Asia-Pacific
Economic Cooperation

LOW CARBON MODEL TOWN (LCMT)
Phase 5

Feasibility Study

Special Economic Zone (SEZ), Bitung

Indonesia

Asia-Pacific
Economic Cooperation

Final Feasibility Study Report

Low Carbon Model Town (LCMT) Phase 5

-

Special Economic Zone (SEZ), Bitung, Indonesia

Submitted to:

Asia Pacific Economic Cooperation Forum (APEC)

Submitted by:

South Pole Carbon Asset Management Ltd.

In partnership with

Factor CO_2 Integral Services, S.L. and
ICLEI - Local Governments for Sustainability SEAS and
Ammari Limited Liability Company

November 2015

Table of contents

List of tables

List of figures

Acronyms and abbreviations

APEC	Asia-Pacific Economic Cooperation
ADB	Asia Development Bank
BAPPEDA	Regional Development Planning Agency
BAPPENAS	National Development Planning Agency
BAU	Business-As-Usual
BKPM	Indonesian Investment Coordinating Board
C	Celsius
CCCC	China Communication Construction Company Limited
CCAP	Center for Clean Air Policy
CE	Cost Effectiveness
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CH_4	Methane
COD	Chemical Oxygen Demand
CO_2	Carbon Dioxide
C40	40 Cities Climate Leadership Group
DGNREEC	Directorate General of the New and Renewable Energy and Energy Conservation
EBT	Renewable Energy
EE	Energy Efficiency
ER	Emission Reduction
EWG	Energy Working Group
e.g.	example given
FS	Feasibility Study
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GW	Giga Watt
GWP	Global Warming Potential
h	Hour
ha	Hectare
HFC	Hydrofluorocarbon
HTI	Industrial Plantation Forest
HR	Community Forest
ICLEI	Local Governments for Sustainability
IDR	Indonesian Rupiah
IPPC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
i.e.	Id est.
KEN	National Energy Policy
Kg	Kilogram
Km	Kilometre
kWh	Kilowatt hour
LCDS	Low Carbon Development Strategy
LCMT	Low Carbon Model Town
LCS	Low Carbon Strategy
LCT	Low Carbon Town
LPG	Liquefied Petroleum Gas
m	Meter
MEMR	Ministry of Energy & Mineral Resources
MoA	Ministry of Agriculture
MoEF	Ministry of Environment & Forestry
MoI	Ministry of Industry
MoPW	Ministry of Public Works
MoT	Ministry of Transport

MoU	Memorandum of Understanding
MP3EI	Masterplan for Acceleration and Expansion of Indonesia's Economic Development
MRV	Monitoring, Reporting & Verification
MSW	Municipal Solid Waste
MW	Mega Watt
MTOE	One million tonne
NAMA	National Appropriate Mitigation Actions
NEP	National Energy Policy
N2O	Nitrous Oxide
PEN	National Energy Management
PEP	Monitoring, Reporting & Evaluation
PLN	National Electricity Company
PP	Presidential Regulation
QA	Quality Assurance
QC	Quality Control
RAC	Refrigeration & Air Conditioning
RAD-GRK	Local Action Plan on Greenhouse Gas Mitigation
RAN-GRK	National Action Plan on Greenhouse Gas Mitigation
RDTR	Bitung Detailed City Planning
RE	Renewable Energy
RHL	Forest and Land Rehabilitation
RIKEN	National Energy Conservation Development Plan
RKPD	City Government Working Plan
RPJMD	Regional Medium Term Development Plan
RPJMD Kota	Bitung City Medium-Term Development Plan
RPJMN	National Medium Term Development Plan
RPJPN	Long-Term National Development Plan
RTRW	National Spatial Planning
RTRWK	Bitung City Spatial Planning
RTRWP	Provincial Spatial Planning
RUEN	National Energy Master Plan
SD	Sustainable Development
SDG	Sustainable Development Goals
SEZ	Special Economic Zone
SKPD	Governmental Unit on City level
SMA	SEZ Management Agency
SMC	SEZ Management Council
tC	Tonne Carbon
tCO_2e	Tonne Carbon Dioxide equivalent
TJ	Terajoule
TOE	Ton Oil Equivalent
US	Unites States of America
WRI	World Resource Institute

Executive Summary

Scope of the study

This report focuses on a low carbon development strategy (LCDS) and implementation roadmap for an industrial greenfield development in the Special Economic Zone (SEZ) in Bitung, Indonesia. It includes a comprehensive feasibility study and detailed implementation action plans for a set of proposed high potential low carbon mitigation measures (LCMs), including recommendations on the institutional and regulatory framework, thoughts on the required financial architecture, and potential funding sources to achieve the proposed LCDS for the SEZ Bitung.

Low Carbon Development Strategy (LCDS) for SEZ Bitung

The LCDS of the SEZ Bitung incorporates a high-level statement; a greenhouse gas (GHG) baseline and Business-As-Usual (BAU) scenario; GHG Emissions Reductions (ER) and Sustainable Development (SD) targets; and introduces a list of potential LCMs for each identified design category and sector of the city's economy.

High Level Vision Statement for the SEZ Bitung

The special economic zone of Bitung will become a national and global model for sustainable, low carbon urban and industrial planning, and will contribute to the national goal of reducing GHG emissions up to a 26% by 2020 compared to the business-as-usual scenario. This vision will be implemented by developing the low carbon model town strategy along the following four axes:

I. Ensure alignment with existing local and national development policies, regulatory frameworks and institutional set-ups;
II. Reduce energy consumption through the use of clean, green energy generation and more energy efficient technologies and practices;
III. Ensure an efficient and environmentally balanced management of resources through the utilisation of the best available low carbon technologies for industry, commercial and residential areas, for solid waste and wastewater management, for forestry and land use, and for transportation; and
IV. Apply an accurate, transparent and functional monitoring, reporting and verification (MRV) system of the GHG emissions and the related sustainable development impacts.

SEZ Bitung Masterplan

The Ministry of Industry (MoI) has provided support for the SEZ Bitung and has developed a SEZ Masterplan since 2008. This Masterplan provides the underlying concept and basis from which this LCMT feasibility study builds its analysis, but its original design features have been adapted and updated responding to the comments, feedback and suggestions received throughout a number of stakeholder consultations carried out at the national, provincial and city level. In addition, the ongoing revisions and expansion plans of the SEZ Masterplan 2008 have also been taken into account in this study, in order to ensure the applicability and feasibility of the proposed low carbon development strategy and its related low carbon measures within the future context of the SEZ Bitung development.

Baseline, Business-As-Usual (BAU) and Mitigation Scenarios

Successful planning for future climate and sectoral developments depends on an accurate understanding of current and future trends in GHG emissions. Therefore, the feasibility study starts with a detailed assessment of the baseline, BAU and Mitigation scenarios.

The GHG emission baseline[1] has been assessed according to the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), which classifies emissions along the following sectors:

1. **ENERGY:** GHG emissions from fuel combustion as well as fugitive emissions released in the process of generating, delivering, and consuming electricity or heat. Energy covers energy generation, but also energy consumption in industry, commercial and residential buildings.

2. **TRANSPORTATION:** GHG emissions from private and public road transport occurring in the city (scope 1), from the grid-supplied electricity used for lighting (scope 2), or from trans-boundary journeys occurring outside the city.

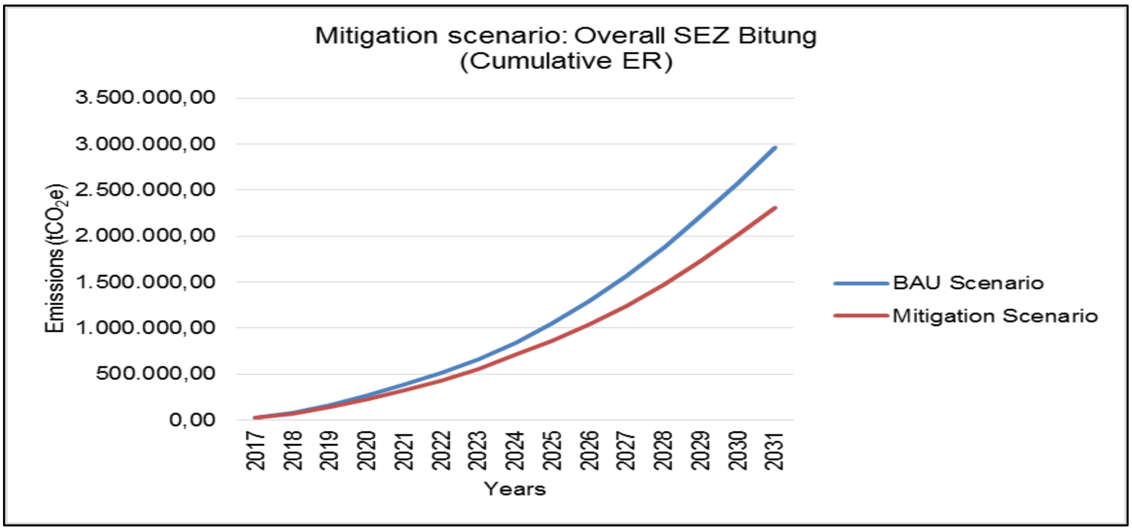
3. **WASTE:** GHG emissions from solid waste disposal, biological treatment (composting), open burning, wastewater treatment and discharge inside the city or outside the city.

4. **AFOLU (Agriculture, Forestry and Land Use):** GHG emissions from agricultural activity, land use & land use change within the city boundary, and out-of-boundary emissions.

The overall SEZ Bitung GHG baseline will account for -120 tCO_2e in 2016. As this is a greenfield development, no land use changes have been assumed prior to SEZ development, and therefore, no carbon stored in the soil has been released. An estimated small growth of agroforestry biomass accounts for the slight absorption of carbon dioxide that represents the small negative amount.

As per the GHG Business as Usual (BAU) scenario[2], overall the SEZ Bitung will emit approx. 2.9m tCO_2e into the atmosphere by 2031. When looking at GHG emissions by source, the energy sector will be the main emitter with 87% of total GHG emissions, followed by the transportation sector (8%), the waste sector (5%) and an almost negligible AFOLU sector (0.07%).

In terms of the GHG Mitigation scenario[3], the GHG ER potential of the selected LCMs under this study has been estimated to approx. 0.65m tCO_2e throughout the phases of the SEZ development. This represents a reduction of up to 22% from the BAU scenario.



[1] The GHG emissions baseline provides a reference scenario of the past and present GHG emissions in the study area
[2] The GHG BAU scenario provides an estimation of the future GHG emissions in the absence of future, unplanned mitigation efforts and policies for the specific timeframe in the study area.
[3] The GHG Mitigation scenario provides an estimation of the future GHG emissions levels in the context of the proposed Low Carbon Measures and policies for the specific timeframe in the study area.

This overall ER target goes beyond the 10% reduction from a BAU Scenario by 2025 that has been set for Bitung City by the local authorities, so it is considered ambitious, yet feasible and aligned with the national target of reducing emissions up to 26/29% by 2020/2030 compared to the BAU Scenario.

Finally, in terms of Sustainable Development (SD) benefits beyond GHG ER, the proposed LCDS for the SEZ Bitung includes, but is not limited to the following SD impacts:

Overall LCMT SD Impacts	
Impact Domain	**Specific Impact**
Environment	Reduction in Air, Water and Soil Pollution
	Noise Reduction
Social	Livelihood
	Health
	Time Savings
Growth & Development	Access to Clean and Sustainable Energy
	Capacity Enhancement
	Energy Security
	Education
Economic	Income Generation
	Expenditure Reduction
	Job Creation

Low Carbon Measures (LCMs) for the LCMT

The process of the identification and analysis of potential LCMs for the SEZ Bitung was systematic and structured while remaining practical and flexible. The process included a preliminary identification of a long list of potential LCMs; a qualitative analysis to narrow down the list to the LCMs with highest potential; and a final, more thorough, quantitative Multi-Criteria Analysis (MCA) of the shortlisted LCMs to prioritize and regroup them looking for potential synergies. Through this comprehensive and detailed MCA exercise, a final list of the 10 most promising LCMs that could be implemented within the SEZ Bitung Masterplan as per its expected development phases (2017 to 2031) has been developed.

LCMT Target Sectors	Sub Sector	Type/ Technology of LCM	Specific LCM
Energy	Energy Generation	Utilisation of Clean Energy	1. Utilisation of Geothermal Energy
		Grid Solar Energy Generation	2. Use of Photo Voltaic (PV) panels on buildings
		Waste-to-Energy Generation	3. Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater
		Biomass Thermal Energy Generation	4. Thermal energy generation from agricultural waste
	Industry	EE in Equipment, Appliances, Building Design and Industry Processes & Product Use (IPPU)	5. Comprehensive EE Program for the Industry Buildings, Appliances and IPPU
	Commercial	EE in Equipment, Appliances & Building Design	6. Comprehensive EE Program for Residential and Commercial Buildings & Appliances
	Residential		
Transportation	Shift and avoid	7. Bus Rapid Transit (BRT) 8. Non-Motorised Transport (NMT) and Transit-Oriented-Development (TOD)	
AFOLU	Land Use and Urban Greening	9. Urban Forestry and Urban Greening	
Waste	Solid Waste and wastewater	Solid Waste Management	10. Integrated Solid Waste Management System and 3R strategies

Implementation Roadmap

The implementation roadmap represents a comprehensive implementation strategy for the LCMT project, covering key aspects such as the required: (i) Institutional and Regulatory Framework, (ii) integrated MRV & M&E system, (iii) enabling activities and technical assistance for implementation readiness, and (iv) financial considerations, including proposed financial architecture, financial instruments and available financing sources (national & international, public & private).

Institutional and Regulatory Framework

The successful implementation of the LCDS for the SEZ Bitung will require the coordination and cooperation of different institutions and actors, each of which with specific tasks and responsibilities. The institutional and regulatory set up for each LCM will vary, depending on the sectoral focus and individual LCM activities. However, the following two institutions will be essential to ensuring the successful implementation of the LCDS, and will be involved in all of the proposed LCMs:

- **SEZ Management Council (SMC):** The SMC has oversight of the SEZ Bitung's overall development. It is suggested that the SMC's authority to be expanded to include oversight of the implementation of the LCDS. The SMC's current structure would need to be adapted so that it could effectively carry out its new envisioned role.
- **SEZ Management Agency (SMA):** The SMA will be the on-the-ground coordinator and implementation entity of the SEZ Bitung Masterplan. The SMA is still being selected and is expected to begin operations in 2017. It will be crucial to mainstream the LCDS's implementation strategy into the SEZ Masterplan, and therefore the SMA will be the key implementation agency to ensure that LCDS and the specific LCMs are integrated and implemented smoothly as part of the SEZ development.

Integrated MRV & M&E System

The integrated MRV and M&E system for the LCDS will measure, report and verify (MRV): (i) the GHG emission reduction impact; (ii) the SD impacts (environmental, economic, growth & development and social); and (iii) the efficiency of the investment/support (MRV of finance). The LCDS will also have to incorporate a monitoring and evaluation (M&E) system to track and evaluate: (i) the effectiveness of the overall implementation and the impact of the proposed LCMs and enabling activities; and (ii) the continuous improvement processes (CIP) indicators; to be in line with the most advanced international best practices.

Enabling Activities for LCMT Implementation

This feasibility study indicates a lack of technical, institutional and financial readiness required to develop and implement the LCMT project in the SEZ Bitung. Creating a favourable environment for the implementation of the low carbon strategy it is therefore recommended as a priority step towards successful implementation. The following table presents an overview of the recommended activities in order to create such an enabling environment[4].

#	Activity	Budget	Timeline
EA1	Streamline LCDS into SEZ Masterplan	70,000 USD	S1 2016
EA2	National & Sub-national Dialogue	230,000 USD	S1 2016
EA3	Institutional Improvements	150,000 USD	S1 2016
EA4	Policy Recommendations	70,000 USD	S1 2016
EA5	Capacity Needs Assessment (CNA)	130,000 USD	S2 2016
EA6	MRV and M&E system set-up	350,000 USD	2016-2017

[4] These values include in-kind contributions from the Indonesian government and TA from the international donor community.

#	Activity	Budget	Timeline
EA7	Capacity Building Programme[5]: I.1 Technical (including MRV[6]) I.2 Institutional I.3 Regulatory I.4 Financial	350,000 USD 125,000 USD 50,000 USD 50,000 USD 125,000 USD	2016-2017
EA8	Financial Support Programme	150,000 USD	2016-2017
EA9	PPP Support Programme	250,000 USD	
EA10	Project Management Unit (PMU)	750,000 USD	2016-2017
	TOTAL	**2,500,000 USD**	

Finance Considerations for Implementation

The finance considerations for the LCMT in Bitung comprise basic finance principles, a list of potential mechanisms and available financing sources. The aim is to facilitate the implementation of the LCMT by highlighting and presenting some options so it can be considered solid, bankable and generally appealing to potential investors. This will ensure that the LCDS for the SEZ Bitung can easily be integrated into the SEZ Bitung Masterplan, and in turn that each of the 10 proposed LCMs attract the necessary level of incremental finance required.

Financial Architecture: Definition, Objectives and Principles

As is the case with the Institutional Framework (which has to be aligned with and build as much as possible on the existing institutional set-up), the LCMT Financial Architecture will have to be strongly integrated within the: (i) National Planning; (ii) the Provincial Planning of North Sulawesi; (iii) the SEZ Bitung Masterplan; and with their related budgetary systems for implementation.

Generally speaking, the four basic sources of funding for the LCDS will be: (i) public finance; (ii) private finance; (iii) domestic (or national) finance; and (iv) international finance.

The LCMT Financial Architecture should therefore be seen as an instrument that seeks to bring together a wide range of players and sources of finance (public and/or private; domestic and/or international) into a coordinated operational framework by combining domestic and international resources to be able to scale-up the most promising (i.e. environmentally and economically effective[7]) mitigation actions.

Financial Instruments

A wide range of diverse financing instruments and financial mechanisms will generally be available, with many potentially being relevant for the LCMs under consideration. In many cases, given the complexity of a LCDS and the challenges and risks that it entails, a targeted combination of instruments will be necessary to enable the LCMT Financial Architecture to reach its full potential.

Potential Finance Sources

The following table provides an overview of potential financial sources for the LCMT implementation in the SEZ Bitung, categorised per relevant sector. All sources listed have track records in financing low carbon activities in Indonesia.

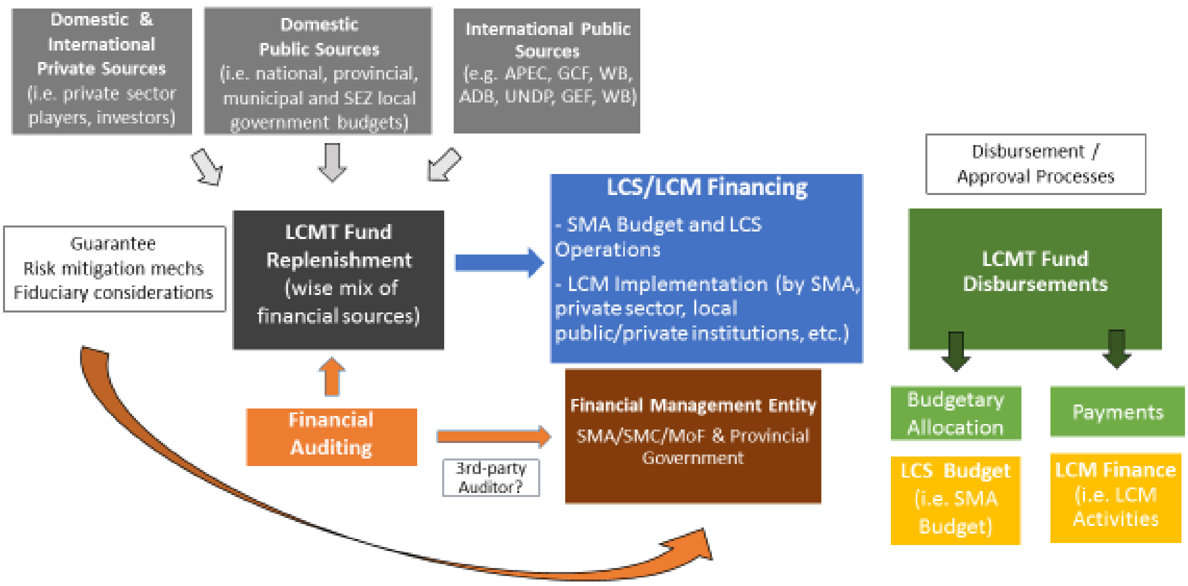
[5] This estimate considers that this activity will build on the outcomes from the national MRV strategy and work conducted to date in regards to MRV.
[6] This item could also include a “train the trainer” activity, which would increase its cost to the maximum range, but would ensure that this step could be done through domestic public sources.
[7] Environmental effectiveness relates to the absolute GHG emission reduction potential; economical effectiveness (cost-effectiveness) to the potential in relation of the GHG achieved per USD.

Topic-Sector	Financial Sources in Indonesia
Low Carbon Cities (i.e. multisector)	APEC, AFD, WB, ADB, EU, GCF
Energy Generation (Renewable Energy)	WB, ADB, USAID, JICA, AFD, UNDP-GEF, GCF, private
Energy End-Use (Energy Efficiency)	WB, ADB, USAID, JICA, GCF, private
Transport	WB, ADB, IDB, AusAID, JICA, AFD, GCF
AFOLU	WB, ADB, GEF, USAID, GCF
Waste	WB, ADB, GCF

Summary of Financial Considerations

In summary, the most recent developments and updates in relation to Financial Architecture for low carbon developments suggests that for this LCMT Financial Architecture to be successful, a targeted combination of sources of finance and financial mechanisms will need to be deployed. While a large number of donors are becoming progressively available, potential financiers should be engaged at the earliest stage, after the first outline of a financing model has been created. Identifying a central financial institution that can provide advice on the structuring of finance will be essential for achieving this. This central institution may play the role of a financial manager that can aggregate the different sources of finance and channel it through the different financial mechanisms based on its understanding of the functions of various financial instruments. The aggregator acts as a neutral financial adviser or "financial engineer" with the aim of eventually becoming involved in the implementation of the LCDS or LCMs at hand.

The following figure describes a general, indicative LCMT Financial Architecture and the inter-relations between the SEZ Management Agency (this is, the manager of the SEZ Bitung Implementation and the underlying LCDS and LCMs), the SMC, the Financial Manager or "aggregator", and the LCDS/LCM beneficiaries (i.e. recipients of funds).



Summary of overall LCMT Impacts and Capital Investment Required

The following table summarises the total impacts of the low carbon model town project for the SEZ Bitung.

Impacts are divided in terms of (i) overall contribution to the national policy objectives, (ii) overall GHG ER, and (iii) overall SD impacts.

In addition, the total estimated investment requirements for the implementation of the developed low carbon strategy for SEZ Bitung, i.e. technical implementation of all 10 selected low carbon measures and the creation of an enabling implementation environment, are presented.

Overall LCMT Contribution to National Policy Objectives	
Sector	**Contribution**
Energy	Contribution to Indonesia's National and Provincial Action Plan to reduce GHG Emissions (INDC & RAN/RAD-GRK)
	Contribution to the National Energy Strategy (KEN)'s objective to increase the share of RE in the national energy mix
	Contribution to the National Energy Conservation Development Plan (RIKEN)'s objective to achieve Indonesia's energy saving potential and reduced energy elasticity through energy efficiency and conservation measures.
Transportation	Contribution to the national sustainable transport and urban mobility objectives as per SISTRANAS, RENSTRA Transport and RPJBM
AFOLU	Contribution to the national objective of achieving a green and sustainable city environment
Waste	Contribution to the National Waste Management Strategy
Overall LCMT GHG ER Impact	
BAU Scenario (tCO_2e)	2,962,413
Total LCMT GHG ER (tCO_2e)	648,504
Mitigation Scenario (tCO_2e)	2,313,910
GHG ER Ratio (compared to BAU)	**21.9%º**
Total LCMT Investment Requirements	
Capital Investment for LCM implementation	~ $33,400,000
Operation & Management costs for LCDS & LCM implementation	~ $13,800,000
Enabling activities (Technical Assistance costs) for LCDS & LCM implementation	~ $2,500,000
Total	**~ $49,740,000**

1 Introduction

1.1 Low Carbon Model Town (LCMT) Initiative

In 2010, the Asia-Pacific Economic Cooperation (APEC) Forum promoted the Low Carbon Model Town (LCMT) initiative with the goal of encouraging the creation of low-carbon communities across the APEC region, and to share best practices to make such communities a reality.

