and Air-Conditioning Engineers: Indonesia Chapter
10	<b>BEA</b>	Building Engineers Association
11	<b>APITU</b>	Indonesian Air Conditioning and Air Conditioning Practitioner Association
12	<b>ACE</b>	Association of Chief Engineer Indonesia
13	<b>PHRI</b>	Indonesian Hotel and Restaurant Association
14	<b>GAPENSI</b>	National Construction Executor Association
15	<b>IAPI</b>	Indonesian Urban Planning Experts Association
16	<b>IAI</b>	Indonesian Architects Association
17	<b>PT. PLN</b>	The National Electricity Company
18	<b>PT. Cikarang Listrindo</b>	PT. Cikarang Listrindo
19	<b>PT. PP</b>	PT. Pembangunan Perumahan
20	<b>PSE – UGM</b>	Energy Research Centre -Gadjah Mada University



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## Annex 2: example from the mapping process using Open Street Mapping

Province	Number of Building	Footprint Area (m <sup>2</sup> )	Mapping Distribution Building Area
Aceh	404,192	52,094,441	
North Sumatera	1,041,771	149,776,510	
West Sumatra	274,618	39,301,756	
Riau	26,718	10,852,657	
Jambi	63,350	8,474,025	

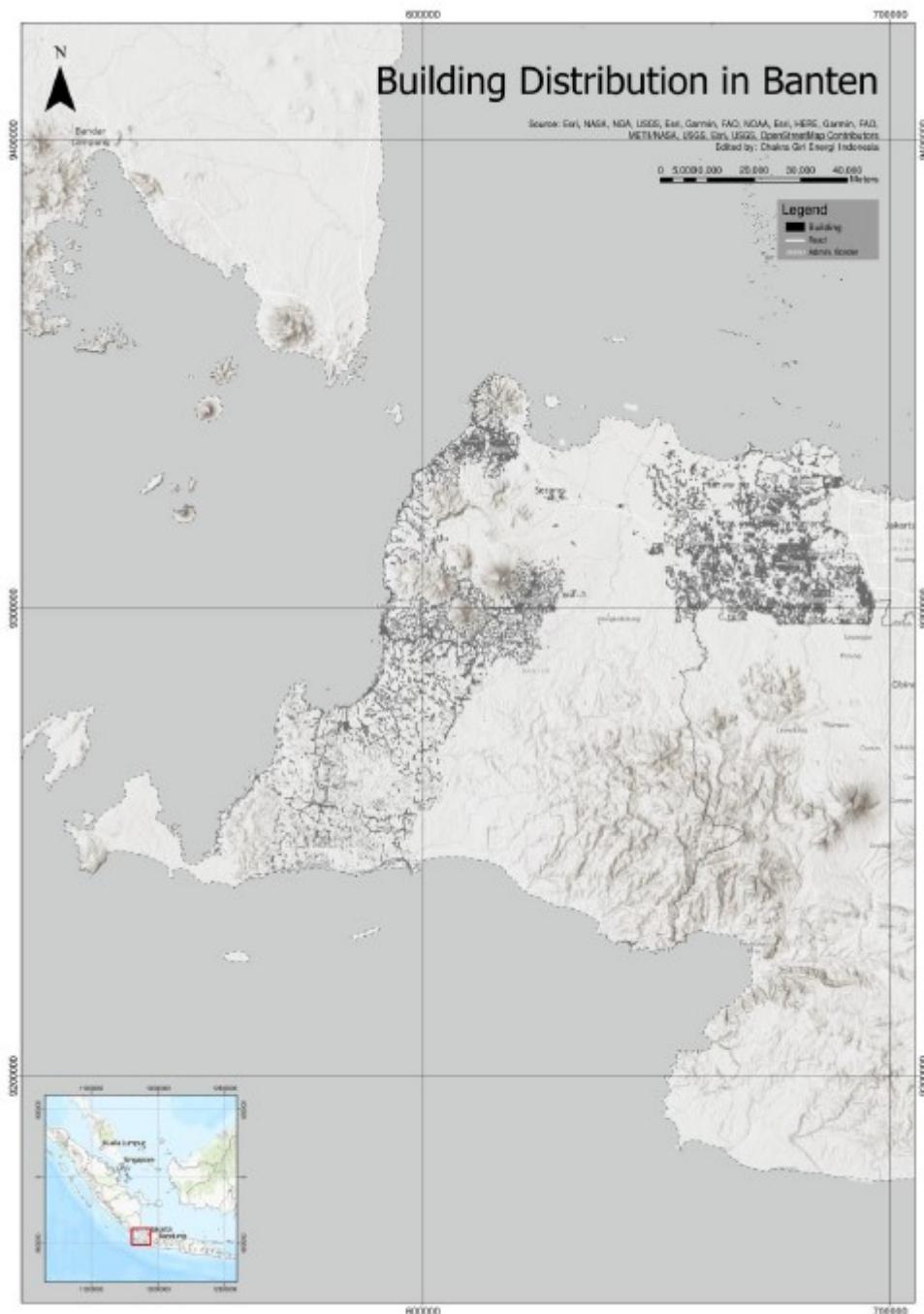


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Banten	1,262,385	115,313,995	
DKI Jakarta	1,671,569	202,689,742	
West Java 1	1,270,402	120,575,144	
West Java 2	521,305	51,012,146	
West Java 3	110,590	9,742,467	
West Java 4	333,171	37,291,407	
West Java 5	2,369,928	233,904,943	



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### Annex 3, CO<sub>2</sub> in building materials:

Type	Material	Functional Unit	Embodied Greenhouse Gas Emissions (KgCO <sub>2</sub> e)
<b>Blocks</b>	Concrete block	Kg	0.24
<b>Cement</b>	Cement mortar	Kg	0.35
	Portland cement	Kg	1.3
<b>Concrete</b>	Autoclaved aerated concrete (AAC)	Kg	0.71
<b>Fiber cement</b>	Fiber cement weatherboard	Kg	2.2
<b>Plaster</b>	Gypsum plaster	Kg	0.44
<b>Tiles</b>	Concrete roof tile	Kg	0.39
<b>Flat glass</b>	Double glazing - flat glass	m <sup>2</sup>	101
	Flat glass	Kg	2
<b>Laminated glass</b>	Laminated glass	Kg	2.8
<b>Toughened glass</b>	Double glazing - toughened glass	m <sup>2</sup>	115
	Toughened glass	Kg	2.2
<b>Cellulose</b>	Cellulose insulation	Kg	0.79
<b>Other</b>	Aluminum foil insulation	m <sup>2</sup>	1.9
	Glasswool insulation	Kg	4
	Rockwool insulation	Kg	3.8
<b>Polystyrene</b>	Polystyrene (EPS/XPS) insulation	Kg	8
<b>Polyurethane</b>	Polyurethane (PU) rigid foam insulation	Kg	17.5
<b>Aluminum</b>	Aluminum bar	Kg	29.6
	Aluminum composite panel	m <sup>2</sup>	102
	Aluminum extruded	Kg	29.4
	Aluminum angle extruded	Kg	32.7
	Aluminum extruded powder coated	Kg	33.6
	Aluminum sheet	Kg	26.7
<b>Copper</b>	Copper pipe	Kg	10.1
	Copper sheet	Kg	15.1
	Copper wire	Kg	41.8
<b>Stainless steel</b>	Stainless steel wire	Kg	13.9
	Cold rolled stainless steel	Kg	9.2
	Stainless steel extruded	Kg	11.8
	Stainless steel sheet	Kg	7.2
	Stainless steel sheet products	Kg	14.7
<b>Steel</b>	Cold rolled steel	Kg	3.7
	Hot rolled galvanized structural steel	Kg	3.3