The LCMT Initiative involves the following three main activities:

1) Development of a "Concept for the Low-Carbon Town"
2) Feasibility Studies
3) Policy reviews of planned town and city development projects

While the development of a low-carbon town concept is set as an ongoing multi-year activity, the feasibility studies and policy reviews are part of regular LCMT pilot projects conducted in selected APEC member economies.

The LCMT feasibility study on the Special Economic Zone (SEZ) in Bitung, Indonesia presented here is the fifth phase of the LCMT initiative. Previous phases and feasibility studies include:

- Phase 1 (2011): Yujiapu Central Business District, China (Focus: Central Business District)
- Phase 2 (2012): Samui Island, Thailand (Focus: Resort Area)
- Phase 3 (2013): Da Nang City, Viet Nam (Focus: Redevelopment of an existing area)
- Phase 4 (2014): San Borja, Peru (Focus: Residential Area)

1.2 Scope of Feasibility Study

This feasibility study focuses on an industrial greenfield development in the Special Economic Zone (SEZ) in Bitung, Indonesia. The feasibility study will provide central and local Indonesian government officials, as well as the developers of the SEZ Bitung Masterplan with valuable advice on how to design an appealing and innovative low carbon development plan by including an integral Low Carbon Development Strategy (LCDS) that incorporates a selection of high potential Low Carbon Measures (LCM) in the energy, industrial, commercial, residential, transportation, waste, land use change & forestry sectors. The study will also incorporate an implementation methodology and related action plans for the proposed LCMs, recommendations on the institutional and regulatory framework, thoughts on the required financial architecture and a selection of funding sources for the proposed activities. The key results of this feasibility study are:

1) Low Carbon Development Strategy (LCDS) for the SEZ Bitung
2) Detailed Impact and Cost Report on selected Low Carbon Measures (LCMs)
3) Implementation Roadmap

The key results and applied approaches and methodologies are elaborated in detail in the following report.

2 Low Carbon Development Strategy (LCDS) for the SEZ Bitung

The Low Carbon Development Strategy (LCDS) is the first activity of the LCMT feasibility study.

The LCDS includes a high-level vision statement on the SEZ Bitung as a low carbon development project; a greenhouse gas (GHG) baseline and related Business-As-Usual (BAU) scenario; GHG Emission Reduction (ER) and Sustainable Development (SD) targets; and a list of potential Low Carbon Measures (LCM) for each identified design category and sector of the city's economy.

The LCDS structure follows the APEC Low Carbon Town (LCT) approach as described in the fourth edition of "The Concept of the Low Carbon Town in the APEC Region".

The first section presents the LCMT high-level vision statement for the SEZ Bitung. The high level vision will serve as a general guideline for all subsequent activities of the LCMT project and takes into consideration the specific national, provincial and city-level circumstances. This initial analysis of the overall framework includes an assessment of (i) the geographic, demographic and economic background; and (ii) the existing relevant policy framework and institutional landscape.

The second part provides an analysis of current and future GHG emissions trends in the area of study. The GHG emission baseline and BAU scenario provide a reference scenario that details the present situation and the expected evolution of GHG emissions of the SEZ Bitung throughout its different development phases.

The third section then estimates conservative GHG ER and SD targets for the SEZ Bitung by taking into account all national and sub-national pledges, existing master plans and planning documents, and relevant policies associated to climate change mitigation and SD goals.

Next, the fourth section introduces low carbon strategy design challenges and potential negative impacts, which could slow down, hamper or prevent the unlocking of the full low carbon and SD potential of the LCMT project.

Finally, and building on the results of previous parts, a long list of potential LCMs is identified, presented and qualitatively analysed in the fifth section of the Strategy. The analysis concludes with the proposed shortlist of high potential LCMs that will be considered for further analysis under the subsequent activities of the LCMT project for the SEZ Bitung.

2.1 High Level Vision

The high level vision presented in this section will set the scene and define the broad principles of Bitung's SEZ Low Carbon Strategy. The section proposes a high level policy statement, including the vision and four axes for the development of the Strategy; introduces the geographic, demographic and economic profile of North Sulawesi and Bitung; and details the policy framework and institutional landscape at the national, provincial and city level.

2.1.1 High Level Vision Statement

The Special Economic Zone of Bitung will become a national and global model for sustainable, low carbon urban and industrial planning, and will contribute to the national goal of reducing GHG emissions by 26% by 2020 compared to a Business-as-Usual Scenario. This vision will be implemented by developing the Low Carbon Model Town strategy along the following four axes:

- *Ensure alignment with existing local and national development policies, regulatory frameworks and institutional set-ups;*
- *Reduce energy consumption through the use of clean, green energy generation and more energy efficient technologies and practices;*
- *Ensure an efficient and environmentally balanced management of resources through the utilisation of the best available low carbon technologies for industry, commercial and residential areas, for solid waste and wastewater management, for forestry and land use, and for transportation; and*
- *Apply an accurate, transparent and functional monitoring, reporting and verification system (MRV) of the GHG emissions and the related sustainable development impacts.*

2.1.2 Geographic, Demographic and Economic Background

This sub-section provides a background description of the regional and local geography, climate, population and economic characteristics. It also includes a summary of information on energy production and end-use consumption in Bitung, North Sulawesi.

The following pages provide context so that readers can better understand the rationale for the LCM recommendations that form the basis of the main scope of the LCMT Strategy.

2.1.2.1 Geography and Climate

Local geographic conditions include location, topography, and climate and hydrological cycle. They affect the underlying project conditions and are critical to understanding the local context, and are generally a very important factor when setting the stage, establishing a Strategy and selecting the most appropriate and feasible LCMs. The following pages summarize the geographic characteristics of North Sulawesi Province and Bitung.

North Sulawesi Province lies at the northern tip of the Sulawesi island and comprises the Minahasa Peninsula and islands stretching into the Celebes Sea. Its location provides ready access to the large markets of the Philippines, Viet Nam and China. The total land area of the province is approximately 14,000 kilometres^2 (km^2), or 0.72% of the land area of Indonesia.

The province has several mountain formations, with altitudes ranging between 1,000 and 2,000 meters (m). There are five regencies (Kabupaten) in North Sulawesi surrounded by active volcanoes – Mount Ambang in Kabupaten Mongondow, Mount Soputan in Kabupaten Minahasa, Mount Lokon and Mount Mahawu in Kota (City) Tomohon, Mount Karangetang in Kepuluan Sangihe and Mount Tangkoko in Kota Bitung. All of the volcanoes have a mountainous shape that result in a hilly morphology with a distinct topographic relief. Materials produced from eruptions can be either solid or in the form of loose ash.

Much of the province has elevations of over 500m above sea level. The combination of a hilly topography and an extensive coastline has a moderating effect on the tropical monsoon climate, and influences the economy to a large extent.

Figure 1: North Sulawesi. Regional Context (Credit: North Sulawesi Tourism Organisation)

The city of Bitung lies on the tip of the Minahasa Peninsula but is protected from the open seas of the Pacific Ocean by Lembeh Island. With a population of approximately 193,000, Bitung is a relatively small city with a land area of 31,000 ha, situated approximately 47 km from the provincial capital of Manado.

Geographically speaking, Bitung is located between 1º23'23" and 1º35'39" North, 125º1'43"and 125º18'13" East.

The location of the city and the relative calm of the Lembeh Strait have allowed Bitung to be developed into a significant commercial port for trade and the cruising ship industry.

Figure 2: Port Facilities at Bitung (Credit: Bitung City)

Most of the city areas are mountainous (33%) or hilly (45%), with flat areas accounting for only 8% of the total area. The eastern part of Bitung, which stretches from the Aertembaga coast to the west at Tanjung Merah, is a relatively flat plain (slope <15^{o}), and hence could be possibly developed as an urban area, for industry, business, or residential purposes. The northern part of the city has a hilly topography with agriculture, plantations, protected forests, wildlife parks and nature reserves. The coast could potentially be developed into a marine tourism area, as with other areas in North Sulawesi which have already been.

According to its geological mapping, the city is generally underlain by volcanic rocks that are partially covered by surface sediments. The city has five small rivers that have their estuaries respectively in Selat Lembeh, Girian, Sagerat, Tanjung Merah, Tewaan, and Rinondoran.

Bitung has large areas of protected forest (4,611 ha), tourism forest (1,271 ha) and reserve forest (7,495 ha). These forests make Bitung the most forested region in North Sulawesi.

The orography, distribution of land and climate/hydrology make the city of Bitung relatively vulnerable to natural disasters such as landslides, land abrasion and flooding.

The area designated as the SEZ comprises 534 ha of the second largest sub-district in the city, Matuari District (3,610 ha, 11% of the total area).

The other districts of Bitung are Madidir District (3,045 ha, 9%), Girian District (516 ha, 1.5%), Lembeh Selatan District (2,353 ha, 7%), Lembeh Utara District (3,061 ha, 9%), Aertembaga District (2,611 ha, 8%), Maesa District (965 ha, 3%) and Ranowulu District (17,117 ha, 51%).

The SEZ Bitung is situated on relatively flat land and close to the coast, and therefore has easy access to the existing port. This port will be expanded for the SEZ in line with Indonesian Government plans for the area to be the centre of the fishery, distribution and logistics industries for the Sulawesi Economic Corridor.

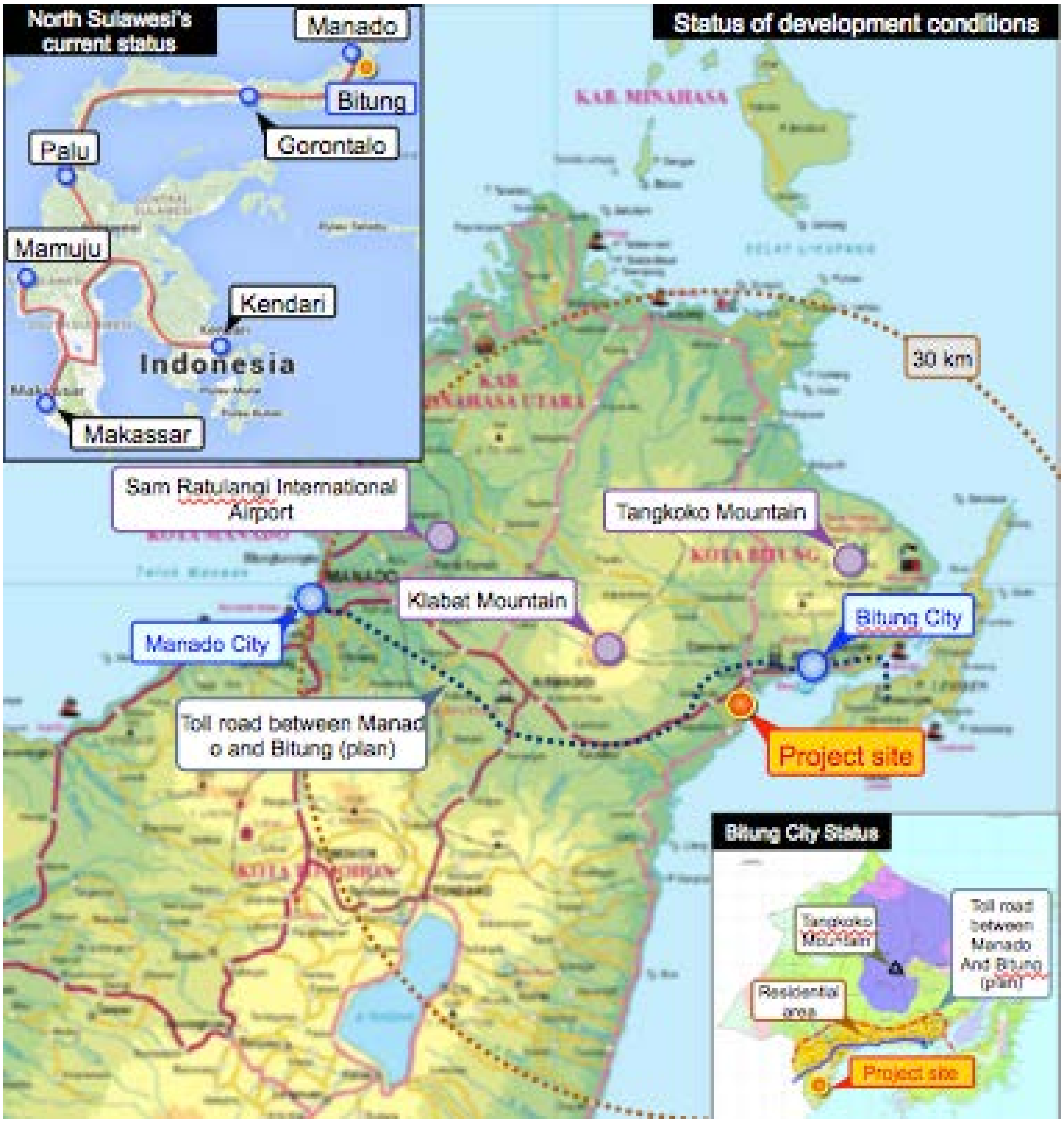


Figure 3: Geography of North Sulawesi (Credit: Korea Land and Housing Corporation)

In addition to the nearby port, the SEZ is served by infrastructure including the airport at Minado and a toll road from Bitung to Manado. Of the 534 ha, 50% has been designated for industry (large, medium and small) and 20% preserved as green open space, so although the area will be predominantly industrial, the plans for its development take into account the liveability of the area for residents. The high proportion of green open space will also assist with water infiltration, reducing the need to manage runoff during the monsoon season, and moderating heat retention within the landscape.

Figure 4: Site Location of SEZ Bitung with Extension to Port Area (Credit: Bitung City)

2.1.2.1.1 Climate and local weather

North Sulawesi has a dominant tropical monsoonal climate, with an average annual temperature of 26 C and average humidity of approximately 80%. Average annual rainfall is approximately 3,000 mm, and is spread across 90 to 130 rain days per year, although the effect of topography and proximity to ocean results in significant variation across the province. A tropical climate typically leads to a high demand for cooling in modern residential and commercial building stock. The concentration of rainfall during December and January results in intense rainfall events that have implications for the design requirements of urban drainage and transportation infrastructure.

Due to its location at the end of the Minahasa Peninsula, Bitung City has two pronounced seasons, which are influenced by the predominant wind direction. The rainy season occurs from October to April and is influenced by winds from the west and northwest that carry a high level of moisture whereas from June to September the air is dry as a result of winds from the east. As with the rest of North Sulawesi, the wettest month is usually January.

The SEZ is situated in a particularly well-sheltered area, given that the dominant winds are from the west, north-west or east and that it is further protected by Lembeh Island. An advantage of the location is that any potential air pollution emissions from industrial facilities at the SEZ are unlikely to be carried over Bitung.

2.1.2.2 Population Structure

North Sulawesi has a population of approximately 2.3 million (2011) with 415,000 people in the capital Manado. Bitung and Kotamobagu (a university city in the south of the province with 109,000 people) are the only other two significant urban centres.

Agriculture, forestry and fisheries are the biggest source of employment in the province (35% of the working population, mostly men) with retail, restaurant and hotels (20%, mostly women) and other services (19%) also being important.

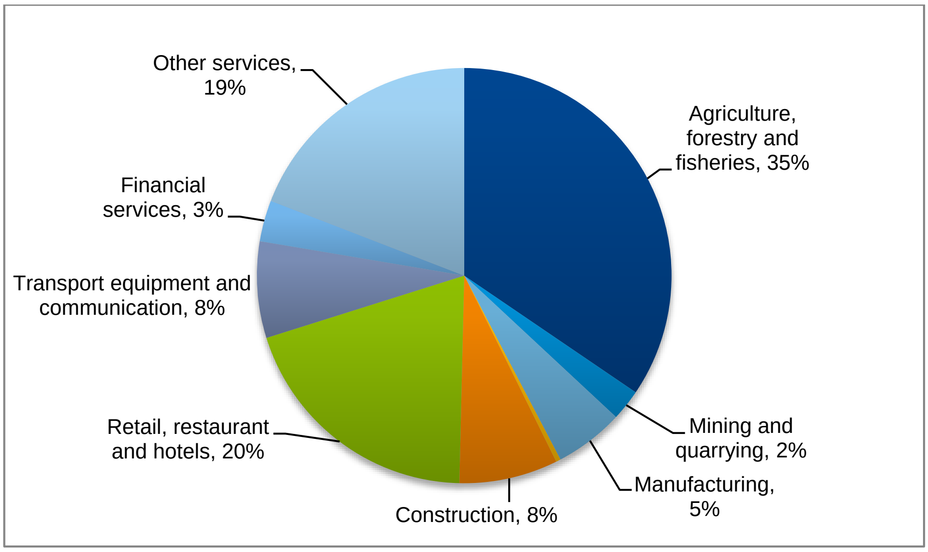


Figure 5: Employment by Sector, North Sulawesi

Bitung had a population of approximately 193,000 in 2012, the latest year for which figures have been published, and has had an average annual population growth rate of almost 3% since 2000.

As with the whole of North Sulawesi, Bitung has a young age structure, with 38% of the population under 20 years of age as of 2012. While this has immediate implications for the high demand of education facilities, it also has significant implications in terms of mid-term employment. In consideration of these factors, development of the SEZ is both timely and much required.

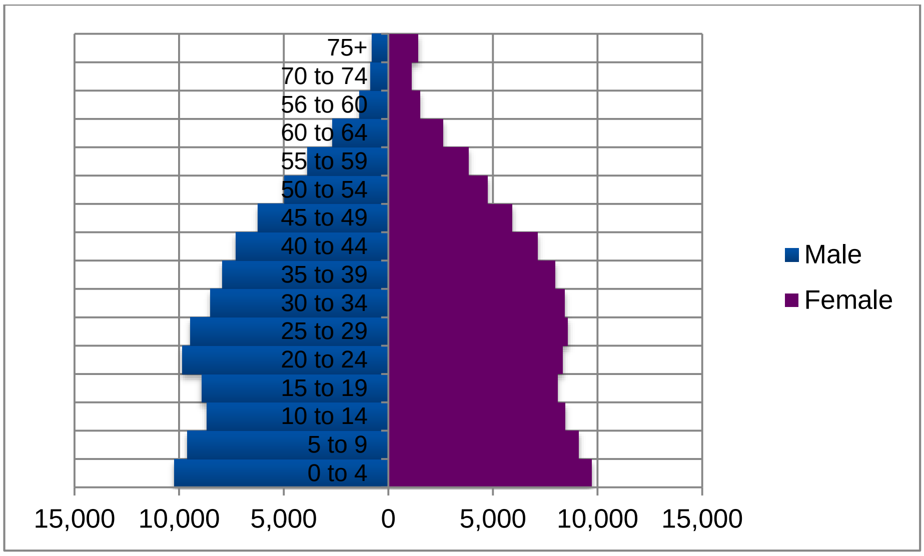


Figure 6: Population Structure of Bitung in 2012

2.1.2.3 Economy

2.1.2.3.1 North Sulawesi Economy

The economy of North Sulawesi is dominated by the agriculture, trade, construction, tourism and the transportation sectors. The provincial economy has been relatively resilient in comparison with a national economy that has been slowing since 2012. Whilst North Sulawesi Province's economic growth of 6.4% (first quarter of 2015) was lower than in 2014 (6.7%), it remained robust. According to the Indonesian Bank, economic growth in North Sulawesi is projected to be 6.3-6.6% for the remainder of 2015 (Bank Indonesia, 2015).

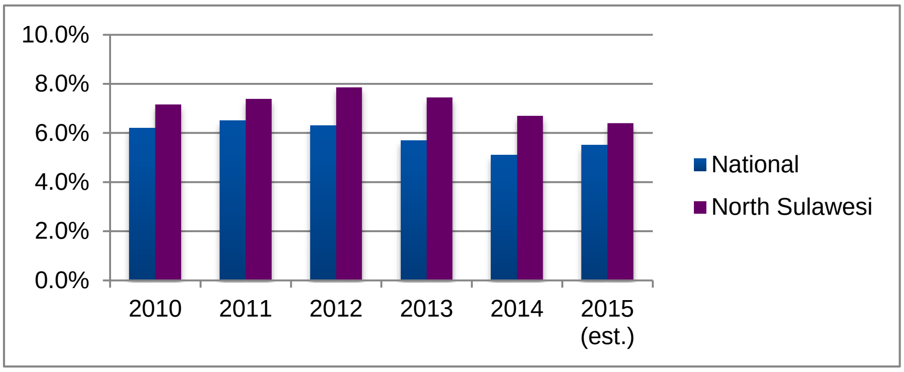


Figure 7: North Sulawesi GDP and National GDP (year on year, % growth)

Other economic indicators are also positive. Inflation in North Sulawesi for the second quarter of 2015 is estimated to be in the range of 7.9% ± 1%, and the current performance of commercial banks is also good and expected to continue. An increase in bank credit during the first quarter of 2015 was in line with a reduction in the Indonesian Bank lending rate by 0.25% to 7.5% during the first quarter. Credit growth is expected to remain stable at approximately 12% per annum, indicating an optimistic outlook regarding the North Sulawesi economy (Bank Indonesia, 2015).

The export value (non-oil and gas) of North Sulawesi in January 2015 was US$ 109.06 million, an increase of approximately 17% compared with December 2014. Exports that went through North Sulawesi reached US$ 85.47 million, while exports through other provinces were valued at US$ 23.59 million. The largest export commodities in the province are fat and animal/vegetable oil, which accounted for 65.2% of total exports. Furthermore, The Netherlands became the main export destination, with a value goods totalling of US$ 37.38 million, equivalent to 34.3% of North Sulawesi's total export value.

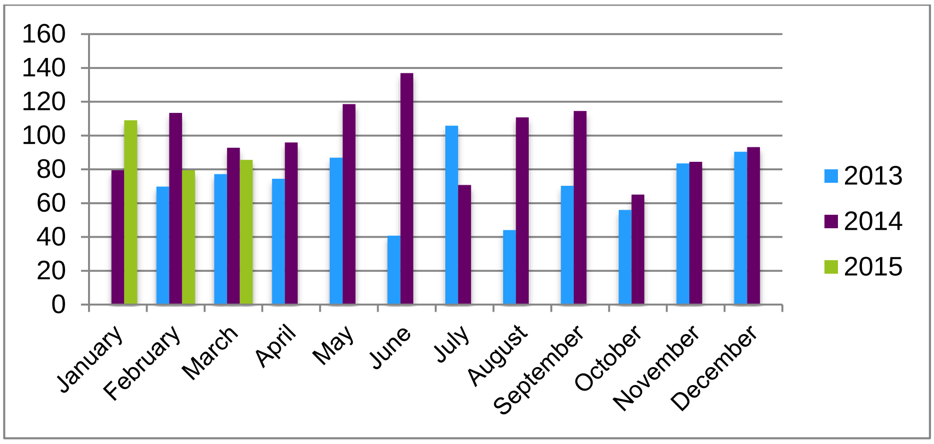


Figure 8: Growth in Exports from North Sulawesi (Month on Month, $US m)

Bitung port is the main export point for the province, processing goods with a value of $US 72.1 million or 66.1% of the total export value in North Sulawesi. In the tourism sector, the number of foreign visitors through Sam Ratulangi International Airport reached 2,248 people in January 2015, an increase of 32.7% compared to the previous year.

2.1.2.3.2 Bitung Economy

From 2000 to 2012, economic growth in Bitung was driven primarily by four major sectors – agriculture, industry, transportation and construction. In 2012, the contribution of these four sectors to GDP was 76.2%. Economic growth in Bitung during 2012 was 8% while in 2011 the economic growth was 7.8%. The transportation sector contributed approximately 23% to Bitung's total GDP, followed by the industrial and agricultural sectors at 20.7% and 18% respectively in 2012. The contribution of the construction sector was 14.5% for the same year.

In the agriculture sector, rice, horticultural crops, fruit, coconuts and spices dominate production in Bitung. Marine fisheries production fell by 16.3% in 2013 to 133,277.6 tonnes but the decline did not affect production value, which increased by 66.9% to IDR 2,820,270 billion. In the industrial sector the value of industrial investment in 2013 was IDR 2,959 billion, which was also a sharp decline when compared with 2012. Consequently, the production value of the sector also declined from IDR 39,839 billion in 2012 to IDR 17,246 billion in 2013 (Kota Bitung, 2014).

Despite Bitung being one of the largest port cities in Sulawesi, in 2013 it experienced a decline in export value and increase in import value in comparison with 2012. Generally, there was a cumulative decline in the freight traffic volume of exports and imports from 524,692 tonnes in 2012 to 383,337 tonnes in 2013. In the tourism sector, the number of domestic and foreign visitors decreased to 5,650 and 2,530 people respectively in 2014 (Kota Bitung, 2014).

2.1.2.3.3 SEZ Plans

Indonesian secondary and tertiary industries account for a large proportion of the national economy. In the manufacturing industry, resource-related industries are depressed and are therefore looking to secure high value added business. The Government of Indonesia has designated the SEZ Bitung with the task of increasing exports and enhancing the competitiveness of exported products. According to the Masterplan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI), the key industries in Sulawesi are agriculture and fishery production and processing. Therefore it is intended that the SEZ Bitung will aim to attract seafood processing, as well as other agriculture-related industries.

The SEZ Bitung is planned to cover an area of 543 hectares (ha) and will potentially expand up to cover 2000 ha in the future. The SEZ is divided into three main zones: the Export Processing Zone the Industrial Zone; and the Logistic Zone. Almost 50% of the SEZ will be allocated for large, medium and small industries, while green open space will occupy 20% of the total area. The development of SEZ Bitung will comprise of five phases and should contribute significantly to the economy of Bitung during the construction phase and beyond.

2.1.2.3.4 Energy background

Electricity in North Sulawesi is mainly supplied by the National Electricity Company (PLN), with off-grid and supplementary generation having only a small role due to the relatively small size of the industrial sector. Across the province sales of 2.28 million kWh were made to 1.14 million customers in 2013. Diesel dominated the fuels used to generate electricity (58% of the total), with coal accounting for a further 18%. Four geothermal plants, two of which were funded by the Asian Development Bank (ADB), provided the remaining 24% of electricity generation.

The main source of geothermal power is the Lahendong field that is located approximately 60 km south of Manado, where there are two 20 MW generating plants, enough to meet 50% of peak demand. The Government of Indonesia is encouraging further participation from private sector investors with 75% of new geothermal production being expected to come from independent power producers.

Bitung City has an electricity grid and diesel-powered generation assets owned by PLN. PLN had 40,641 customers in 2013, of which 94% were households, 3% business premises and 3% other, including industry. Despite the small number of industrial customers, electricity use in manufacturing accounted for 27% of all electricity used in Bitung in 2013. Business premises and households were the other significant users of electricity. Information on fuels sold by Pertamina (Indonesia’s state-owned oil and natural gas corporation) is not available.

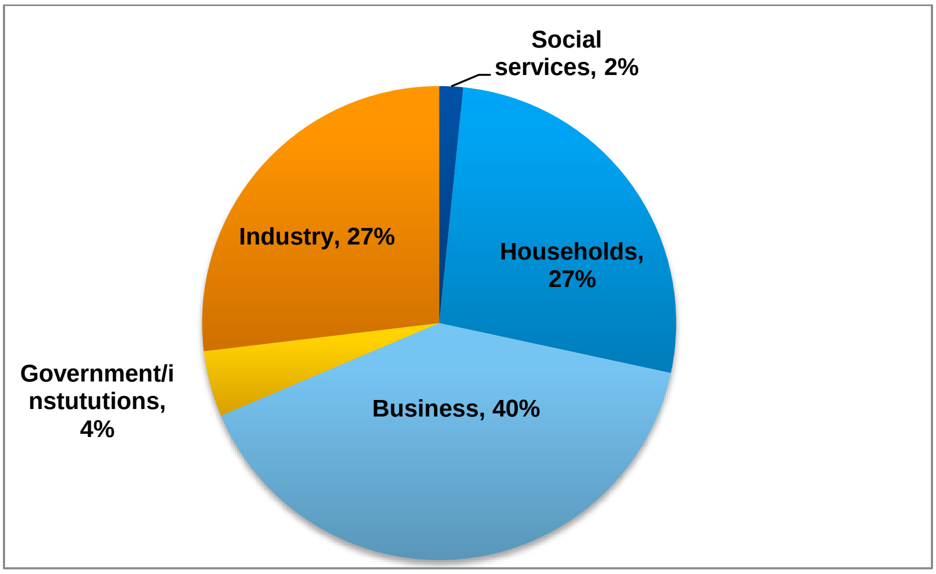


Figure 9: Electricity Use in Bitung, by Sector 2013

2.1.3 Policy Framework and Institutional Landscape

This sub-section comprehensively reviews the national, provincial and city level policy frameworks most relevant to the development of an urban low carbon strategy for the SEZ Bitung. It also briefly describes the existing institutional structure of and individual roles related to the SEZ Bitung.

The review is based on the findings of comprehensive desk research, corroborated with stakeholder discussions and meetings that were organized during two missions to Manado and Bitung (which took place in May and June 2015 respectively). The stakeholders provided an explanation of the roles and responsibilities of institutions with regards to the SEZ Bitung development, as well as their own assessment of the national policy and institutional framework.

2.1.3.1 Policy Framework LCMT Bitung

2.1.3.1.1 Overview of the policy framework

The following sub-section presents an overview of the key policies relevant to the LCMT Bitung.

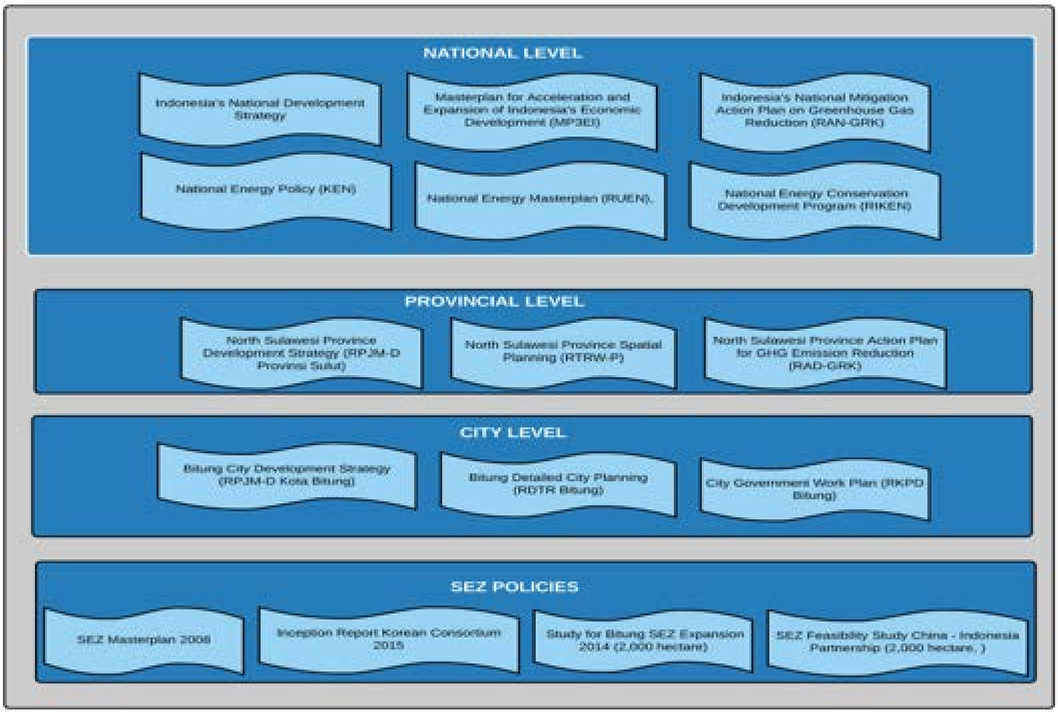


Figure 10: Policy Overview for the LCMT Bitung

2.1.3.1.2 National Policies

2.1.3.1.2.1 Indonesia's National Development Strategy (RPJPN & RPJMN)

Indonesia's national development strategy consists of two integrated development plans, distinguished by their respective timeframes. The Long-Term National Development Plan (*Rencana Pembangunan Jangka Panjang Nasional, RPJPN 2005-2025*) focuses on institutional restructuring while simultaneously ensuring that Indonesia keeps pace with other nations. It is implemented through a series of five-year Medium-Term National Development Plans (*Rencana Pembangunan Jangka* Menengah, RPJMN).

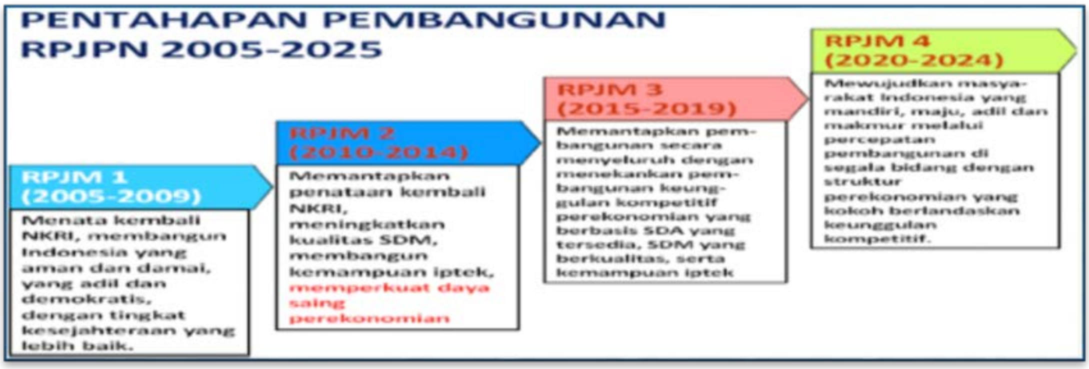


Figure 11: Long-Term National Development Plan (RPJPN 2005 - 2025)

Analysis of Indonesia's National Development Strategy

Sustainable development has been stated as one objective of the Long-Term Development Plan and is mainstreamed into all aspects of development through the current Medium-Term Development Plan (2015-2019). One of ten challenges to national development identified in the RPJMN 2015-2019 focuses on how economic growth can avoid damaging the natural environment, since environmental damage will ultimately lead to unsustainable economic growth. The Government has acknowledged that ineffective management of natural resources will result in the rapid depletion of resources and could easily lead to the recurrence of a food and energy crisis which will result in a drastic increase in the cost of living and a severe reduction in the quality of life.

Indonesia's national development strategy sets the framework for the development of the SEZ Bitung as a centre of economic growth in North Sulawesi while integrating SD principles.

2.1.3.1.2.2 Masterplan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI)

Supporting the RPJPN and RPJMN, the Government developed a Masterplan for Acceleration and Expansion of Indonesia's Economic Development (Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia, MP3EI). The MP3EI functions as a complementary working document to strengthen the existing development plans.

MP3EI is a working document and as such it will be updated and refined progressively. It contains the main direction of development for specific economic activities, including infrastructure needs and recommendations for change/revision of regulations as well as initiatives for new regulations to push for acceleration and expansion of investments. MP3EI is an integral part of the national development planning scheme.

MP3EI Analysis

Six economic corridors are identified as growth-centres in Indonesia with their specific economic conditions set as economic drivers. Sulawesi as a centre for production and processing of agricultural produce, plantations, fisheries, oil & gas, and mining is included in one of those economic corridors and supports the establishment of SEZs, including the SEZ Bitung.

MP3EI is also formulated in consideration of the National Action Plan for GHG Emission Reduction (Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca – RAN-GRK; described below), recognizing global climate change mitigation as a national commitment.

2.1.3.1.2.3 Indonesia's National Action Plan for GHG Mitigation (RAN-GRK)

In September 2009 at the G20 Summit Meeting in Pittsburg, Indonesia committed to reduce emissions by 26% unilaterally and up to 41% relative to a BAU scenario with international support by 2020.

As concrete follow-up to the commitment, the Government of Indonesia adopted its RAN-GRK with Presidential Regulation (Peraturan Presiden) 61 / 2011.

In addition, Presidential Regulation 71 / 2011 has also been issued to develop the national GHG inventory delivering important data and information for RAN-GRK implementation.

The RAN-GRK is a working document that provides the foundation for various ministries, institutions and local governments to implement mitigation action.

The purpose of RAN-GRK is twofold: providing an overview of the national potential for mitigation actions, and initiating the design of programmes and actions to reduce emissions.

RAN-GRK aims to provide guidance for concrete actions needed to reach the 26-41% ER target by 2020, in five predefined sectors:

Table 1: Indonesia's GHG ER Targets by Sector

Sector	Emission Reduction ($GtCO_{2eq}$)		Action Plan	Institutions
	26%	+ 15%		
Forestry & Peat Land	0.672	0.367	Forest and land fire control, network system and water management, RHL (forest and land rehabilitation), HTI (Industrial Plantation Forest), HR (Community Forest), Illegal logging eradication, Deforestation prevention, Community empowerment	MoEF, MoPW, MoA, Ministry of Environment and Forestry, Ministry of Public Works, Ministry of Agriculture
Agriculture	0.008	0.003	Introduction of low-emission paddy varieties, efficient irrigation water management, organic fertilizer use	MoA, MoPW, MoEF
Energy & Transport	0.038	0.018	Bio-fuel use, engines with higher fuel efficiency standard, improvement in TDM (Transportation Demand Management), quality of public transport and roads, demand side management, energy efficiency, (EE) renewable energy (RE) development	MoT, MEMR, MoPW Ministry of Transport, Ministry of Energy and Mineral Resources
Industry	0.001	0.004	EE, use of RE, cement process improvement, etc.	MoI Ministry of Industry
Waste	0.048	0.030	Use of landfill gas, waste management by 3R (reduce reuse recycle) and urban integrated waste water management	MoPW, MoEF
TOTAL	**0.767**	**0.422**		

Source: "Guideline for Implementing Greenhouse Gas Emission Reduction Action Plan", Bappenas, 2013[8]

[8] http://ranradgrk.bappenas.go.id/rangrk/images/documents/Buku_Pedoman_Pelaksanaan_Rencana_Aksi_Penurunan_Emisi_GRK_English.pdf

RAN-GRK Analysis

All mitigation activities conducted under the APEC LCMT Bitung will support the implementation of the RAN-GRK and will contribute to achieving Indonesian's national ER target.

The RAN-GRK target sector categorisation is very similar to the one applied in this feasibility study (elaborated under section 2.2) and facilitates a detailed sectoral contribution through the LCMT project in Bitung. This study will also develop a Monitoring, Reporting & Verification (MRV) concept in line with RAN-GRK MRV requirements to allow for a transparent, accurate and effective flow of data and information from the SEZ Bitung to the city, provincial and national levels.

2.1.3.1.2.4 National Energy Policies

Energy is one of the primary drivers of national economic development, with significant fossil fuel based resources and abundant RE. The share of primary energy in the national energy mix is shifting from oil to coal and natural gas. At the same time, diversification to new and RE (*Energi Baru Terbarukan, EBT*) such as geothermal, hydropower, biomass and others is increased. In addition, the overall energy infrastructure shall be improved. These plans are included in Ministry of Energy and Mineral Resources' National Energy Management (*Pengelolaan Energi Nasional, PEN*) Blueprint 2010-2025. The Government Regulation 79 / 2014 (replacing the President Regulation 5 / 2006) on the National Energy Policy (*Kebijakan Energi Nasional, KEN*) serves as the basis of the National Energy Master Plan (*Rencana Umum Energi Nasional, RUEN*). The President Regulation 1 / 2014 on the Guidance for National Energy Master Plan Development would also be implemented, as the RUEN is currently under development. The Indonesia Renewable Energy Policy needs to be adapted to the upcoming RUEN, in line with the new KEN (2014). The National Energy Policy on Article 9 stipulated Indonesia Energy Mix target with increasing share of New and RE up to 23% (by 2025) and 31% (by 2050) of total primary energy resources utilisation.

The Ministry of Energy and Mineral Resources (MEMR), Directorate General of the New and Renewable Energy and Energy Conservation (DGNREEC), in 2013 put priority for the Indonesian RE development on geothermal, hydropower, bioenergy and solar. A master plan study for geothermal power development in August 2007 (WestJEC), together with another master plan study for hydropower development in August 2011 (Nippon Koei), were provided to the Ministry of Energy and Mineral Resources. However, the RE target stated in the National Energy Policy (2006) has since been revised upwards from 17% to 23% of total primary energy resources utilisation in the latest revision of the National Energy Policy (2014).

On the other hand, the National Energy Conservation Master Plan (*Rencana Induk Konservasi Energi Nasional, RIKEN*) aims to achieve Indonesia's energy saving potential through EE and conservation measures, avoiding wasteful energy use practices. RIKEN also identified individual sectoral energy saving potentials, e.g. 15-30% in industry, 25% in commercial buildings for electricity, and 10-30% in the household sector.

The National Energy Policy also provides a set of very specific indicators, baselines and targets as expressed below.

Table 2: National Energy Policy 2014 Indicators, Baseline and Targets

Indicators	Baseline	Target	
		2025	2050
Access for the primary energy supply	190 MTOE (2013)[9]	400 MTOE	1000 MTOE
Utilization of the primary energy per capita	0.467 TOE (2014)[10]	1.4 t	3.2 t
Power generating capacity supply	55.7 GW (2015)[11]	115 GW	430 GW
Utilization of electricity per capita	843 kWh (2014)[12]	2,500 kWh	7,000 kWH
Energy elasticity	>1	< 1	-
Reduction in final energy intensity	-	1%	-
Electrification ratio	85% (2015)	100% (2020)	-
RE share in total energy consumption	8%(2013)[13]	23%	31%
Oil share in total energy consumption	44% (2013)[14]	25%	20%

Source: Ministry of Energy and Mineral Resources, 2014

Analysis of National Energy Policies

All described national energy policies above build the framework for energy related activities under the LCMT project. The use of RE sources, the improvement of EE in different sectors and the electricity outreach and grid stability are all sustainability principles applied under this study and the LCMT will contribute to national energy targets and the energy development plan of Indonesia.

2.1.3.2 Provincial Policies

2.1.3.2.1 Medium Term Regional Development Plan (Rencana Pembangunan Jangka Menengah Daerah, RPJMD Provinsi Sulawesi Utara)

The Regional Medium Term Development Plan (*Rencana Pembangunan Jangka Menenga Daerahh, RPJMD)* is a guideline, which contains the provincial vision, mission, and priorities of regional development and implementation phases over five years.

RPJMD Analysis

In order to realise the targets and visions of the RPJMD, a variety of efforts focussed on strengthening the surrounding areas of the SEZ in North Sulawesi through land preparation and infrastructure support have been undertaken. As a result, the SEZ Bitung was categorised as a priority in the provincial RPJMD. The RPJMD North Sulawesi 2010 – 2015 (subsequently revised in 2014) describes the SEZ Bitung initiative. Upon adoption by the newly elected Governor in December 2015, the next RPJMD 2016 – 2020 will become official and provide the level of support required for SEZ Bitung development.

[9] Dewan Energi Nasional. “Outlook Energi Indonesia 2014” (http://energynusantara.com/wp-content/uploads/2011/10/paparan-Outlook-Energi-Nasional-2014-.pdf)
[10] Kompasiana, dated 25 Nov 2014 (http://www.kompasiana.com/mulyady1688/10-peringkat-indonesia-di-dunia_54f934b0a333112c048b4a1a)
[11] Kementrian Energi dan SUmber Daya Mineral Direktorat Jenderal Ketenagalistrikan (http://kiosk.djk.esdm.go.id/index.php/view/19/rencana-kapasitas-pembangkit)
[12] Kompas.com, dated 23 Nov 2014 (http://www.kompasiana.com/mulyady1688/10-peringkat-indonesia-di-dunia_54f934b0a333112c048b4a1a)
[13] Idem as footnote 11
[14] Idem as footnote 11

Table 3: RPJMD North Sulawesi in relation to SEZ Bitung

Mission	Purpose	Output
Mission V: Empowering businesses at the global, regional, and local levels based on the development of Micro, Small and Medium Enterprises (SMEs) and cooperatives	Improve local economy	Establishment of SEZ and supporting areas
Mission VIII: Realising North Sulawesi as the Indonesia Gateway to East Asia and the Pacific	Setting up SEZ Bitung	The creation of the location of SEZ

Source: Own elaboration

2.1.3.2.2 North Sulawesi Province Spatial Planning (Rencana Tata Ruang Wilayah Provinsi, RTRWP)

The North Sulawesi Province Spatial Planning (RTRWP) is based on the National Spatial Planning (RTRW) and ensures spatial planning implementation at the provincial level. The RTRWP has identified the Manado – Bitung economic development region as a priority area, which includes the marine processing, industrial and mining sectors.

RTRWP Analysis

The North Sulawesi Province Spatial Plan (*Rencana Tata Ruang Wilayah Provinsi, RTRWP*) includes the SEZ Bitung area in its Industrial Corridor planning (Bitung – Kema – Airmadidi). Furthermore, the Bitung City Spatial Plan (*2010 – 2030 Rencana Tata Ruang Wilayah Kota, RTRWK*) designated the Matuari District for industrial area development, and Ranowulu District for housing area development (to support SEZ Bitung).

2.1.3.2.3 North Sulawesi Province Action Plan for GHG Emissions Reduction (RAD-GRK)

In order to adjust national and sectoral policies and instruments originating from RAN-GRK, the Provincial government developed a provincial action plan for GHG ER (Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca – RAD-GRK).

The RAD-GRK is to be used in conjunction with the RAN-GRK to improve coherence between the sub-national and national levels, especially with regards to data relevant to GHG inventories and emissions scenarios. The RAN-/RAD-GRK target actions by the following sectors: agricultural, forestry and peat land, energy and transportation, industrial, and waste management.

The RAD-GRK considers the following steps: calculation of GHG inventory and of a provincial multi-sectoral BAU baseline; identification and selection of mitigation action; development of mitigation scenarios according to selected and prioritised GHG mitigation actions in line with their local development priorities and plans; identification of key stakeholders / institutions and financial resources.

Government Regulation 323 / 2012 (dated 14 December 2012) on RAD-GRK North Sulawesi Province put the responsibility for RAD-GRK Monitoring, Reporting & Evaluation (Pemantauan Evaluasi Pelaporan - PEP) reporting procedures on the North Sulawesi Regional Development Planning Agency (Bappeda). Responsible for the overall coordination of the implementation of GHG mitigation measures and PEP data collection, the North Sulawesi Bappeda is to provide PEP reports to the RAN-GRK Secretariat at Bappenas, the Ministry of Domestic Affairs and the Ministry of Environment and Forestry (MoEF). To date, the periodic reporting of the North Sulawesi RAD-GRK progress has not been fully completed.

RAD-GRK Analysis

The LCMT concept in SEZ Bitung aims to enable low carbon development by targeting the energy management, transport and traffic management, solid waste and wastewater management, industrial process and land use sectors which align with RAD-GRK and expected GHG emissions reduction.

In establishing sectoral GHG ER goals and also by identifying measures within each sector in the LCMT concept, the initial impacts of the long-term plan can be demonstrated, contributing to the North Sulawesi GHG ER target.

2.1.3.3 City-level Policies

2.1.3.3.1 Bitung City Development Strategy (Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung)

Similar to North Sulawesi Province's RPJMD, the RPJMD for Bitung City is a guideline, which contains the city level vision, mission, and priorities of city development and implementation phases over five years.

RPJMD (City Level) Analysis

The Bitung City development strategy currently covers the period of 2011 – 2015 Upon adoption by the newly elected Mayor of Bitung City in December 2015, the next period of RPJM-D 2016 – 2020 will incorporate and provide support for the SEZ Bitung development.

The RPJMD Bitung 2011-2015 is outlined in the annual City Government Work Plan and represents a guideline for each Government Unit in drafting the strategic plan, work plan and budget plan. The LCMT concept in SEZ Bitung should be in line and integrated with the RPJMD Bitung work plan.

2.1.3.3.2 Bitung Detailed City Planning (Rencana Detail Tata Ruang, RDTR Kota Bitung)

The office of Spatial Planning (*SKPD Dinas Tata Ruang*) has completed the Bitung Detailed City Planning (Rencana Detail Tata Ruang – RDTR Kota Bitung) for the SEZ Bitung which is located in the Matuari District. A detailed spatial plan for each District and Village in Bitung covers:

- Structural analysis for the area planning,
- Area designation analysis for the block planning,
- Transport infrastructure analysis,
- Service facility analysis,
- Public utility analysis,
- Spatial envelope analysis, and
- Institutional and community participation analysis.

The RDTR Bitung adopted RTRWK Bitung, designating Matuari District for industrial area development, and Ranowulu District for housing area development (to support the SEZ Bitung). Detailed maps for each specific district area (Matuari and Ranowulu) are provided in the RDTR Bitung, on each part of the assessment (land use structure, transport infrastructure, public utility and services, etc.)

2.1.3.3.3 City Government Work Plan (Rencana Kerja Pemerintah Daerah, RKPD Kota Bitung)

The Bitung City Government Work Plan (Rencana Kerja Pemerintah Daerah – RKPD Kota Bitung) documents outline the following:

- Background information, legal basis, and the correlation with other planning documents, as well as its purpose,
- Evaluation of previous year RKPD Bitung implementation, and the City Government performance,
- Draft regional economic framework and financial policies,
- Regional development priorities and targets, and

- Regional Plan programs and priority activities.