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	Hot rolled structural steel	Kg	2.9
	Steel hollow section extruded	Kg	4.6
	Steel bar	Kg	2.1
	Steel pipe	Kg	3.5
	Steel sheet corrugated	Kg	5.5
	Steel sheet corrugated - pre-painted	m <sup>2</sup>	24.9
	Steel sheet corrugated - per square meter	m <sup>2</sup>	17.9
<b>Asphalt</b>	Asphalt	Kg	0.2
<b>Carpet</b>	Nylon carpet	m <sup>2</sup>	31.2
	Tufted carpet, nylon – prestige	m <sup>2</sup>	55.3
	Tufted carpet, nylon – quality	m <sup>2</sup>	33.3
	Woven carpet, nylon – average	m <sup>2</sup>	23.9
	Woven carpet, nylon - quality	m <sup>2</sup>	24.8
	Wool carpet	m <sup>2</sup>	41
	Tufted carpet, wool - prestige	m <sup>2</sup>	64.2
	Tufted carpet, wool – quality	m <sup>2</sup>	49.1
<b>Other</b>	Silicone	Kg	13.8
	Solar hot water system	no.	1 863
	Water	Kg	0.001
	Wood glue (PVA)	Kg	5.4
<b>Paint</b>	Solvent-based paint	Kg	6.3
	Water-based paint	Kg	6.8
<b>Paper</b>	Wallpaper	Kg	16
<b>Rubber</b>	Natural rubber	Kg	2.5
	Synthetic rubber	Kg	3.7
<b>High density polyethylene (HDPE)</b>	High-density polyethylene (HDPE) film	Kg	6.4
<b>Low density polyethylene (LDPE)</b>	Low-density polyethylene (LDPE) film	Kg	6.4
<b>Nylon</b>	Nylon 66	Kg	22.2
<b>Other</b>	Acrylonitrile butadiene styrene (ABS)	Kg	16
	Ethylene tetrafluoroethylene (ETFE)	Kg	798
	Glass reinforced plastic (GRP)	Kg	18.8
	Linoleum	Kg	4.4
	Polycarbonate	Kg	14
	Polymethyl methacrylate (PMMA)	Kg	15.4
<b>Polypropylene</b>	Polypropylene (PP) sheet	Kg	7.4
<b>Polyurethane</b>	Polyurethane (PU) flexible foam	Kg	7.7
<b>Polyvinyl chloride (PVC)</b>	Polyvinyl chloride (PVC) film	Kg	11.2



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	Un-plasticized polyvinyl chloride (uPVC)	Kg	4.2
<b>Brick</b>	Clay brick	Kg	0.32
<b>Other</b>	Gravel	Kg	0.036
	Recycled aggregate	Kg	0.008
	Sand	Kg	0.024
	Sanitary ceramic	Kg	6.4
<b>Stone</b>	Dimension stone	Kg	1.3
<b>Tiles</b>	Ceramic tile	Kg	1.3
	Clay roof tile	Kg	0.61
<b>Cork</b>	Cork slab	Kg	9.5
<b>Hardwood</b>	Hardwood	m <sup>3</sup>	944
	Hardwood kiln-dried - dressed	m <sup>3</sup>	2 269
	Hardwood kiln-dried - structural	m <sup>3</sup>	1 178
<b>Manufactured timber product</b>	Cross laminated timber (CLT)	m <sup>3</sup>	645
	Glued laminated timber (glulam)	m <sup>3</sup>	1 718
	Glulam outdoor	m <sup>3</sup>	1 605
	Laminated veneer lumber (LVL)	m <sup>3</sup>	1 059
	MDF sheet	m <sup>3</sup>	899
	OSB sheet	m <sup>3</sup>	751
	Particleboard	m <sup>3</sup>	696
	Particleboard outdoor	m <sup>3</sup>	813
	Plywood	m <sup>3</sup>	3 680
	Plywood outdoor	m <sup>3</sup>	1 777
	Structural insulated panel (SIP)	m <sup>2</sup>	135
<b>Softwood</b>	Softwood	m <sup>3</sup>	549
	Softwood kiln-dried	m <sup>3</sup>	583