The annual City Government work plan (RKPD), which is based on the five-year period of the Bitung City Development Strategy (RPJMD), is continuously updated.

Analysis RKPD

The upcoming 2016 – 2020 Bitung City Development Strategy (RPJMD Kota Bitung) should adopt the SEZ Bitung concept, to be implemented by the City Government. The detailed approach for developing the SEZ Bitung area should be described on an annual basis, starting from the 2016 RKPD document.

2.1.3.4 SEZ Policies

2.1.3.4.1 SEZ Masterplan 2008

The Ministry of Industry (MoI) has provided support for the SEZ Bitung Masterplan development from 2008 onwards. The SEZ Bitung master plan output is the conception of an integrated industrial park that is organised based on core competency areas, corresponding to spatial and environmental requirements. The work was completed in 2013 / 2014, for a total area of 534 ha. Currently, Bitung City Government has designated a 92 ha area to proceed with for Stage 1 of the SEZ Bitung development.

Initially, planning in the industrial park is focussed on the development of three categories (heavy, medium, and light industry zones). In addition to the industrial zone, there are other areas for commercial and office buildings. A retail centre and ample green open space will also be provided.

Figure 12: General Layout, Industrial Park Master Plan

The stages of the SEZ Bitung development associated with land development include land acquisition and land clearing. Land for the SEZ Bitung will be gradually acquired. In the early stages, the local government is utilising the existing readily available land area of 92 ha. Land acquisition from the local community will be required for remaining areas.

The development of SEZ Bitung will be carried out in five stages:

Table 4: SEZ Development Stages

	
Year: 2017 - 2019 Main Focus: • Basic Infrastructure Development • First residential, commercial and industrial activities	**Year: 2020-2021** Main Focus: • Improvement and expansion of basic infrastructure and support facilities • Expansion of residential, commercial and industry development
	
Year: 2022-2023 Main Focus: • Development of education and training facilities	**Year: 2024-2028** Main Focus: • Development of recreational areas • Further expansion of residential and industrial areas
	**Year: 2029-2031** Main Focus: • Further expansion of industrial areas

Source: Own elaboration

Phase 1 of the SEZ Bitung Development will focus on the construction of the basic area infrastructure for a total land coverage of 114.96 ha. This includes the development of the main road infrastructure, basic support utilities such as water access, electricity access to the PLN power grid & basic waste management infrastructure, as well as land plot preparation for the industrial, commercial and residential sector. First industrial and housing activities are expected to start during phase 1. All selected LCMs should be initiated in this first phase, varying in their individual scopes depending on the main purpose of the phase.

Phase 2 of the SEZ Bitung Development will focus on the expansion of industrial land plots, and improving and progressing commercial support facilities. Phase 2 will also mark the beginning of housing development and further expansion of roads, electricity and water connections to individual land plots. This SEZ development phase will cover a rather small area of 43 ha in total.

The third SEZ Bitung development phase will focus on the further enhancement of commercial and support facilities such as education and training facilities. In addition, residential and commercial sector developments will continue. No further industry development is expected in this phase. This phase will focus on a total land area of 46ha.

The fourth development phase aims mainly to advance the construction and development of residential and recreation areas for the SEZ Bitung. Furthermore, basic infrastructure and support facilities will be expanded in order to provide access to the additional development area of 216 ha. Additional industrial actors are expected to begin operations, enhancing the overall amount of industrial activities during this 5-year long development phase.

The fifth and last phase of the SEZ Bitung Development will focus on the completion of all infrastructure developments for the residential, commercial and industry sector as well as for all supporting facilities. Medium and large size industry expansion is expected to be at the core of this phase. The total land development area consists of 114.04 ha, finalizing the development of the envisioned 534 ha SEZ Bitung area.

SEZ Masterplan Analysis

The SEZ Masterplan 2008 is the only officially endorsed development plan for the SEZ area and represents the main reference for the Bitung LCMT development.

2.1.3.4.2 Study on the revision of the the SEZ Bitung Masterplan, Inception Report (Korea – Indonesia partnership)

A Memorandum of Understanding (MoU) has been signed between the Coordinating Ministry for Economy of Republic of Indonesia and the Ministry of Land, Infrastructure and Transport of the Republic of Korea for technical support in relation to the establishment of the Masterplan for SEZ Bitung.

The objective of the project is to establish an implementable SEZ promotion plan. Procedures performed for the project are development condition assessment (in-site survey and data collection), determination of development conditions and indicators (review of existing master plan, survey and analysis of demand), master plan establishment (development concept, land use plan, traffic system plan, park and green area plan, supply processing plan, and planning stages) and plan for revitalisation of the SEZ Bitung.

With a total land area of 534 ha, potential tenant companies of the SEZ Bitung include industry and logistics, which can be divided into three main business sectors: (i) Fishery processing industry (fresh fish processing, canning), (ii) plantation products processing (vegetable oil, coconut processing) and industrial plants, and (iii) logistics (packaging, inspection services, container and warehousing).

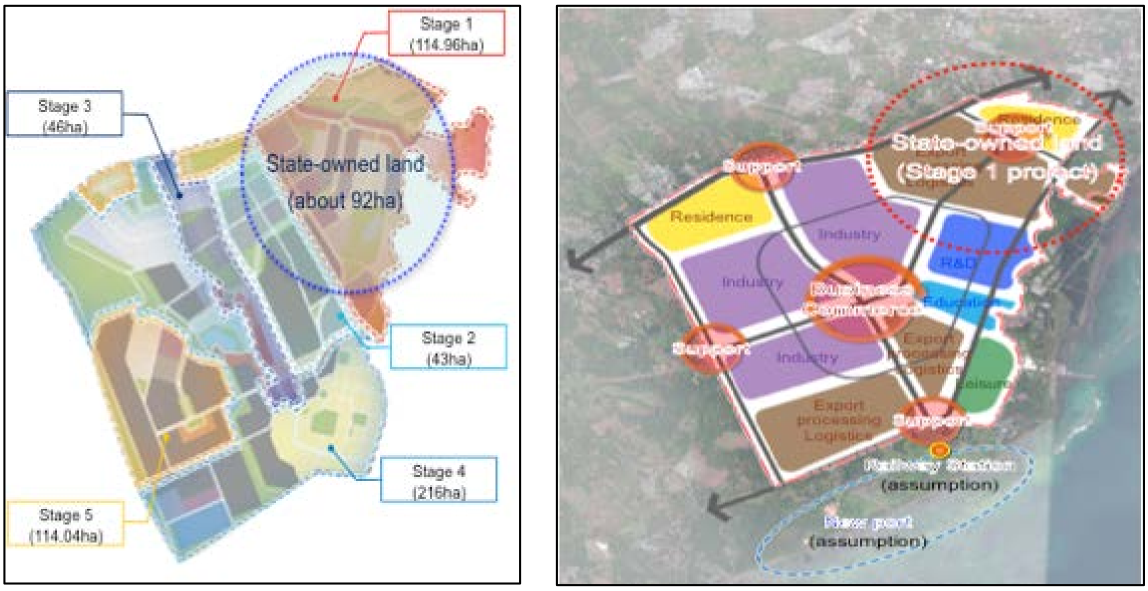


Figure 13: Phased Plan of SEZ Bitung 534 ha site

Analysis on SEZ Masterplan Revision Study

Since the study is still ongoing and no officially endorsed results have been presented, this study could not be considered for the Bitung LCMT planning. However, progress of the study will be continuously monitored so that any potentially relevant and useful information for the urban LCDS is accounted for and included in the analysis.

2.1.3.4.3 Study on SEZ Bitung Expansion (2,000 ha)

In view of the potential expansion of SEZ Bitung, the MoI has also initiated works on a 2,000 ha Masterplan (covering the 534 ha of Bitung City area, and an additional of 1,500 hectare area in the North Minahasa Regency). Some of the concepts that form the basis for the development of the SEZ Bitung 2000 ha area are, among others, environmental sustainability, an innovative city concept, the separation of Industrial Zones and public facilities with green open space, local economic and incentive framework development. Further, it is predicted that the SEZ Bitung of 2000 ha will have a major impact on import and export growth and help to strengthen and develop new industry.

The master plan for the 2,000 ha SEZ Bitung will be developed in five stages: Phase I Processing zone (512 ha), Phase II Green open space and supporting industry, Phase III Logistic zone including reclamation (22 ha), Phase IV Industrial zone and Phase V Processing zone.

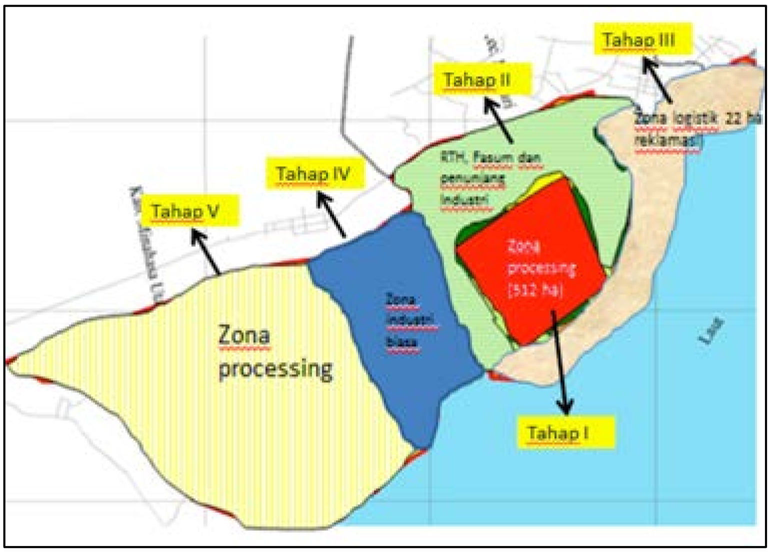


Figure 14: Development Stages of SEZ Bitung 2,000 ha area

Analysis of the MoI Study on SEZ Bitung Expansion

The potential expansion study is based on the SEZ Masterplan 2008 and focuses on its expansion. The LCMT project area comprises only the 534h as outlined in the SEZ Masterplan 2008. Therefore, the potential SEZ expansion has not been considered under the scope of the LCMT project.

2.1.3.4.4 Feasibility Study on SEZ Expansion (2,000 ha, China – Indonesia partnership)

In collaboration with the Provincial government of North Sulawesi, the China Communication Construction Company Limited (CCCC) is working on a feasibility study for the SEZ Bitung. The two main activities carried out by the CCCC consist of (i) developing a general plan of the SEZ Bitung and North Minahasa, North Sulawesi which covers 2,000 ha, and (ii) developing a feasibility study for a new port in the SEZ.

The overall layout for land use under the general Masterplan, covering development of the SEZ 2,000 ha area in Bitung and North Minahasa, is provided below.

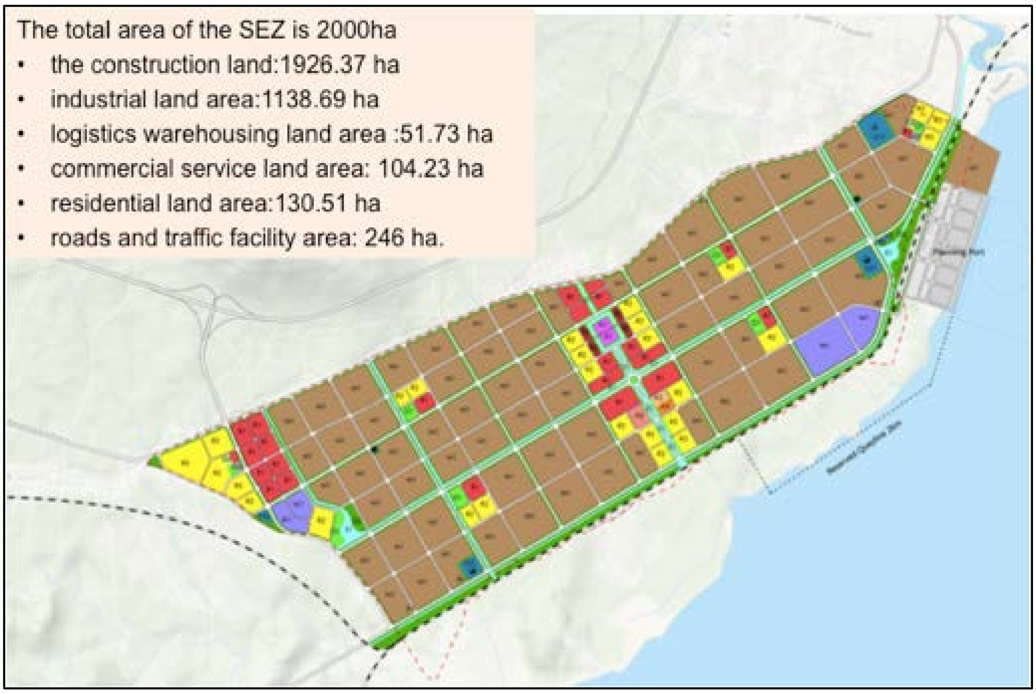


Figure 15: Overall Layout for the SEZ Bitung 2,000 ha area

Implementation of the Bitung SEZ expansion will be divided into four phases. Phase I, implementation of SEZ in 128.61 ha including 37.5 ha of harbour area, fishing processing and food industry, and two terminals. Phase 2, SEZ development for industry, public service facilities and municipal facilities in 658.55 ha. Phase 3, SEZ development for daily-use and light industry, manufacturing, retail and logistics services in 844.19 ha. Lastly, Phase 4 for small-scale mechanical and electrical equipment, metal hardware components and other light transport equipment services and two Terminals in 509.15 ha.

A feasibility study analysed the necessity of the new port. It found that the new port has become an indispensable part of the SEZ and is the most important means of transportation of raw materials and products from the SEZ. It will accelerate development of the logistics industry and act as a gateway to drive regional economic development and enhance trade relationships with other countries and APEC member economies. Further specific study, scientific research and test work will be carried out for future activities to better understand the port's impact on economic development.

Analysis of the Feasibility Study on the SEZ Expansion

Since the study is still ongoing and no officially endorsed results have been presented, this study could not be considered for the Bitung LCMT planning. However, progress of the study will be continuously monitored so that any potentially relevant and useful information for the urban LCDS is accounted for and included in the analysis.

2.1.3.5 Institutional Landscape

2.1.3.5.1 Overview of the institutional landscape

Following is an overview of the key institutional actors relevant to the LCMT Bitung development in Indonesia.

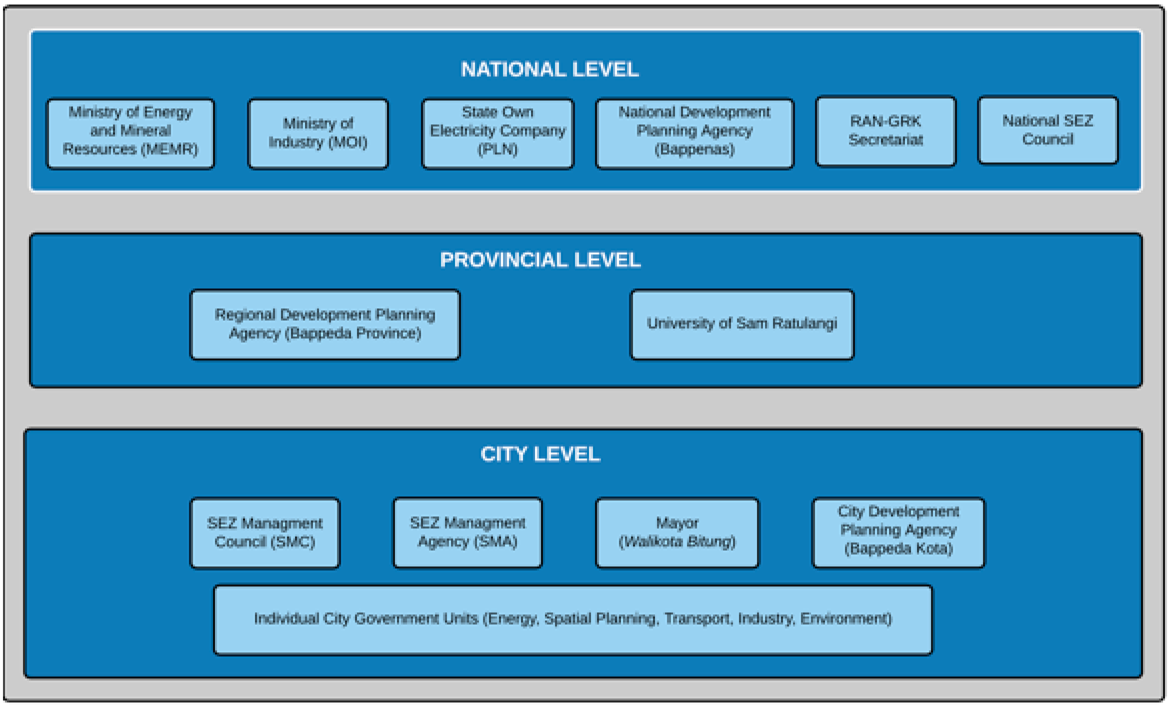


Figure 16: Overview of LCMT Institutional Landscape

2.1.3.5.2 National Level

2.1.3.5.2.1 Ministry of Energy and Mineral Resources[15] (MEMR)

The Ministry of Energy and Mineral Resources (MEMR) introduced SEZ Bitung at the meeting of the 47th Meeting of the APEC Energy Working Group (APEC EWG 2014) in Kun Ming, China, as an LCMT.

The MEMR's cooperation with the APEC Energy Working Group (EWG) is managed by the Directorate of Energy Conservation (Directorate General of New and Renewable Energy and Energy Conservation, DGNREEC).

2.1.3.5.2.2 Ministry of Industry (MoI)

One of MoI's programmes is the development of special economic zones in Palu and Bitung, through the Government Regulation 32 / 2014 on SEZ Bitung. As a follow up to this programme, the MoI prepared the SEZ Masterplan 2008 for the infrastructure development of the SEZ Bitung.

2.1.3.5.2.3 National Electricity Company[16] (Perusahaan Listrk Negara, PLN)

PLN is the sole public utility and the main power generation company in the country. Under Government Regulation 17 / 1972 on the National Electricity Company Establishment, the PLN is responsible for provide electricity to meet public needs.

[15] http://www.esdm.go.id/index-en.html
[16] http://www.pln.co.id/eng/

With the assignment of SEZ Bitung, the PLN North Sulawesi office is to provide the electricity supply for the proposed industrial facilities in the new area. With the expected development of industry in SEZ Bitung over the coming years, PLN North Sulawesi is currently exploring the feasibility of several types of electricity power plants to be connected to the main North Sulawesi power grid.

2.1.3.5.2.4 National Planning Agency[17] (Bappenas)

The National Planning Agency (Bappenas) is responsible for development and coordination of the National Development Strategy (both Long-Term RPJPN and Medium-Term RPJMN).

Hosting the National Centre for the coordination of the National Action Plan for GHG Emissions Mitigation (Secretariat RAN-GRK), it improves the accessibility of information and technical assistance related to RAN-GRK. The RAN-GRK Secretariat[18] manages periodic RAD-GRK reports from 34 Provinces in Indonesia. The Monitoring Reporting Evaluation (Pemantauan Evaluasi Pelaporan, PEP) procedure developed by Bappenas is a document that briefly explained the institutional arrangement, monitoring, evaluation and reporting mechanism, and reporting matrix.

2.1.3.5.3 Provincial Level

2.1.3.5.3.1 Regional Planning Agency[19] (Bappeda Sulut) North Sulawesi Province

As the regional office of Bappenas, North Sulawesi Bappeda is responsible for the production of a range of development programmes, such as the North Sulawesi Provincial Development Strategy (RPJM-D, every five years), the Government Workplan (RKPD, annually), the Provincial Spatial Planning (RTRW-P) and other development policy and budget allocations at the Province level.

The North Sulawesi Bappeda is responsible for RAD-GRK PEP reporting procedures and manages the overall coordination of the implementation of GHG mitigation measures and PEP data collection. The North Sulawesi Province PEP reports are provided to the Bappenas (RAN-GRK Secretariat), Ministry of Domestic Affairs and the Ministry of Environment and Forestry (MoE&F).

The North Sulawesi Bappeda prepared the Bitung LCMT nomination proposal in 2014 in order to promote LCMT development in SEZ Bitung. The APEC selection team visited North Sulawesi and Bitung in 2014 and 2015, in coordination with the APEC EWG (Ministry of Energy and Mineral Resources, Directorate of Energy Conservation), to assess Bitung for the Phase-5 LCMT development.

2.1.3.5.3.2 Academic Institutions

The University of Sam Ratulangi (Unsrat) has undertaken several studies and planning exercises on the SEZ Bitung development since 2008. Currently, a number of Unsrat academic staff are also involved in the SEZ Bitung Council management.

2.1.3.5.4 City Level

2.1.3.5.4.1 National and Local SEZ Management Council[20]

The National SEZ Management Council was established in 2010, upon the President Decree 8 / 2010 on the National SEZ Council. The Coordinating Ministry of Economics serves as the Head of National SEZ Council, and several line Ministers are SEZ Council Members (MoF, MoTrade, MoI, MoIA, MoPW, MoT, MoM, Bappenas, BKPM).

SEZ Bitung designation was approved by the Government Regulation 32 / 2014 on SEZ Bitung. Subsequently, the local SEZ Management Council (SMC) was established in 2014, upon the President Decree 34 / 2014 on the North Sulawesi Special Economic Zone Council. Officially, the Head of the local SEZ Management Council is the Governor of North Sulawesi, and the Deputy is

[17] http://www.bappenas.go.id/
[18] http://ranradgrk.bappenas.go.id/rangrk/english
[19] http://bappeda.sulutprov.go.id/
[20] http://kek.ekon.go.id/en/

the Bitung City Mayor. Currently, the Head of the North Sulawesi Office for Industry serves as the Council Executive (Administrator) to manage daily activities. The local SEZ Management Board is temporarily led by the Academic staff of Unsrat.

The main purpose of the SMC is to oversee the development of SEZ Bitung. In this role, this institution will play a very important part in the planning and implementation of the low carbon strategy developed in this study. A detailed description and the envisioned future role of the SMC will be discussed within the implementation roadmap (see 4.2.1).

It is expected that by 2016, a Province-Government Owned Company will be in charge of a SEZ Bitung Management Committee. A detailed work description for PT Sulut Membangun is not currently available.

2.1.3.5.4.2 SEZ Management Agency

The SEZ Management Agency (SMA) is currently under development and is expected to start operations in 2017. The SMA is planned to serve as a one-stop service institution and as operational arm of the SMC in regard to the overall development of the SEZ Bitung. For the implementation of the SEZ Bitung LCDS this institution will be crucial as it will be responsible for the actual implementation of low carbon activities and will serve as focal point for all facilities to operate within the SEZ. A detailed description and the envisioned future role of the SMA will be discussed within the implementation roadmap (see 4.2.1).

2.1.3.5.4.3 Government of Bitung City (Walikota Bitung)

The government of Bitung City oversees the development of the SEZ Bitung and the LCMT initiative, with several Bitung City government stakeholders involved.

Governmental units on city level (SKPDs) will be involved in the SEZ Bitung development process. A number of licenses or permits to be issued by each SKPD will be required for private sector investment in SEZ Bitung. Some of the most relevant government units on Bitung City level include: The City Development Planning Agency[21] (Bappeda Bitung), SKPD Energy, SKPD Transport, SKPD Health, SKPD Industry, SKPD Environment and SKPD Public Works.

2.2 Emission Baselines and Business-As-Usual (BAU) Scenarios

Successful planning for future climate and sectoral developments will depend on an accurate understanding of current and future trends in GHG emissions. As such, the present section reviews the methodology and approach, which have been used in this study to determine: 1) the GHG emission baseline; and, 2) the GHG emissions BAU scenarios. The approach employed details many aspects of the project such as the project boundaries, the scope of emissions, the targeted sectors and any existing data gaps.

The GHG emissions baseline aims to provide a reference scenario, which will determine the past and present context in terms of GHG emissions in the study area. Generally, the most important among these scenarios is the baseline set to characterise future emissions, based on the assumption that no new climate change policies or measures will be adopted. In this regard, this section provides a calculation of the GHG emission baseline and sets out the impacts associated to each targeted sector by taking into account the local context and the selected timeframe of 2010 to 2016.

BAU scenarios for GHG emissions provide future GHG emissions levels in the absence of future, additional mitigation efforts and policies for a specific timeframe and area. In the context of the SEZ Bitung the BAU scenario has been determined according to the impacts associated with each of the target sectors and by taking into account the local context and the selected timeframe of 2017 to 2031.

This section therefore defines and establishes the current state and future trends of GHG emissions in the SEZ Bitung.

[21] http://bappedakotabitung.blogspot.com/

2.2.1 Individual Target Sector GHG Emission Baselines

2.2.1.1 Approach and Methodology

As the SEZ Bitung is a Greenfield Development, i.e. no advanced infrastructure exists yet, a top-down approach to calculate the GHG emissions baseline and the BAU scenarios has been applied. Data collection has focussed on available data from local and provincial level sources to determine historical and actual macroeconomic indicators including: Gross Domestic Product (GDP), sectoral GDP, population, and energy intensity, etc. Moreover, specific efforts have been made to gather the most accurate local indicators (primary data) in the study area, so that there exists a bottom-up approach, which can complement the previous analysis carried out. One of the main challenges faced is the identification of the most suitable information among a mix of sources at different levels, specifically targeting the SEZ Bitung. In view of this, current development plans and strategies have been reviewed at the national, provincial and local levels to ensure that the whole range of initiatives that could potentially affect Bitung - and especially the SEZ - are taken into account.

The GHG emission baseline has been assessed according to the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)[22], one of the most recognised and accepted standards worldwide in terms of evaluating GHG emissions in cities (WRI, ICLEI, C40). The GPC is based on the IPPC Guidelines for National Greenhouse Gas Inventories[23].

Whilst no GHG inventory has been developed for the city of Bitung to-date, this study has taken into account an existing GHG emission assessment carried out for the province of North Sulawesi.

The following steps were undertaken in order to determine the GHG emission baseline:

- **Selection of the GHG emission base year**

According to the scope of the study, the SEZ is a Greenfield Development, which is going to be implemented in Bitung as an expanded area of the city. Consequently, the selection of the GHG emission base year will depend on the construction year of the SEZ. Based on the SEZ Bitung Master Plan the base year has been set to 2016.

- **Definition of the project boundaries**

The GHG emissions assessment is focussed on the geographical area defined by the SEZ Master Plan, which consists of a total of 534 ha alongside the city of Bitung. The SEZ is located in the south western side of Bitung City and is 9 km away from the Bitung's port and 30 km away from Manado.

[22] Greenhouse Gas Protocol (2014). Retrieved from: http://www.ghgprotocol.org/city-accounting
[23] 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Retrieved from: http://www.ipcc-nggip.iges.or.jp/public/2006gl/

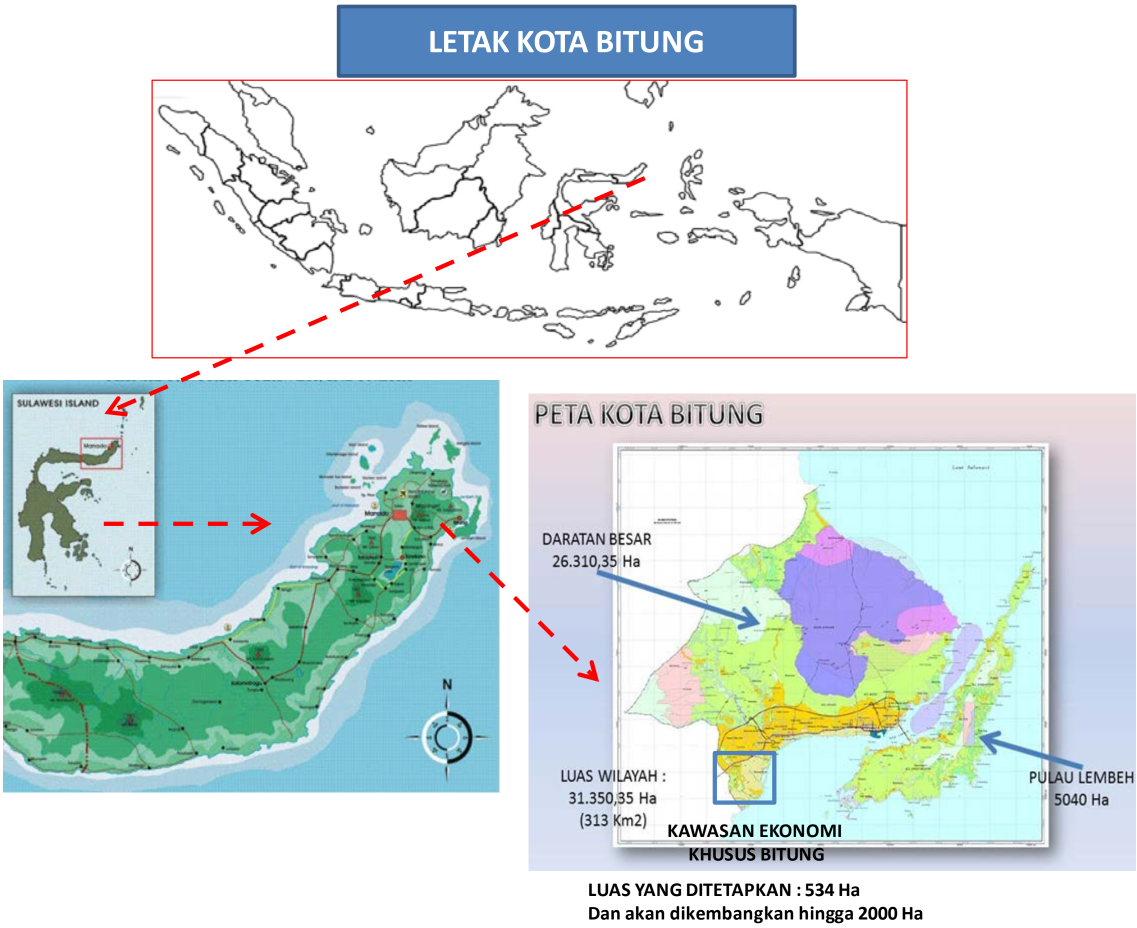


Figure 17: SEZ Bitung Location Map

- **Scope of the GHG emissions assessed**

The GHG emissions accounted for in the assessment include: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Furthermore, GHG emissions have also been assessed according to the scope: Scope 1 (direct emissions), Scope 2 (indirect emissions) and Scope 3 (other indirect emissions).

Table 5 and Figure 18 provide a breakdown of the different emission sources, an explanation of the types of emission sources according to their scope and the GHG emission boundaries within a city.

Table 5: Scopes Definition for City Boundaries

Scope	Definition	Emissions sources by type
Scope 1	GHG emissions from sources located within the city boundary	AFOLU, stationary fuel consumption, in-boundary waste and wastewater, IPPU, in-boundary transportation
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary	Grip-supplied energy (electricity, heat, steam and/or cooling)
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary	Out-of-boundary waste and wastewater, transmission and distribution losses, out-of-boundary transportation, other indirect emissions

Source: Adapted from Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)

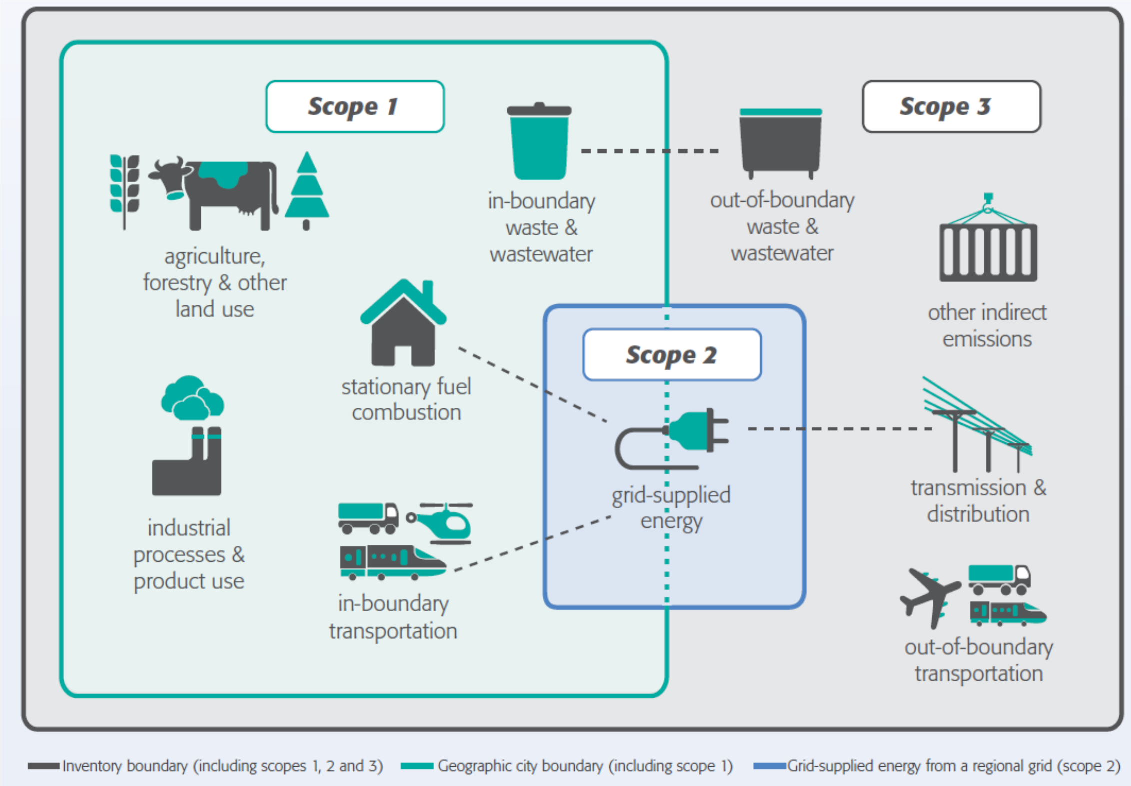


Figure 18: Sources, Scope and Boundaries of City GHG Emissions (Source: GPC)

Table 6 illustrates the Global Warming Potential (GWP) for each GHG, which is used to calculate the tonnes of Carbon Dioxide Equivalent (tCO_2e[24]).

Table 6: List of GHG Emission GWP

GWP (100 years)		
CO_2	CH_4	N_2O
kg CO_2e/kg CO_2	kg CO_2e/kg CH_4	kg CO_2e/kg N_2O
1	25	298

Source: 4th Assessment Report (AR), IPCC, 2007

- **Selection of the target sectors**

APEC Guidelines[25] classify the identified measures associated with the LCMT concept into 12 different categories. However, these measures will be categorised in accordance with the classification set in the GPC standard and appropriately assigned to the SEZ Bitung study (refer to mapping in Table 7). This approach aims to ensure that coherent and standardised data is used for the assessment of the GHG emissions baseline and the BAU scenarios, and that this data is based on an international recognised protocol.

Table 7 describes the allocation of APEC sector categorisations into GPC categories and SEZ Bitung categories.

[24] tCO_2e is the internationally standardised and comparable unit of measurement used to evaluate the impacts of climate change in terms of emissions.
[25] Source: The Concept of the Low-Carbon Town in the APEC region, Fourth Edition, November 2014.

Table 7: Low Carbon Sector Categorisation

APEC Guidelines Categories	GPC Categories		LCMT SEZ Bitung Categories	
	Sector	Sub-sector	Sector	Sub-sector
Town structures	TRANSPORTATION	-	TRANSPORTATION	-
Buildings	STATIONARY ENERGY	Residential buildings	ENERGY	Residential
	STATIONARY ENERGY	Commercial and institutional buildings and facilities	ENERGY	Commercial
	STATIONARY ENERGY	Manufacturing industries and construction	ENERGY	Industry
Energy Management Systems	STATIONARY ENERGY	Residential buildings	ENERGY	Energy management
	STATIONARY ENERGY	Commercial and institutional buildings and facilities		
	STATIONARY ENERGY	Manufacturing industries and construction		
Transportation	TRANSPORTATION	On-road	TRANSPORTATION	On-road
		Railways		Railways
		Waterborne navigation		Waterborne navigation
		Aviation		Aviation
		Off-road		Off-road
Area Energy Network	STATIONARY ENERGY	Manufacturing industries and construction, Energy industries	ENERGY	Industry
Untapped Energy	STATIONARY ENERGY	Manufacturing industries and construction	ENERGY	Industry
Renewable Energy	STATIONARY ENERGY	Energy industries	ENERGY	Energy generation
Smart Grid System	STATIONARY ENERGY	Commercial and institutional buildings and facilities	ENERGY	Energy management
	STATIONARY ENERGY	Manufacturing industries and construction		
Smart Energy System	STATIONARY ENERGY	Residential buildings	ENERGY	Energy management
	STATIONARY ENERGY	Commercial and institutional buildings and facilities		
	STATIONARY ENERGY	Manufacturing industries and construction		

APEC Guidelines Categories	GPC Categories		LCMT SEZ Bitung Categories	
	Sector	Sub-sector	Sector	Sub-sector
Water Treatment	WASTE	Wastewater treatment and discharge	WASTE	Wastewater treatment and discharge
Solid Waste Management	WASTE	Solid waste disposal	WASTE	Solid waste disposal
	WASTE	Incineration and open burning	WASTE	Incineration and open burning
Greenery	AFOLU	Land	AFOLU	Land
		Livestock		Livestock
		Aggregate sources and non-CO_2 emission sources on land		Aggregate sources and non-CO_2 emission sources on land
-	IPPU*	Industrial processes	ENERGY	Industry
		Product Use		IPPU

* Industrial Processes and Product Use. Source: Adapted from APEC Guidelines and GPC

Table 7 shows the five main target sectors for the LCMT SEZ Bitung:

1. **ENERGY:** this sector includes the GHG emissions that come from fuel combustion (Scope 1), as well as fugitive emissions released in the process of generating, delivering, and consuming useful forms of energy (such as electricity or heat - scope 2).

    - Energy generation: includes power generation from RE sources as well as related EE and energy management activities. It doesn't apply for the GHG emissions baseline and BAU scenarios assessment but it does for the LCMs.

    - Industry: includes GHG emissions from small, medium and large industries, in addition to the warehouses and any logistic facility connected with the industries (e.g. agroindustry including coconuts, fisheries and industries focussed on exportation). Additionally, includes the IPPU-related GHG emissions from non-energy related industrial activities and product uses (scope 1). All GHG emissions occurring from industrial processes, product use, and non-energy uses of fossil fuel occurring within the city (scope 1) (e.g. halocarbons) or other out-of boundary emissions (scope 3).
    - Commercial: includes the GHG emissions from commercial buildings and related facilities (e.g. offices, trade centers, business, etc.) and institutional buildings and related facilities (e.g. the public services, education facilities, etc.).

    - Residential: includes the GHG emissions from residential buildings.

2. **TRANSPORTATION:** includes GHG emissions originating from road transport, both private and public (e.g. passenger cars, motorcycles, buses and trucks) occurring in the city (scope 1), from the grid-supplied electricity used in the city (scope 2), or from trans-boundary journeys occurring outside the city (scope 3).

3. **WASTE:** includes the GHG emissions from solid waste disposal, biological treatment waste (composting), open burning and wastewater treatment and discharge treated inside the city (scope 1) or outside the city (scope 3).

4. **AFOLU (Agriculture, Forestry and Land Use):** includes the GHG emissions from in-boundary emissions from agricultural activity, land use and land use change within the city boundary (scope 1) and other out-of-boundary emissions (scope 3).

Additionally, Table 8 illustrates the classification of the distribution of land use expected in the SEZ Bitung once it is fully operational. This classification is important in defining which main target sectors will have a relevant role in the Greenfield Development area. A preliminary assessment shows that the industrial sector (and in particular large industry) will occupy the largest amount of the land in the SEZ, followed by green areas.

Table 8: Land Use Area and Distribution of the SEZ Bitung

Category number	Land use	Land area (ha)	Distribution (%)
1	Large Industry	134.50	25.19
2	Green Open Space	102.10	19.12
3	Small Industry	65.70	12.30
4	Warehouse	48.60	9.10
5	Housing	47.40	8.88
6	Medium Industry	36.00	6.74
7	Mixes use	25.90	4.85
8	Logistics	22.00	4.12
9	Service	15.20	2.85
10	Commercial	9.70	1.82
11	Social Facility	8.90	1.67
12	Offices	8.40	1.57
13	Trade center	6.30	1.18
14	Education Facility	3.30	0.62
TOTAL		**534.00**	**100.00**

Source: SEZ Master plan

A further evaluation of land uses, areas and distribution shown in Table 8 is illustrated in Table 9, matching the land use categories with the target sectors. These results confirm that industry (large, medium, small and warehouse) is the most relevant sector in terms of spatial occupation in the SEZ, accounting for more than 50% of the land use.

Table 9: Land Use Area and Distribution of the SEZ Bitung

Sector	Subsector	Land use	Land use distribution (%)
ENERGY	Industry	• Small Industry • Medium Industry • Large Industry • Warehouse • Logistics	57.45
ENERGY*	Commercial	• Mixes use • Service • Commercial • Social Facility • Offices • Trade center • Education Facility	12.13
ENERGY	Residential	• Housing	8.88
AFOLU	-	• Green Open Space	19.12
TRANSPORTATION**	-	• Mixes use	2.43
TOTAL			**100.00**

*50% of the Mixed use in the Table 3 are applied to the Commercial subsector
** 50% of the Mixed use in the Table 3 are applied to the Transportation sector

Source: Own elaboration

- **Definition of the data QA/QC**

There is a lack of primary data in the SEZ Bitung for the period of 2010-2016 on both a sectoral basis and overall. Estimated data and default values have therefore been applied to the study area based on geophysical maps.

2.2.1.2 Assumptions

The GHG emission baseline assessment has been conducted taking into account historical and actual data (where available) within the timeframe 2010-2016. Table 10 shows several assumptions that have been made in order to show transparency and coherence with the GHG emission baseline calculation.

Table 10: Main Assumptions of the GHG Emission Baseline per Sector in SEZ

Sector	Subsectors	Main assumption	Data gap assessment
Energy	Manufacturing, industries, IPPU and construction	No industry has been established yet within the SEZ Bitung.	There is no clear information regarding the industrial processes and/ product use in the area of study.
	Commercial and institutional buildings and facilities	No commercial, institutional buildings and facilities have been established yet within the SEZ Bitung.	-
	Residential buildings	No official dwellings have been established yet within the SEZ Bitung.*	There is no clear information regarding any legal and official surveyed dwellings in the area of study as of 2015.
Transportation	-	This sector has no GHG emissions.	There is no clear information regarding the road infrastructures.
Waste	-	This sector has no GHG emissions.	There is no clear information regarding the waste management services or/and infrastructures.
AFOLU	Land	The following land use categories have been assumed: settlements, dry land agriculture, mixed dry land agriculture, agroforestry, other (rice fields, open land etc.).	There is no clear information regarding the exact distribution of the land use in the area of study.

* Existing villages (informal settlements) within the SEZ have not been considered for the baseline calculation

Source: Own elaboration

As detailed in Table 10, the only sector with implications for GHG emissions in the SEZ Bitung from 2010 to 2016 is the AFOLU, with only small crop plantations and secondary forests being identified as potential major economic activities in the study area. For this reason, the GHG emission baseline calculation will be focussed on the AFOLU sector and the amount of carbon that has been stored in the timeframe analysed.

2.2.1.3 AFOLU

Sectoral assumptions:

- **Land use changes**: it is assumed that there are no land use changes within the period 2010-2016.

- **Land use distribution**: the following land use distribution has been assumed: settlements (5%), dry land agriculture (20%), mixed dry land agriculture (15%), agroforestry (5%), other (55%).

- **Carbon storage**: the following carbon storage factors have been assumed: settlements (5 tC/ha), dry land agriculture (10 tC/ha), mixed dry land agriculture (30 tC/ha), agroforestry (65 tC/ha), other (2 tC/ha).

- **Biomass growth ratio**: an average above-ground net biomass growth for natural forests in a tropical climate has been considered. The ratios considered are: 2.6 tonnes of dry matter per hectare year (tC/ha·year) and 0.47 tC per dry matter[26] (the conversion ratio from carbon to carbon dioxide is 3.67).

Calculation:

Land use distribution in the area of study has been determined in order to assess the carbon stored and the carbon removed during the period of 2010-2016. On this basis, settlements account for 27 ha, followed by dry land agriculture (107 ha), mixed dry land agriculture (80 ha), agroforestry (27 ha) and the other land use (294 ha) (see Table 11).

In terms of GHG emissions, it has been assumed that there was no land use change before the development of the SEZ Bitung, hence no carbon which was stored has been released. However, in the case of the agroforestry it has been considered that there is growth in the biomass, therefore there is carbon removal of 120 tCO_2e annually (see table below). In the context of agroforestry, an increase in biomass causes absorption of carbon dioxide (CO_2) that amounts to 120 tCO_2e on a yearly basis (see Table 12), meaning that there were more carbon removals[27] than emissions for the period analysed.

[26] Source: Table 4.9 Above-ground net biomass growth in natural forests, Volume 4, IPCC, 2006.
[27] Carbon removal is referred to the capture and long term storage of CO_2.

Table 11: Baseline Activity Data from the AFOLU Sector

Surface without land use change:

SCOPE 1		Years						
Land use	**Unit**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Settlement	ha	26.70	26.70	26.70	26.70	26.70	26.70	26.70
Dry Land Agriculture	ha	106.80	106.80	106.80	106.80	106.80	106.80	106.80
Mixed Dry Land Agriculture	ha	80.10	80.10	80.10	80.10	80.10	80.10	80.10
Agroforestry	ha	26.70	26.70	26.70	26.70	26.70	26.70	26.70
Other	ha	293.70	293.70	293.70	293.70	293.70	293.70	293.70
SUBTOTAL Scope 1		534.00	534.00	534.00	534.00	534.00	534.00	534.00

Source: Own elaboration

Table 12: Baseline GHG Emissions from the AFOLU Sector

SCOPE 1		Years						
Land use	**Unit**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Settlement	t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dry Land Agriculture	t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Dry Land Agriculture	t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agroforestry	t CO_2e	-119.63	-119.63	-119.63	-119.63	-119.63	-119.63	-119.63
Other	t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL Scope 1		-119.63	-119.63	-119.63	-119.63	-119.63	-119.63	-119.63

Source: Own elaboration

2.2.2 Overall SEZ GHG Emission Baseline

According to the GHG emissions baseline assessment, the overall SEZ Bitung will account for -120 tCO_2e in 2016. In this regard, the minus sign (-) indicates carbon removal due to the growth of biomass in agroforestry land use.

Taking into account that the SEZ Bitung is a green field area and has therefore not undergone any further development during the past years, the GHG emission baseline for the SEZ Bitung is equal to that calculated for the AFOLU.

A high increase in GHG emissions is therefore expected from 2016 onwards as a result of the beginning of the construction of the SEZ Bitung.

2.2.3 Individual Target Sector GHG Emission BAU Scenarios

2.2.3.1 Approach and methodology

The GHG emission BAU scenarios per sector and for the overall SEZ have been conducted following a top-down approach gathering the data from the following sources: 1) land use areas per phases defined in the SEZ Bitung Master plan; 2) the main macroeconomic and demographic indicators from provincial and local sources; and, 3) the current BAU scenarios developed for the North Sulawesi province. Emission projections are based on the combination of these data sources. The assessment was undertaken according to the following methodological steps:

1. **Collect historical and actual data** from Bitung City (if any, otherwise provincial sources) in order to develop the best extrapolation possible for the area of study (SEZ) based on growth trends in population and gross domestic product (GDP) per sector and overall SEZ.
2. **Define the main macroeconomic indicators** needed to conduct an accurate extrapolation. These indicators take into account demographic (population), geographic (hectares and land uses) and economic parameters (GDP).
3. **Determine the timeframes** of the analysis (e.g. short-term, mid-term and long-term), taking into account the five phases of development expected in the SEZ Bitung.
4. **Calculate** GHG emission projections based on assumptions - explained in detail in each sector - and on the extrapolation of the current SEZ Bitung Master Plan context, plus the macroeconomic and demographic indicators identified.
5. **The results** of the BAU scenarios have been represented in terms of overall GHG emissions (tCO_2e), Scope of emissions (1, 2 and 3) and share of GHG emissions by type of emission source (percentage).

2.2.3.2 Assumptions

The GHG emission BAU scenarios calculation for the SEZ Bitung are based on data from the "Provincial Action Plan on GHG Reduction for North Sulawesi (RAD-GRK)" and the "Master Plan SEZ Bitung"[28].

It should be pointed out that the existing data available for this assessment is based on a mix of sources at provincial (North Sulawesi), city (Bitung) and SEZ (Industrial Estate) level. In this regard, several assumptions have been applied in order to achieve an estimated but accurate assessment of the BAU scenario per sector and overall SEZ.

There is currently no clear timeframe regarding when the SEZ is going to be operational as a dynamic industrial, commercial and logistic area within Bitung. A main assumption has therefore been made in order to define the timeline for each phase of development of the SEZ Bitung complementary to the surface area and land use that is expected to be developed. Table 13

[28] Source*: Dokumen Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca* (RAD-GRK) *Sulut*, 2012.
Source: *Master Plan Pengembangan Kawasan Industri Bitung*, Jakarta, 2008.

shows the estimated level of development of the SEZ Bitung according to its Master Plan and the assumptions on the timeframes at different stages.

Table 13: SEZ Bitung Development Phases

Phase number	Initial year*	Completion year*	Duration (years)*	Overall surface area (ha)
1	2017	2019	3	114.96 (92 ha state-owned land)
2	2020	2021	2	43.00
3	2022	2023	2	46.00
4	2024	2028	5	216.00
5	2029	2031	3	114.04
TOTAL			**15**	**534.00**

Source: Own elaboration.

It is important to note that in Phase 1, an area of 92 ha is considered state-owned land while the rest is considered private-owned (including the rest of the phases). Figure 19 illustrates the scope of the study in terms of geographical area and the different phases of development planned for the SEZ Bitung according to its Master plan.

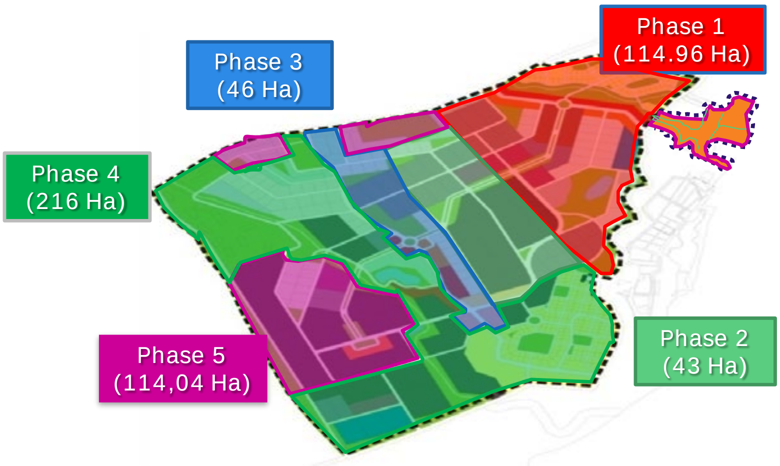


Figure 19: SEZ Bitung Development Phases

Source: Board of Bitung Special Economic Zone, Government of North Sulawesi (2014)

The data collection process has been focussed on obtaining two main groups of indicators: 1) share of land use area per phase (see Table 14) and, 2) the main macroeconomic and demographic indicators to be extrapolated to the SEZ Bitung (see Table 15 and Table 16). These indicators have been used to perform the GHG emission projections along the life cycle of the project.

Table 14: Share of Land Use Area per Phase

	2017-2019		2020-2021		2022-2023		2024-2028		2029-2031		2017-2031	
Sector	**Phase 1**	**Share (%)**	**Phase 2**	**Share (%)**	**Phase 3**	**Share (%)**	**Phase 4**	**Share (%)**	**Phase 5**	**Share (%)**	**TOTAL**	**Share (%)**
ENERGY - Industry	66.05	57%	24.70	57%	26.43	57%	124.10	57%	65.52	57%	306.80	57.45%
ENERGY - Commercial	13.94	12%	5.21	12%	5.58	12%	26.19	12%	13.83	12%	64.75	12.13%
ENERGY - Residential	10.20	9%	3.82	9%	4.08	9%	19.17	9%	10.12	9%	47.40	8.88%
TRANSPORTATION	2.79	2%	1.04	2%	1.12	2%	5.24	2%	2.77	2%	12.95	2.43%
AFOLU	21.98	19%	8.22	19%	8.80	19%	41.30	19%	21.80	19%	102.10	19.12%
TOTAL	**114.96**	**100%**	**43**	**100%**	**46**	**100%**	**216**	**100%**	**114.04**	**100%**	**534.00**	**100%**

Source: Own elaboration from different sources

Table 15: Main Macroeconomic Indicators based on Historical Data (2007-2010)

%	2007	2008	2009	2010	Average
Overall GDP variation rate	6.5%	7.6%	7.8%	7.1%	7.2%
Electricity sector	5.7%	7.5%	14.9%	5.0%	8.3%
Transport sector	6.0%	11.0%	16.9%	8.0%	10.5%
Commercial sector	5.4%	7.9%	8.9%	7.3%	7.4%
Services	2.7%	5.4%	6.8%	6.2%	5.3%
Trade, hotels & restaurants	7.9%	10.9%	12.3%	8.8%	10.0%
Finance, lease and services of the Company	5.7%	7.3%	7.6%	6.9%	6.9%
Residential sector*	2.8%	2.4%	1.3%	3.9%	1.9%
Agriculture sector	7.6%	2.7%	2.1%	11.6%	6.0%
Industry sector	7.5%	8.8%	6.2%	3.9%	6.6%
Mining and quarrying	8.7%	9.4%	5.5%	3.1%	6.7%
Processing industry	6.3%	6.2%	7.0%	6.5%	6.5%
Construction	7.6%	10.7%	6.1%	2.1%	6.6%

Source: Own elaboration retrieved from the document RAD-GRK

Table 16: Main Demographic Indicators based on Historical Data (2007-2010)

%	2007	2008	2009	2010	Average
Residential sector	2.8%	2.4%	1.3%	3.9%	1.9%

Source: Own elaboration retrieved from the document RAD-GRK

2.2.3.3 Energy - Industry

Sectoral assumptions:

- **Electricity consumption**: following the Technical Guidelines Development of Regional Industrial Estate[29], 0.15-0.2 MVA/ha (MW/ha) are required to supply electricity in the SEZ. The number of hectares defined in the SEZ for the industrial sector has been accounted on this basis and the hours of operation (8 hours at maximum power during 360 days/year) have been estimated to come up with the overall electricity consumption.
- **Type of fuels**: it has been assumed that the amount of fuel consumed equals the electricity consumption (in TJ) within the industries. Specifically, coal for thermal energy (co-generation with 75% efficiency) and marine fuel oil/heavy fuel oil (engine with 35% efficiency).
- **Process emissions**: there is no available data regarding the process emissions of each industry, but it is assumed that there is no heavy industry in the area (e.g. cement, iron and metal, etc.).
- **Refrigerants**: there is no available data regarding the amount of halocarbons that will be used in the Refrigeration and Air Conditioning (RAC) within the industries, commercial and residential subsectors in SEZ Bitung. However, it is known the type of halocarbons that might be consumed: HFC - R134a, CFC-R22 and CFC-R12.

[29] Source: *Master Plan Pengembangan Kawasan Industri Bitung*, Jakarta, 2008.

Data gap assessment:

- **Number, size and type of industries**: there is no available disaggregated data regarding the number of industries according to their size (small, medium and large) and their type (mainly fisheries and coconut).

Calculation:

The industry subsector is one of the most significant sectors in the SEZ Bitung. The activity data projections estimate that energy consumption from electricity will rise from less than 12,000 MWh in Phase 1 to reach more than 154,000 MWh up to 2031 once Phase 5 is completed. Moreover, the oil consumed as fuel will increase from almost 115 TJ in 2017 to more than 1,500 TJ in 2031, whereas coal will represent less than 55 TJ in Phase 1 and slightly above 740 TJ at the end of Phase 5 (see Table 17).

In terms of GHG emissions, the industry subsector will account for more than 21,800 tCO_2e in Phase 1 and will increase to more than 300,000 tCO_2e in 2031 (see Table 18 and Figure 20).

In terms of emissions by scope, Scope 1 will account for more than 62% of the overall GHG emissions, whereas Scope 2 will account for less than 38% (see Figure 21).

By share, fuel oil will represent almost 39% of the overall GHG emissions, followed by electricity (38%) and coal (23%) (see Figure 22).

Table 17: Activity Data from the Industry Subsector

			Years					
SCOPE 1	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Fuel consumption by type	Coal	TJ	-	159.78	219.55	283.49	636.54	742.21
	Growth rate	%	-	-	37.4%	29.1%	124.5%	16.6%
	Fuel oil	TJ	-	342.39	470.46	607.47	1,364.02	1,590.45
	Growth rate	%	-	-	37.4%	29.1%	124.5%	16.6%
SUBTOTAL Scope 1			0.00	502.18	690.01	890.95	2,000.56	2,332.66

			Years					
SCOPE 2	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Electricity consumption	Electricity	MWh	0.00	33,288.28	45,739.54	59,059.48	132,612.61	154,627.20
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 2			0.00	33,288.28	45,739.54	59,059.48	132,612.61	154,627.20

Note: The continuous growth regarding the type of source is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

Table 18: GHG Emissions from the Industry Subsector

			Years					
SCOPE 1	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Fuel consumption by type	Coal	t CO_2e	-	15,190.96	20,873.04	26,951.54	60,517.18	70,563.44
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
	Fuel oil	t CO_2e	-	25,458.28	34,980.77	45,167.63	101,419.73	118,256.09
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 1			0.00	40,649.24	55,853.81	72,119.16	161,936.91	188,819.53

			Years					
SCOPE 2	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Electricity consumption	Electricity	t CO_2e	0.00	24,833.06	34,121.69	44,058.37	98,929.01	115,351.89
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 2			0.00	24,833.06	34,121.69	44,058.37	98,929.01	115,351.89

TOTAL BAU ENERGY - Industry subsector	t CO_2e	0.00	65,482.30	89,975.50	116,177.53	260,865.92	304,171.42

Note: The continuous growth regarding the GHG emissions is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

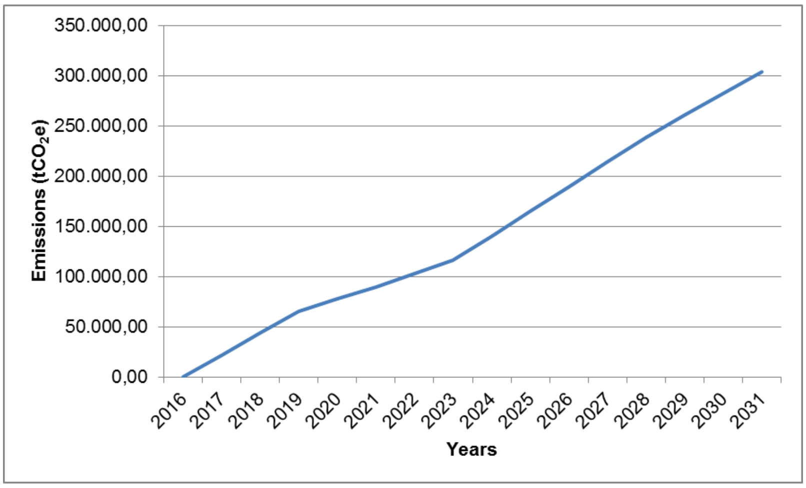


Figure 20: GHG Emissions from the Industry Subsector

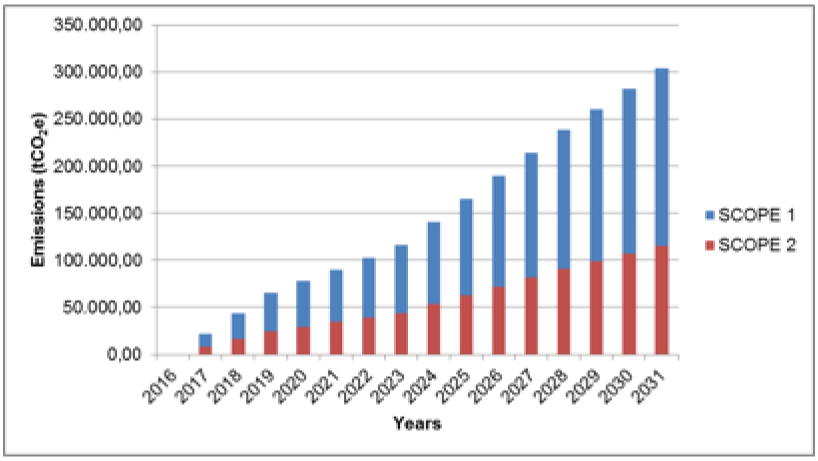


Figure 21: GHG Emissions from the Industry Subsector by Scope

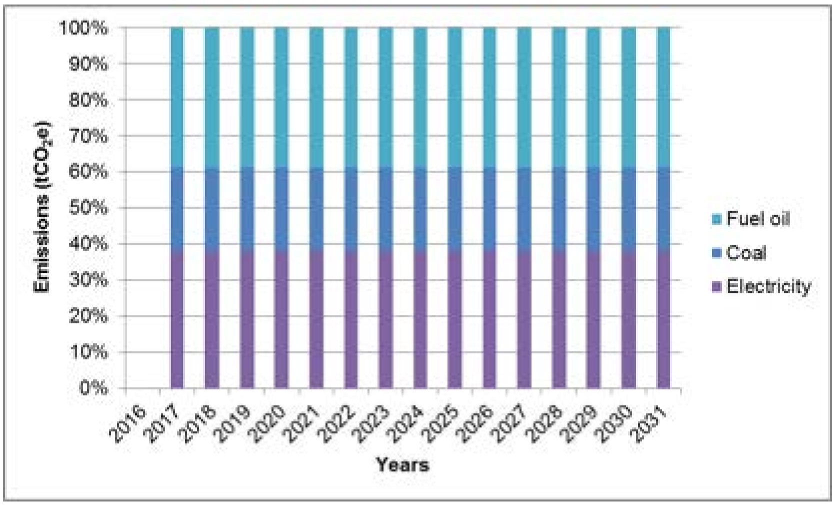


Figure 22: GHG Emissions from the Industry Subsector by Source

2.2.3.4 Energy - Commercial

Sectoral assumptions:

- **Electricity consumption**: following the Technical Guidelines Development of Regional Industrial Estate, 0.15-0.2 MVA/ha (MW/ha) are required to supply electricity in the SEZ. The number of hectares defined in the SEZ for the commercial and institutional buildings and facilities subsector and the hours of operation (8 hours at maximum power during 360 days/year), have been estimated to come up with the overall electricity consumption.

- **Type of fuels**: it has been assumed that the electricity supply is supported by diesel generators (50% of the overall electricity consumption), with an efficiency of 35%.

Calculation:

The commercial subsector is expected to have a minor role in terms of environmental impact in the SEZ Bitung. The activity data projections estimate that energy consumption from electricity is going to rise from more than 2,600 MWh in Phase 1 to reach more than 12,200 MWh up to 2031 once Phase 5 has been completed. In turn, the diesel consumed by the gensets will amount to 27 TJ in 2019 and 126 TJ in 2031 (see Table 19).

In terms of GHG emissions, this subsector will account for almost 4,000 tCO_2e in Phase 1 and will increase to almost 18,500 tCO_2e in 2031 (see Table 20 and Figure 23)

In terms of emissions by scope, Scope 1 will account for more than 50% of the overall GHG emissions, whereas Scope 2 will account for less than 50% during the development of the SEZ Bitung (see Figure 24).

In terms of emissions by source, diesel will represent more than 50% of the overall GHG emissions, whereas electricity will account for less than 50% during the development of the SEZ Bitung (see Figure 25).

Table 19: Activity Data from the Commercial Subsector

			Years					
SCOPE 1	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Fuel consumption by type	Diesel	TJ	0.00	27.10	37.23	48.08	107.95	125.87
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 1			0.00	27.10	37.23	48.08	107.95	125.87

			Years					
SCOPE 2	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Electricity consumption	Electricity	MWh	0.00	2,634.55	3,619.99	4,674.18	10,495.44	12,237.75
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 2			0.00	2,634.55	3,619.99	4,674.18	10,495.44	12,237.75

Note: The continuous growth regarding the type of source is due to the development of the 5 phases in the SEZ Bitung along the period.

Source: Own elaboration

Table 20: GHG Emissions from the Commercial Subsector

			Years					
SCOPE 1	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Fuel consumption by type	Diesel	t CO_2e	0.00	2,014.86	2,768.50	3,574.73	8,026.72	9,359.21
	Growth rate	%			37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 1			0.00	2,014.86	2,768.50	3;574.73	8,026.72	9,359.21

			Years					
SCOPE 2	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Electricity consumption	Electricity	t CO_2e	0.00	1,965.38	2,700.51	3,486.94	7,829.60	9,129.36
	Growth rate	%			37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 2			0.00	1,965.38	2,700.51	3,486.94	7,829.60	9,129.36
TOTAL BAU ENERGY - Commercial		t CO_2e	0.00	3,980.24	5,469.02	7,061.66	15,856.32	18,488.57

Note: The continuous growth regarding the GHG emissions is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

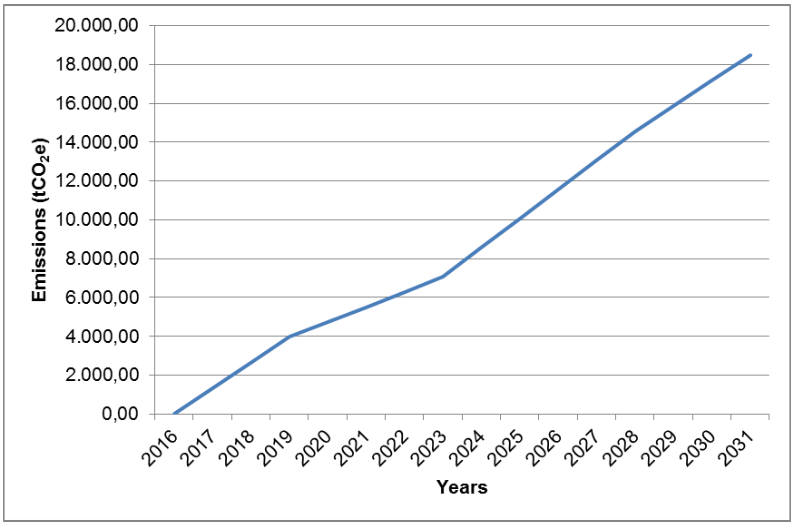


Figure 23: GHG Emissions from the Commercial Subsector

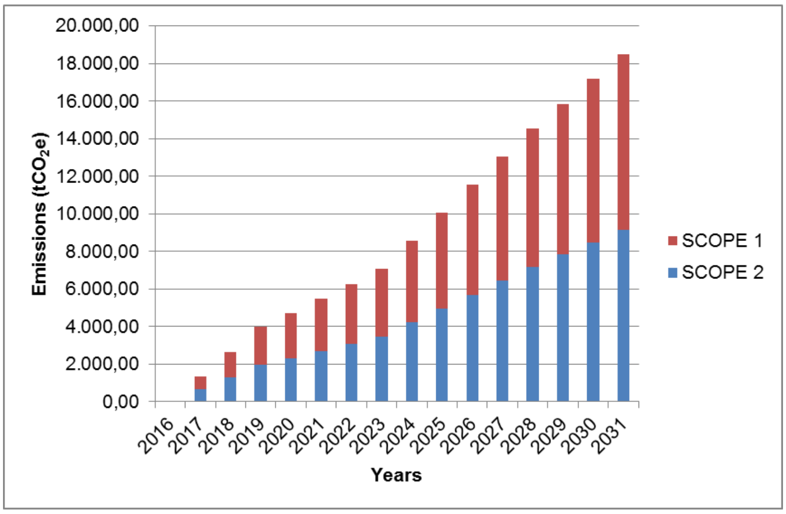


Figure 24: GHG Emissions from the Commercial Subsector by Scope

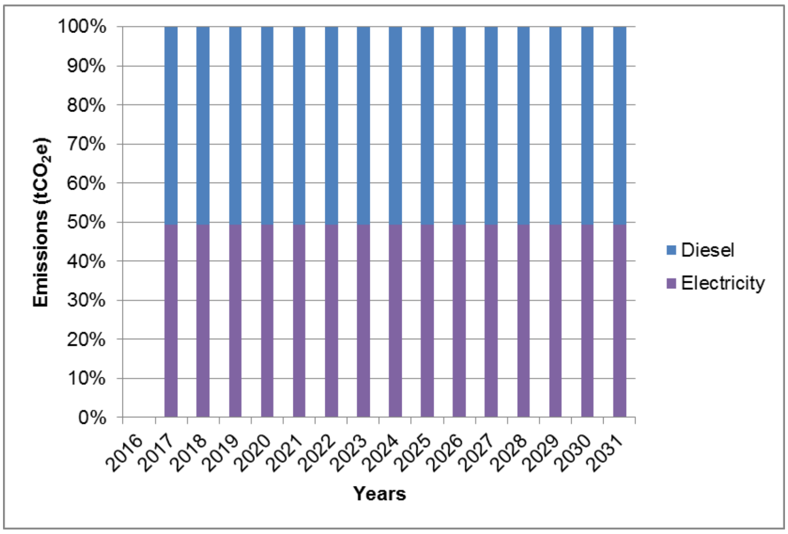


Figure 25: GHG Emissions from the Commercial Subsector by Source

2.2.3.5 Energy - Residential

Sectoral assumptions:

- **Electricity consumption**: following the Technical Guidelines Development of Regional Industrial Estate, 0.15-0.2 MVA/ha (MW/ha) are required to supply electricity in the SEZ. The number of hectares defined in the SEZ for the residential buildings subsector and the average daily activity of residents at home (6h) have been estimated to come up with the overall electricity consumption.

- **Type of fuels**: according to current statistics, the fuels used and their distribution in the residential buildings subsector in North Sulawesi are: firewood (69%), electricity (21%), Liquified Petroleum Gas LPG (8%) and Kerosene (1%). In the case of the firewood consumption, the AFOLU sector has been analysed following IPCC Guidelines. In addition, it is assumed that the electricity supply is supported by diesel gensets (50% of the overall electricity consumption) with an efficiency of 35%.

Calculation:

When compared with the industry subsector, data projection estimates that there will be minor environmental impacts in the SEZ Bitung due to the residential buildings subsector and even less in the commercial subsector.

The activity data projections estimate that the energy consumption from electricity is going to reach slightly more than 1,920 MWh in Phase 1 and will increase to less than 9,000 MWh by 2031 once Phase 5 is completed. Furthermore, diesel gensets will amount to slightly less than 20 TJ in 2019 and 92 TJ in 2031, whereas LPG will account for 5 TJ in Phase 1 and slightly more than 25 TJ in Phase 5. Finally, kerosene will be the least used energy source, accounting for less than 1 TJ in 2019 while increasing to less than 4 TJ in 2031 (see Table 21).

In terms of GHG emissions, the residential subsector will account for more than 3,300 tCO_2e in Phase 1 and will increase to more than 15,400 tCO_2e in 2031 (see Table 22 and Figure 26)

With regards to emissions by scope, Scope 1 emissions will account for more than 57% of total GHG emissions and Scope 2 emissions will account for the remaining 43% in during the development of the SEZ Bitung (see Figure 27).

When looking at emissions by source, diesel will account for more than 44% of overall GHG emissions, followed by electricity (43%), LGP (10%) and kerosene (2%) (see Figure 28).

Table 21: Activity Data from the Residential Subsector

			Years					
SCOPE 1	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Fuel consumption by type	LPG	TJ	0.00	5.50	7.56	9.76	21.90	25.54
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
	Kerosene	TJ	0.00	0.81	1.11	1.43	3.21	3.74
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
	Diesel	TJ	0.00	19.84	27.26	35.19	79.03	92.15
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 1			0.00	26.14	35.92	46.38	104.14	121.43

			Years					
SCOPE 2	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Electricity consumption	Electricity	MWh	0.00	1,928.62	2,650.00	3,421.72	7,683.15	8,958.60
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 2			0.00	1,928.62	2,650.00	3,421.72	7,683.15	8,958.60

Note: The continuous growth regarding the type of source is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

Table 22: GHG Emissions from the Residential Subsector

			Years					
SCOPE 1	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Fuel consumption by type	LPG	t CO_2e	0.00	347.26	477.15	616.10	1,383.40	1,613.06
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
	Kerosene	t CO_2e	0.00	58.12	79.86	103.11	231.53	269.97
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
	Diesel	t CO_2e	0.00	1,474.97	2,026.67	2,616.87	5,875.93	6,851.38
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 1			0.00	1,880.35	2,583.68	3,336.08	7,490.86	8,734.40

			Years					
SCOPE 2	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Electricity consumption	Electricity	t CO_2e	0.00	1,438.75	1,976.90	2,552.60	5,731.63	6,683.12
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 2			0.00	1,438.75	1,976.90	2,552.60	5,731.63	6,683.12

TOTAL BAU ENERGY - Residential	t CO_2e	0.00	3,319.10	4,560.58	5,888.68	13,222.49	15,417.51

Note: The continuous growth regarding the GHG emissions is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

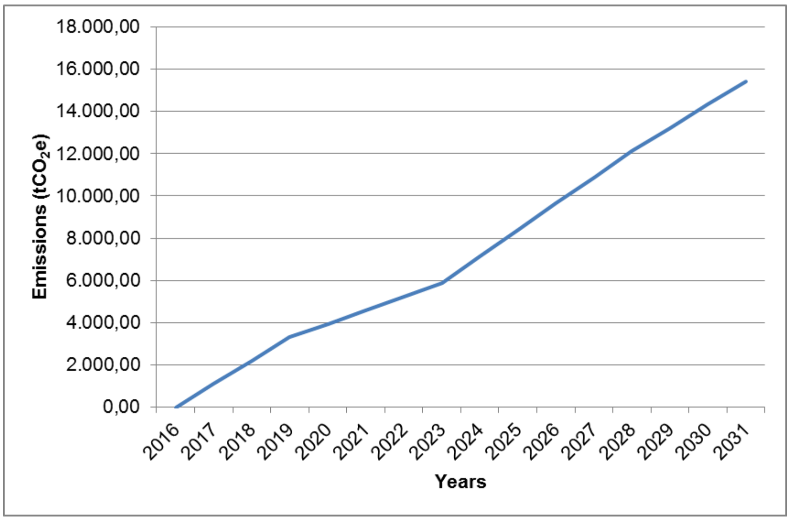


Figure 26: GHG Emissions from the Residential Subsector

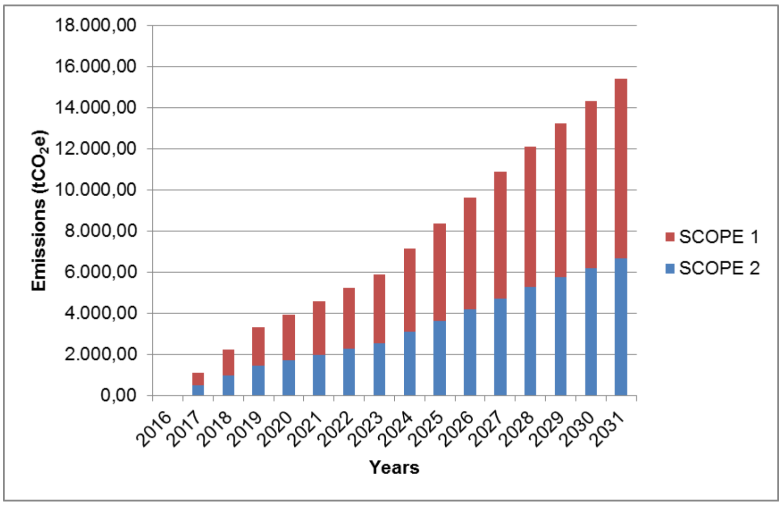


Figure 27: GHG Emissions from the Residential Subsector by Scope

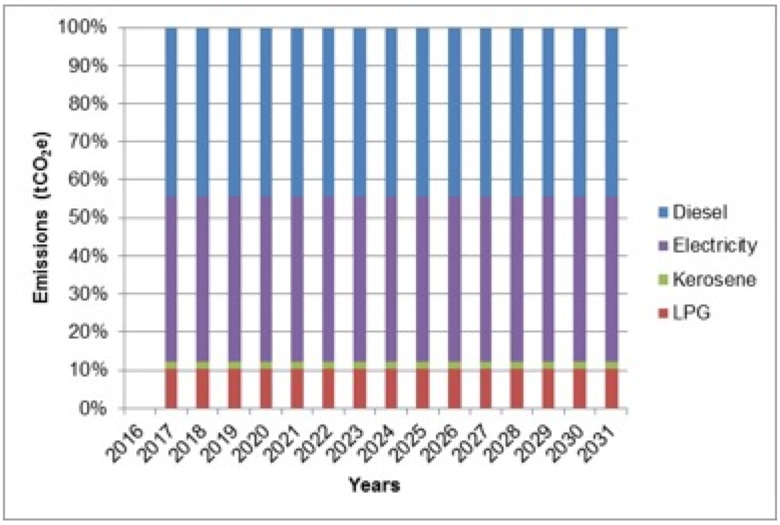


Figure 28: GHG Emissions from the Residential Subsector by Source

2.2.3.6 Transportation

Sectoral assumptions:

- **Type of vehicles and number**: passenger cars, motorcycles, buses and trucks have been included in the assessment. The number of vehicles per type has been extrapolated based on the ratio of vehicles per inhabitants in North Sulawesi, then multiplied by the number of employees expected in the SEZ Bitung (34,710) per hectare (534 ha) and divided by the index of occupation per type of vehicle. Nevertheless, these assumptions only take into account the data associated with the new inhabitants living in Bitung during the development of the project. It is therefore clear that the number of households expected to be constructed in the area is not enough to supply the expected number of individuals (inhabitants and workers) in the SEZ Bitung.

- **Type of fuels and consumption**: according to current statistics[30], vehicles in Bitung are fuelled with diesel (buses, trucks and passenger cars) and gasoline (motorcycles and passenger cars). The distribution of fuel in passenger cars is 16.7% diesel and 83.3% gasoline.

- **Index of occupation**: an average occupation of 30 people per bus, 1 people per passenger car, two people per truck and 2 persons per motorcycle has been estimated.

- **Distance travelled**: according to current statistics the average distance travelled by each type of vehicle in North Sulawesi is: passenger car (7.36 km/trip); bus (13.3 km/trip); motorcycle (4.9 km/trip); and truck (9.2 km/trip).

- **Fuel consumed per type of vehicle**: according to current statistics the average fuel consumed by type of vehicle in North Sulawesi is: passenger car (0.13 liters/km); bus (0.18 liters/km); motorcycle (0.05 liters/km); and truck (0.22 liters/km).

Calculation:

The transportation sector is expected to play a key role in logistics and mobility within the SEZ Bitung. The activity data projections estimate that the energy consumed will derive from diesel and gasoline fuels. Fuel consumption distribution will account for 55% and 45% respectively throughout the SEZ development period. In absolute terms, this represents an increase in the diesel consumption from 51 TJ in 2019 to 239 TJ in 2031. In turn, gasoline consumed will rise from 42 TJ in Phase 1 to 197 TJ in Phase 5 (see Table 23).

In terms of GHG emissions, the transportation sector will account for slightly more than 6,800 tCO_2e in Phase 1 and will increase to more than 31,500 tCO_2e in Phase 5. Diesel consumption will therefore emit to the atmosphere 3,800 tCO2e in 2019 and will reach 17,700 tCO_2e in 2031. Gasoline consumed will emit 985 tCO_2e and 13,700 tCO_2e during the same period (see Table 24 and Figure 29).

With regards to emissions scope, all GHG emissions will arise from diesel and gasoline consumed within the project boundaries, and will therefore be Scope 1 emissions. The share of GHG emissions from the transportation sector will be divided between diesel consumption (56%) and gasoline consumption (46%) (see Figure 30).

[30] Source: Source*: Dokumen Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca* (RAD-GRK) *Sulut*, 2012.

Table 23: Activity Data from the Transportation Sector

SCOPE 1	Type of source	Unit	Years 2016	2019	2021	2023	2029	2031
Fuel consumption by type	Diesel	TJ	0.00	51.49	70.75	91.35	205.12	239.18
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
	Gasoline	TJ	0.00	42.47	58.35	75.34	169.18	197.26
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 1			0.00	93.96	129.10	166.70	374.30	436.44

Note: The continuous growth regarding the type of source is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

Table 24: GHG Emissions from the Transportation Sector

SCOPE 1	Type of source	Unit	Years 2016	2019	2021	2023	2029	2031
Fuel consumption by type	Diesel	t CO_2e	0.00	3,828.48	5,260.49	6,792.41	15,251.74	17,783.63
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
	Gasoline	t CO_2e	0.00	2,953.68	4,058.49	5,240.37	11,766.77	13,720.14
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Scope 1			0.00	6,782.16	9,318.98	12,032.79	27,018.51	31,503.76
TOTAL BAU TRANSPORTATION		t CO_2e	0.00	6,782.16	9,318.98	12,032.79	27,018.51	31,503.76

Note: The continuous growth regarding the GHG emissions is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

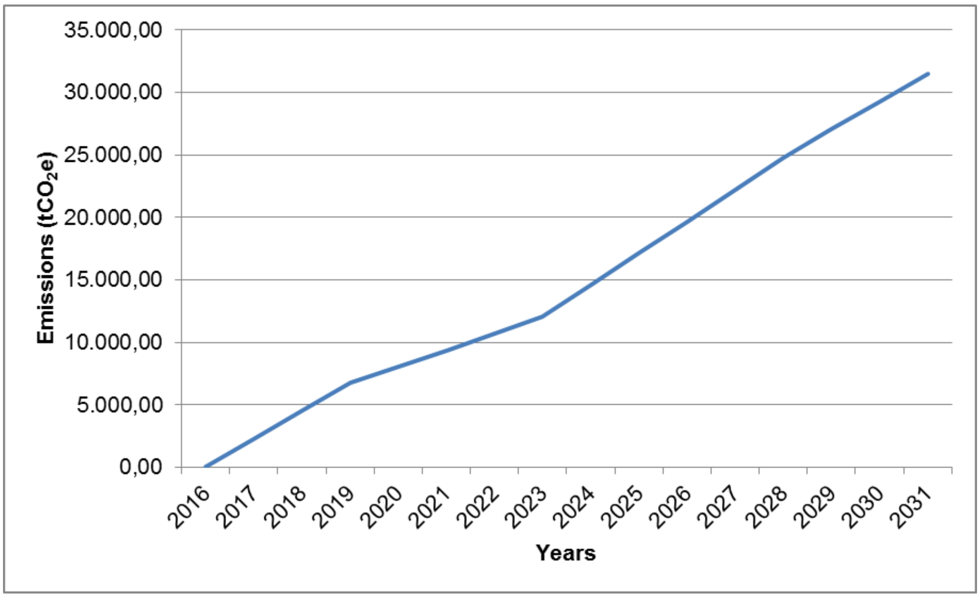


Figure 29: GHG Emissions from the Transportation Sector

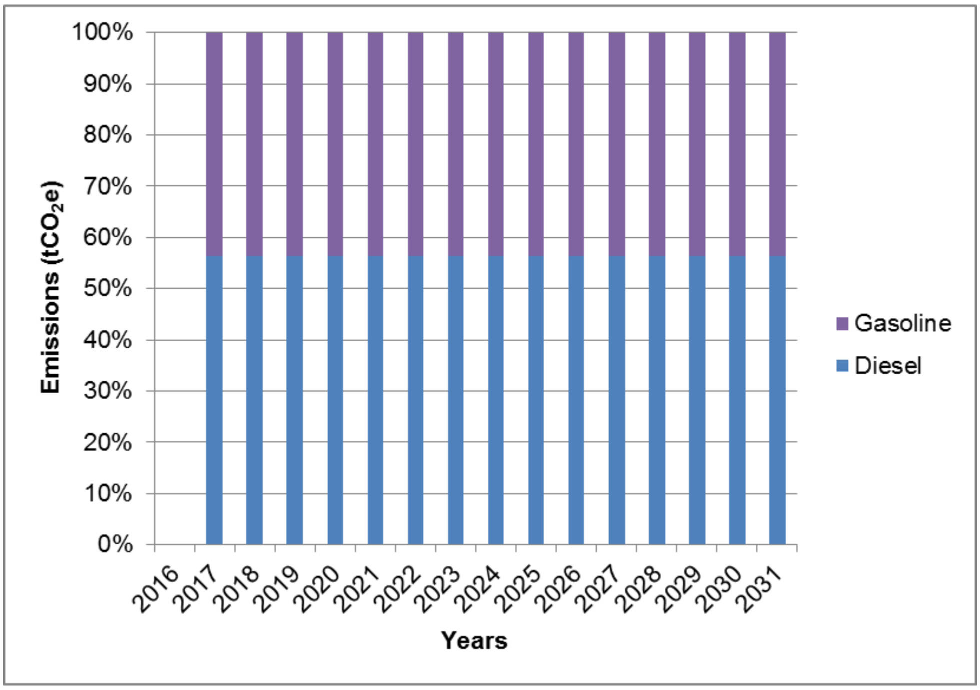


Figure 30: GHG Emissions from the Transportation Sector by Source

2.2.3.7 Waste

Sectoral assumptions:

- **Waste production**: according to current statistics the ratio of solid waste produced per capita in Bitung is equivalent to 0.5 kg/inhabitant per day.

- **Waste management distribution**: according to current statistics, waste management in Bitung is distributed according to waste transported to landfill (75%), composting (1%), open burned (4.80%) and dumped anywhere (19.20%). It should be noted that the "dumped anywhere" category has been included in the "landfill" category, thereby representing 94.20% of the overall waste. In addition, no methane recovery has been taken into account. It is also important to underline that the composting emissions are considered to be zero.

- **Municipal Solid Waste (MSW) composition**: according to current statistics the dry matter content in domestic waste in urban areas in North Sulawesi is: leftovers (66%), paper, cardboard and nappies (13%), wood and garbage Park (0%), fabrics and textile products (1%), rubber and leather (0%), plastic (11%), metal (2%), glass (1%) and others (6%).

- **Wastewater**: according to the available information wastewater production in the SEZ Bitung would be 1,008 litres per second. A Chemical Oxygen Demand (COD) for the fisheries industry of 2.67 kg COD/m^3 has been estimated.

Calculation:

The activity data projections for the waste sector estimate that the overall MSW in SEZ Bitung will increase from almost 3,110 tonnes in Phase 1 to more than 14,700 tonnes in Phase 5. The majority of waste will be transported to landfill (1,645 tonnes in 2019 and 7,860 tonnes in 2031), seconded by industrial wastewater (1,460 tonnes in 2019 and 6,780 tonnes in 2031) open burning (9 tons in 2019 and 55 tons in 2031), composting (2 tons in 2019 and 11 tons in 2031) and followed by domestic wastewater (0.04 tons in 2019 and 0.18 tons in 2031) (see Table 25:)

In terms of GHG emissions, the waste sector will account for more than 4,730 tCO_2e in Phase 1, which will increase to more than 19,450 tCO_2e in Phase 5 (see Table 26: , Table 22 and Figure 31:).

With regards to emissions by scope, all GHG emissions analysed are Scope 3 emissions (out-of-boundary waste and wastewater).

When looking at emissions by source, wastewater from industries will account for 125 tCO_2e in 2019 and 580 tCO_2e in 2031. Waste transported to landfill will emit less than 4,000 tCO_2e in Phase 1 and almost 18,840 tCO_2e in Phase 5, whereas open burning will emit more than 5 tCO_2e rising to more than 29 tCO_2e in the same period (see Figure 32).

Table 25: Activity Data from the Waste Sector

			Years					
SCOPE 3	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Waste management								
Composting		tonnes	0.00	1.97	2.81	3.77	9.48	11.47
	Growth rate	%	-	-	42.68%	34.08%	151.40%	21.08%
Open burning		tonnes	0.00	9.46	13.50	18.09	45.49	55.07
	Growth rate	%	-	-	42.68%	34.08%	151.40%	21.08%
Landfill		tonnes	0.00	1,645.40	2,270.63	2,945.00	6,708.09	7,861.62
	Growth rate	%	-	-	38.00%	29.70%	127.78%	17.20%
SUBTOTAL Waste management			0.00	1,656.83	2,286.94	2,966.86	6,763.05	7,928.17
Wastewater								
Domestic		tonnes	0.00	0.04	0.05	0.07	0.16	0.18
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
Industry		tonnes	0.00	1,459.77	2,005.79	2,589.91	5,815.39	6,780.79
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Wastewater			0.00	1,459.81	2,005.85	2,589.98	5,815.55	6,780.97
TOTAL Waste		tonnes	0.00	3,116.64	4,292.79	5,556.83	12,578.60	14,709.14

Note: The continuous growth regarding the type of source is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

Table 26: GHG emissions from the Waste Sector

			Years					
SCOPE 3	**Type of source**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Waste management								
Composting		t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00
	Growth rate	%	-	-	0.00%	0.00%	0.00%	0.00%
Open burning		t CO_2e	0.00	5.01	7.15	9.59	24.10	29.18
	Growth rate	%	-	-	42.68%	34.08%	151.40%	21.08%
Landfill		t CO_2e	0.00	3,942.34	5,440.40	7,056.16	16,072.46	18,836.32
	Growth rate	%	-	-	38.00%	29.70%	127.78%	17.20%
SUBTOTAL Waste management			0.00	3,947.35	5,447.55	7,065.75	16,096.56	18,865.50
Wastewater								
Domestic		t CO_2e	0.00	0.47	0.65	0.84	1.88	2.19
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
Industry		t CO_2e	0.00	125.31	172.18	222.32	499.19	582.06
	Growth rate	%	-	-	37.40%	29.12%	124.54%	16.60%
SUBTOTAL Wastewater			0.00	125.78	172.83	223.15	501.07	584.25
TOTAL BAU WASTE		t CO_2e	0.00	4,073.13	5,620.37	7,288.90	16,597.63	19,449.75

Note: The continuous growth regarding the GHG emissions is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

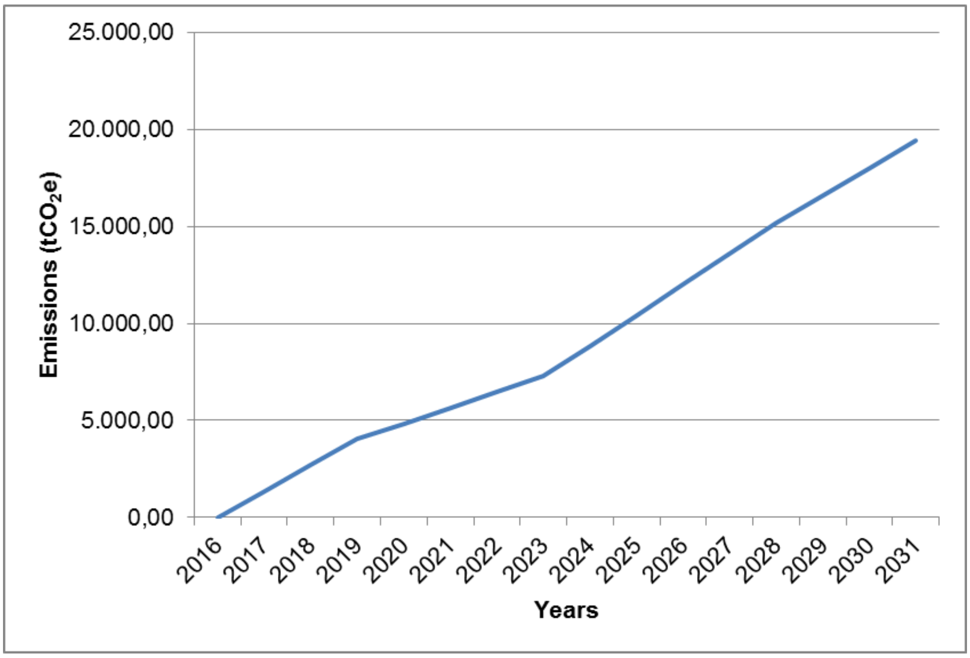


Figure 31: GHG Emissions from the Waste Sector

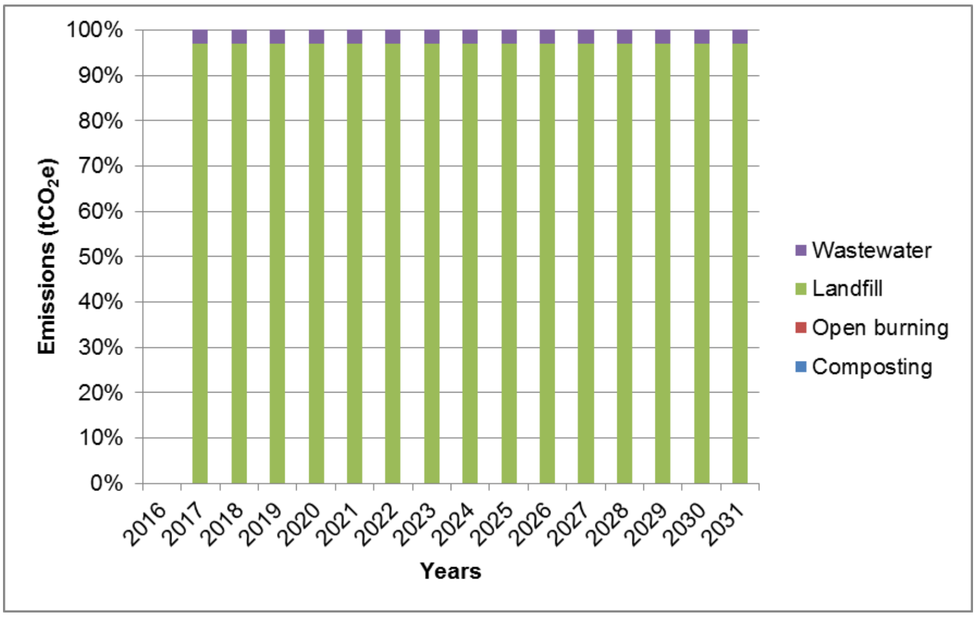


Figure 32: GHG Emissions from the Waste Sector by Source

2.2.3.8 Agriculture, Forestry and Other Land Use (AFOLU)

Sectoral assumptions:

- **Land use changes**: it is assumed that there will be land use changes from dry land agriculture, mixed dry land, agroforestry and others, to settlements within the period 2017-2031.

- **Firewood**: the domestic sector in Bitung uses this type of fuel which represents 69% of the total amount of energy. According to the IPPC guidelines firewood should be reported under the AFOLU sector as opposed to under the ENERGY sector.

- **Biomass growth ratio**: an average above-ground net biomass growth rate for natural forests in a tropical climate has been considered. The ratios considered are: 2.6 tonnes of dry matter per hectare per year (tC/ha per year) and 0.47 tC per dry matter[31] (the conversion ratio from carbon to carbon dioxide is 3.67).

Calculation:

The activity data projections for the AFOLU sector estimate that firewood consumption will rise from 45 TJ in Phase 1 to less than 210 TJ in Phase 5.

Moreover, in terms of land use, settlements will not change whereas agroforestry will lose its capacity as a means of carbon removal as the SEZ Bitung is developed. In addition, the other land uses (dry land agriculture, mixed dry land agriculture, agroforestry and other) will be converted to settlements in the period 2017-2031. This means that settlements will total 534 ha at the end of the Phase 5. In this regard, dry land agriculture will be converted into settlements (107 ha), as well as mixed dry land agriculture (80 ha), agroforestry (27 ha) and other land use (294 ha) (see Table 27).

In terms of GHG emissions, firewood will account for 5 tCO_2e in Phase 1 but will increase to less than 24 tCO_2e in Phase 5.

In addition, in terms of land use, the carbon removal capacity from agroforestry will decline progressively from 120 tCO_2e in 2016 to zero in 2031. In turn, carbon stored in the land for uses such as dry land agriculture, mixed dry land agriculture, agroforestry and other land use, will be released once these are converted to settlements. On this basis, mixed dry land agriculture will account for 142 tCO_2e, followed by agroforestry (114 tCO_2e) and dry land agriculture (38 tCO_2e) in 2031. Conversely, the land use change from other land use to settlements will increase the carbon removals by up to 62 tCO_2e at the end of Phase 5. One potential reason for this is the effect of urban greenery in the new development of the SEZ Bitung (see Table 28 and Figure 33).

It should be noted that the carbon originally stored in the area of study will be released each year depending on the number of hectares constructed in each phase during the development of the SEZ Bitung.

[31] Source: Table 4.9 Above ground net biomass growth in natural forests, Volume 4, IPCC, 2006.

Table 27: Activity Data from the AFOLU Sector

			Years					
SCOPE 1	**Type of fuel**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Fuel consumption by type	Firewood	TJ	0.00	45.06	61.92	79.95	179.52	209.32
	Growth rate	%	-		37.40%	29.12%	124.54%	16.60%
SUBTOTAL			0.00	45.06	61.92	79.95	179.52	209.32

Surface without land use change

			Years					
Land use		**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Settlement		ha	0.00	1.92	1.08	1.15	1.90	1.90
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
Agroforestry		ha	26.70	20.95	18.80	16.50	3.80	0.00
	Growth rate	%	-	-21.53%	-10.26%	-12.23%	-76.96%	-100.00%
SUBTOTAL			26.70	24.78	22.87	20.95	19.88	18.80

Surface with land use change

			Years					
Land use 1	**Land use 2**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Dry Land Agriculture	Settlement	ha	0.00	7.66	4.30	4.60	7.60	7.60
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
Mixed Dry Land Agriculture	Settlement	ha	0.00	5.75	3.23	3.45	5.70	5.70
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
Agroforestry	Settlement	ha	0.00	1.92	1.08	1.15	1.90	1.90
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
Other	Settlement	ha	0.00	21.08	11.83	12.65	20.91	20.91
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
SUBTOTAL			0.00	36.40	20.43	21.85	36.11	36.11

Note: The continuous growth regarding the type of source is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

Table 28: GHG Emissions from the AFOLU Sector

			Years					
SCOPE 1	**Type of fuel**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Fuel consumption by type	Firewood	t CO_2e	0.00	5.13	7.06	9.11	20.46	23.85
	Growth rate	%	-		37.40%	29.12%	124.54%	16.60%
SUBTOTAL			0.00	5.13	7.06	9.11	20.46	23.85
Surface without land use change			Years					
Land use		**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Settlement		t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00
	Growth rate	%	-	0.00%	0.00%	0.00%	0.00%	0.00%
Agroforestry		t CO_2e	-119.63	-93.88	-84.25	-73.94	-17.03	0.00
	Growth rate	%	-	-21.53%	-10.26%	-12.23%	-76.96%	-100.00%
SUBTOTAL			-119.63	-93.88	-84.25	-73.94	-17.03	0.00
Surface with land use change			Years					
Land use 1	**Land use 2**	**Unit**	**2016**	**2019**	**2021**	**2023**	**2029**	**2031**
Dry Land Agriculture	Settlement	t CO_2e	0.00	38.32	21.50	23.00	38.01	38.01
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
Mixed Dry Land Agriculture	Settlement	t CO_2e	0.00	143.70	80.63	86.25	142.55	142.55
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
Agroforestry	Settlement	t CO_2e	0.00	114.96	64.50	69.00	114.04	114.04
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
Other	Settlement	t CO_2e	0.00	-63.23	-35.48	-37.95	-62.72	-62.72
	Growth rate	%	-	-	-43.89%	6.98%	65.28%	0.00%
SUBTOTAL			0.00	233.75	131.15	140.30	231.88	231.88
TOTAL BAU AFOLU		t CO_2e	-119.63	145.01	53.96	75.47	235.30	255.73

Note: The continuous growth regarding the GHG emissions is due to the development of the 5 phases in the SEZ Bitung along the period

Source: Own elaboration

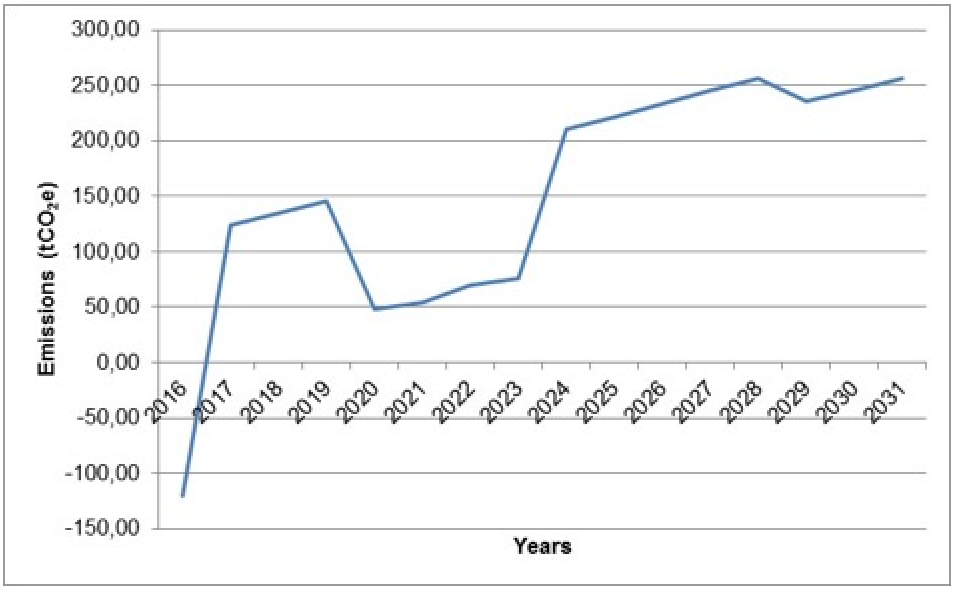


Figure 33: GHG Emissions from the AFOLU Sector

2.2.4 Overall SEZ GHG Emission BAU Scenarios

According to the GHG emissions BAU scenarios assessment, overall the SEZ Bitung will emit around 390,000 tCO_2e into the atmosphere at the end of Phase 5 in 2031.

The main variation in GHG emissions during the SEZ Bitung development will occur at the end of Phase 1 (199%), compared with the first year of construction (2017), and in Phase 4 (125%), compared with Phase 3. Overall, the change in GHG emissions will total more than 1,290% for the entire period from 2017 to 2031. This means that GHG emissions will increase more than 10 times from the completion of the first year in which the construction works will begin (2017), until the finalisation of the SEZ Bitung (2031) (see Table 29).

In terms of GHG emissions by sector, energy will account for more than 338,000 tCO_2e, and will be the main emitting sector in the SEZ Bitung. It will be followed by the transportation sector with 31,500 tCO_2e, waste (19,450 tCO_2e) and AFOLU (255 tCO_2e). Taking into account the energy subsectors, the industrial sub-sector would account for more than 304,000 tCO_2e, followed by the commercial sub-sector (18,480 tCO_2e) and the residential sub-sector (15,400 tCO_2e) (see Table 29 and Figure 34).

Variation in GHG emissions by sector will be particularly high in the waste sector (201%), the energy sector and the transportation sector (200%), with much less variation in the AFOLU sector (16%) in Phase 1. Moreover, taking into account the whole period from 2017 to 2031, GHG emissions from the waste sector will skyrocket by 1,340%, whereas the energy and transportation sector will rise by 1,290%, while the AFOLU sector emissions will just double (105%) (see Table 29).

In terms of GHG emissions by scope, at the end of Phase 5 in 2031, Scope 1 emissions will be the highest, totalling almost 240,000 tCO_2e (61% of total GHG emissions), whereas Scope 2 emissions will account for more than 130,000 tCO_2e (33%) and Scope 3 emissions will represent a mere 19,450 tCO_2e (5%) (see Table 30 and Figure 35).

As per the variation in GHG emissions by scope, Scope 1 emissions overall will vary 1,285 % from 2017-2031. Specifically, the increase will be led by the energy and transportation sector (1,294%) and the AFOLU sector (105%). In turn, Scope 2 emissions will increase by approximately 1,294% and Scope 3 emissions by more than 1,340% (see Table 30 and Figure 35).

Finally, when looking at GHG emissions by source, by 2031 the energy sector will be the main emitter, with 87% of the total GHG emissions, followed by the transportation sector (8%), the waste sector (5%) and the AFOLU sector (0.07%) with almost negligible contribution (see Figure 36).

Table 29: Overall GHG Emissions from the SEZ Bitung by Sector

SECTOR	Unit	Years 2016	2017	2019	2021	2023	2029	2031
Energy	t CO_2e	0.00	24,260.54	72,781.63	100,005.10	129,127.88	289,944.73	338,077.51
Industry	t CO_2e	0.00	21,827.43	65,482.30	89,975.50	116,177.53	260,865.92	304,171.42
Commercial	t CO_2e	0.00	1,326.75	3,980.24	5,469.02	7,061.66	15,856.32	18,488.57
Residential	t CO_2e	0.00	1,106.37	3,319.10	4,560.58	5,888.68	13,222.49	15,417.51
Transportation	t CO_2e	0.00	2,260.72	6,782.16	9,318.98	12,032.79	27,018.51	31,503.76
Waste	t CO_2e	0.00	1,352.17	4,073.13	5,620.37	7,288.90	16,597.63	19,449.75
IPPU	t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AFOLU	t CO_2e	-119.63	124.41	145.01	53.96	75.47	235.30	255.73
TOTAL BAU		-119.63	27,997.85	83,781.93	114,998.41	148,525.04	333,796.17	389,286.76

SECTOR	Unit	Phase 1 '17 -'19	Phase 2 '20 -'21	Phase 3 '22 -'23	Phase 4 '24 -'28	Phase 5 '29 -'31	TOTAL '17-'31
Energy	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Industry	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Commercial	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Residential	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Transportation	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Waste	t CO_2e	201.23%	37.99%	29.69%	127.71%	17.18%	1,338.41%
IPPU	t CO_2e	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AFOLU	t CO_2e	16.55%	-62.79%	39.86%	211.79%	8.68%	105.55%
TOTAL BAU		199.24%	37.26%	29.15%	124.74%	16.62%	1,290.42%

Source: Own elaboration

Table 30: Overall GHG Emissions from the SEZ Bitung by Scope

		Years						
SCOPE 1	**Unit**	**2016**	**2017**	**2019**	**2021**	**2023**	**2029**	**2031**
Energy	t CO_2e	0.00	14,848.15	44,544.45	61,205.99	79,029.97	177,454.50	206,913.14
Industry	t CO_2e	0.00	13,549.75	40,649.24	55,853.81	72,119.16	161,936.91	188,819.53
Commercial	t CO_2e	0.00	671.62	2,014.86	2,768.50	3,574.73	8,026.72	9,359.21
Residential	t CO_2e	0.00	626.78	1,880.35	2,583.68	3,336.08	7,490.86	8,734.40
Transportation	t CO_2e	0.00	2,260.72	6,782.16	9,318.98	12,032.79	27,018.51	31,503.76
Waste	t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IPPU	t CO_2e	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AFOLU	t CO_2e	-119.63	124.41	145.01	53.96	75.47	235.30	255.73
SUBTOTAL Scope 1		-119.63	17,233.28	51,471.61	70,578.93	91,138.23	204,708.31	238,672.64

		Years						
SCOPE 2	**Unit**	**2016**	**2017**	**2019**	**2021**	**2023**	**2029**	**2031**
Energy	t CO_2e	0.00	9,412.39	28,237.18	38,799.11	50,097.91	112,490.23	131,164.37
Industry	t CO_2e	0.00	8,277.69	24,833.06	34,121.69	44,058.37	98,929.01	115,351.89
Commercial	t CO_2e	0.00	655.13	1,965.38	2,700.51	3,486.94	7,829.60	9,129.36
Residential	t CO_2e	0.00	479.58	1,438.75	1,976.90	2,552.60	5,731.63	6,683.12
SUBTOTAL Scope 2		0.00	9,412.39	28,237.18	38,799.11	50,097.91	112,490.23	131,164.37

		Years						
SCOPE 3	**Unit**	**2016**	**2017**	**2019**	**2021**	**2023**	**2029**	**2031**
Waste	t CO_2e	0.00	1,352.17	4,073.13	5,620.37	7,288.90	16,597.63	19,449.75
SUBTOTAL Scope 3		0.00	1,352.17	4,073.13	5,620.37	7,288.90	16,597.63	19,449.75

		Years						
		2016	**2017**	**2019**	**2021**	**2023**	**2029**	**2031**
TOTAL	t CO_2e	-119.63	27,997.85	83,781.93	114,998.41	148,525.04	333,796.17	389,286.76

		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	TOTAL
SCOPE 1	**Unit**	**'17 -'19**	**'20 -'21**	**'22 -'23**	**'24 -'28**	**'29 -'31**	**'17-'31**
Energy	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Industry	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Commercial	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Residential	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Transportation	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Waste	t CO_2e	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
IPPU	t CO_2e	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
AFOLU	t CO_2e	16.55%	-62.79%	39.86%	211.79%	8.68%	105.55%
SUBTOTAL Scope 1		198.68%	37.12%	29.13%	124.61%	16.59%	1,284.95%

		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	TOTAL
SCOPE 2	**Unit**	**'17 -'19**	**'20 -'21**	**'22 -'23**	**'24 -'28**	**'29 -'31**	**'17-'31**
Energy	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Industry	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Commercial	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
Residential	t CO_2e	200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%
SUBTOTAL Scope 2		200.00%	37.40%	29.12%	124.54%	16.60%	1,293.53%

		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	TOTAL
SCOPE 3	**Unit**	**'17 -'19**	**'20 -'21**	**'22 -'23**	**'24 -'28**	**'29 -'31**	**'17-'31**
Waste	t CO_2e	201.23%	37.99%	29.69%	127.71%	17.18%	1,338.41%
SUBTOTAL Scope 3		201.23%	37.99%	29.69%	127.71%	17.18%	1,338.41%

		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	TOTAL
		'17 -'19	**'20 -'21**	**'22 -'23**	**'24 -'28**	**'29 -'31**	**'17-'31**
TOTAL	t CO_2e	199.24%	37.26%	29.15%	124.74%	16.62%	1290.42%

Source: Own elaboration

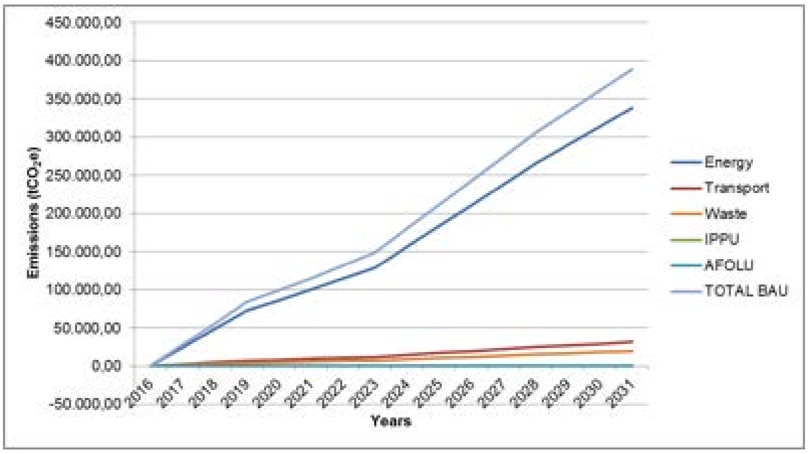


Figure 34: Overall GHG Emissions from the SEZ Bitung by Sector

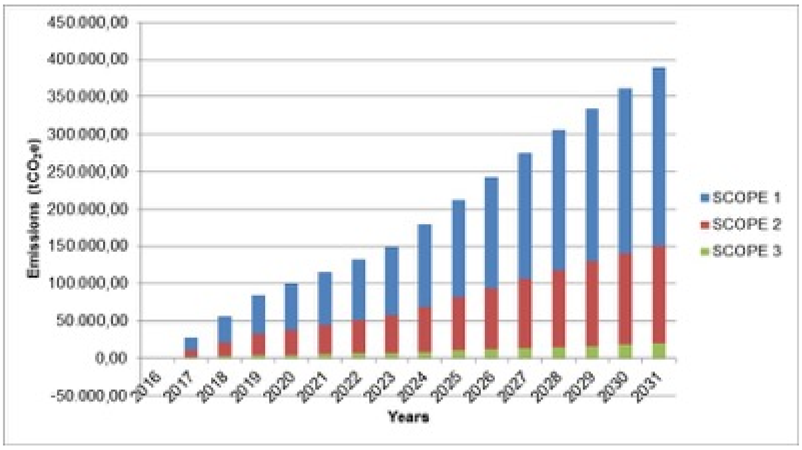


Figure 35: Overall GHG Emissions from the SEZ Bitung by Scope

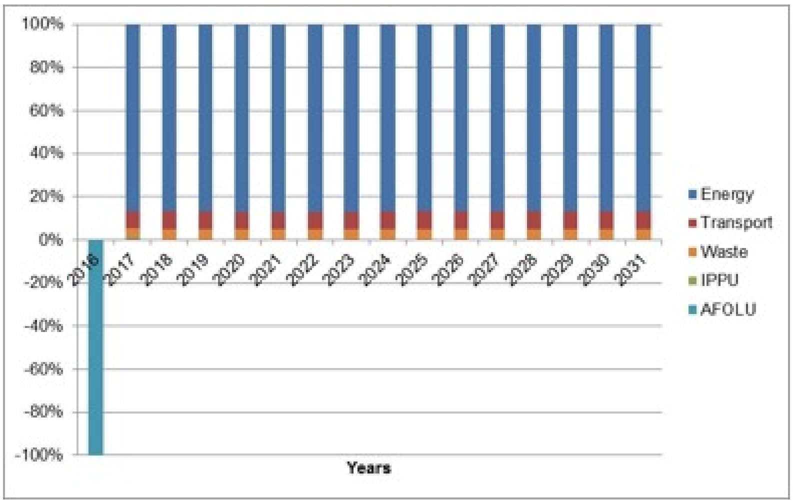


Figure 36: GHG Emissions from the SEZ Bitung by Source

2.3 Emission Reduction and Sustainable Development Targets

After setting the GHG emission baselines and BAU scenarios in the previous part, this section provides an overview of the ER targets by sector and overall for the SEZ Bitung project. The first sub-section presents the methodological approach that has been used to determine the GHG ER targets. Both sectoral and general approaches have been taken into account in order to develop:

1) a sectoral target-setting methodology that allows for the estimation of GHG ER in the identified targeted sectors; and

2) the GHG ER targets for the overall SEZ Bitung project.

In this regard, all national and sub-national pledges, planning and policies associated with climate change goals have been taken into account and analysed to ensure alignment with the SEZ Bitung ER targets.

In addition, SD targets will be set so as to identify and track potential environmental impacts (both positive and negative) resulting from the mitigation actions to be implemented and from the ER targets set for the SEZ Bitung.

2.3.1 Approach and Methodology

The GHG ER and SD targets which will be set for the SEZ Bitung have been assessed by applying a top-down and bottom-up approach. A set of broad ER and SD (economic, social and environmental) indicators have been identified and selected according to local circumstances, to allow for the monitoring of impacts and for the inclusion of these indicators into the local/national MRV[32] system, so they can be used in the eventual implementation phase of this LCMT strategy.

The methodology followed is based on the APEC LCMT Concept Guideline[33] and follows the steps described below:

1. **A desk review** of current planning and strategies for Bitung's development, and specifically for the SEZ, has been conducted. Moreover, special attention has been paid to documents relating to low carbon development.
2. **Climate and environmental targets** already set in place have been identified and analysed for the overall study area as well as per sector.
3. **A set of indicators** has been defined to track and evaluate progress towards the targets throughout the implementation of the LCMT (see tables of "summary of proposed ER targets" below and the section "SEZ Sustainable Development Targets").
4. **Qualitative assessment** has been conducted, with the aim of reviewing and contrasting the mitigation potential that was determined in the impact and cost of the project. This process is established on a coherent evaluation of the target setting and the impact of the selected mitigation actions to be implemented.
5. **Quantitative assessment and final revision of the ER and SD targets**. Once specific LCMs have been selected and quantitatively assessed under Activity 2 of the LCMT project, the qualitative assessment above was revised and refined using concrete estimations of the potential ER and SD results that could be achieved by carrying out the measures. In terms of mitigation potential, two scenarios have been assessed and compared in order to come up with ER targets per sector and for the overall SEZ Bitung:
    - BAU scenario: which includes GHG emissions levels in the absence of future, additional mitigation efforts and policies.
    - Mitigation scenario: which includes GHG emissions levels with the additional implementation of the LCMs.

[32] MRV: Monitoring, Reporting and Verification.
[33] APEC, "The Concept of the Low-Carbon Town in the APEC Region, Fourth Addition", November 2014.

2.3.2 Individual Target Sector Emission Reduction Targets

The existing SEZ Bitung Masterplan doesn't set any specific GHG ER targets at the local, sectoral or overall levels. A provincial target for North Sulawesi has also not been set, with a GHG ER target only being set at the national level. Specifically, Indonesia has set a voluntary GHG ER target of 26% based on national financial sources and up to 41% with international support by 2020 compared to 2005 baseline estimation. However, as the timeframe differs from that of the SEZ Bitung development (2017-2031), the target cannot be taken as a reference point for this project.

As a result, the evaluation of the mitigation potential per sector will qualitatively and quantitatively define the reference level of the sectoral targets. In order to do so, the BAU scenario for each sector has been assessed against the mitigation scenario. Specifically, the mitigation scenario has been developed based on the sectoral aggregation of the GHG ER potential achievable through the implementation of the 10 selected LCMs (see detailed information about the LCMs assessment in the Impact and Cost Report of selected LCMs).

It is important to note that the sectors have to be prioritised in order to select the mitigation actions that will be implemented in the future. There are two main components that define this process from a sectoral point of view: 1) the level of magnitude of GHG emissions; and 2) the level of ER potential.

Taking into account these two components, the sectors have been classified into high, mid and low priority. In the following parts, both scenarios (i.e. BAU and Mitigation) will be presented in two different approaches:

1) Yearly basis: the amount of GHG ERs achieved every year; and,

2) Cumulative basis: the amount of GHG ERs achieved throughout the period analysed, i.e. the sum of each year.

- **Energy Sector:**

GHG Emissions in the energy sector are driven by the consumption of fossil fuels and the end-use of electricity. As detailed in the previous sub-section, the baseline of North Sulawesi province has been defined according to its energy mix, which is related to the grid emission factor of the electricity consumption and the share of renewable energies in the grid[34]. In addition, an important note is that the electrification ratio of the area covered in the study, i.e. Bitung, was estimated at more than 95% in 2010[35].

In terms of the impact of the LCMs assessed in the energy sector (see "Impact and Cost Report of selected LCMs"), the utilisation of renewable energies and the implementation of EE measures are presented as crucial to achieving GHG ER and SD benefits in SEZ Bitung.

The LCMs examined in relation to RE are led by geothermal energy potential (150 MW), which is planned as a mid to long-term solution to the energy demand of the SEZ Bitung. The geothermal installation is expected to be up and running in 2025 (Phase 4) and will be operational for a period of 30 years.

Another LCM is the methane capture and anaerobic digestion (AD) system for solid waste and wastewater, which will be in place in the short-term (Phase 1) and will be operational for a period of 30 years. In addition, thermal energy generation from agricultural waste in the industrial sector will play a key role in GHG ER. Finally, solar rooftop installations in industrial, commercial and residential buildings all contribute to the mitigation potential of the energy sector.

These LCMs will all gradually replace the use of diesel generators and coal (e.g. industrial sector) and the regular North and Central Sulawesi power grid as the main source of energy for the SEZ. This will ultimately lead to significant GHG ER, and independence and security of the energy supply, along with additional SD benefits.

[34] The grid emission factor has been estimated in 0.7460 tCO_2e/kWh (year 2012).
[35] Source: RAD GRK SULUT document.

Moreover, the LCMs examined in relation to EE are led by a comprehensive EE programme for industrial buildings, appliances and processes which is followed by a similar programme in the residential and commercial sector.

These LCMs will reduce anticipated energy demand in the SEZ Bitung by reducing the dependence on fossil fuels and on the use of the power grid, providing significant GHG ER and SD benefits as a result.

The following table summarises the GHG ER that can be achieved in the energy sector for each LCM.

Table 31:Summary of GHG ER achieved in the energy sector per LCM

Sector	Subsector	LCMs assessed	GHG ER achieved in 2031 (tCO_2e)	Cumulative GHG ER achieved in 2031 (tCO_2e)
Energy	Industry, Commercial and Residential	Utilisation of Geothermal Energy	36,679.1	256,753.4
	Industry, Commercial and Residential	Use of Photo Voltaic (PV) panels on buildings	2,265.9	17,248.9
	Industry, Commercial and Residential	Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater	6,727.8	92,823.6
	Industry	Thermal energy generation from agricultural waste	6,003.7	49,230.2
	Industry	Comprehensive EE Program for the Industry Buildings, Appliances and Processes	18,740.2	140,601.5
	Commercial and Residential	Comprehensive Energy Efficiency (EE) Program for the Residential and Commercial Buildings and Appliances	5,786.1	44,044.8
	TOTAL		76,202.8	600,702.4

Source: Own elaboration

According to the BAU scenario, the energy sector will account for 87% of overall GHG emissions by the end of the development of the SEZ Bitung (2031). The GHG ER potential of each of the LCMs detailed above has been assessed under the Mitigation scenario.

Mitigation potential was assessed by comparing the Mitigation scenario with the BAU scenario. The mitigation potential of the energy sector equates to a reduction in GHG emissions of up to 22.5% below BAU levels on a yearly basis (2031) and an average of up to 21% below BAU levels throughout the project's development (2017-2031) (see Figure 37 and Table 33). Moreover, on a cumulative basis, mitigation potential is up to 23% and 19% below BAU levels respectively (see Figure 38 and Table 34).

The following table shows a summary of proposed ER targets in the energy sector:

Table 32:Summary of proposed ER targets in the energy sector

ER targets	End of SEZ Bitung development (2031) % below BAU	Average during the SEZ Bitung development (2017-2031) % below BAU
Yearly basis	22%	21%
Cumulative basis	23%	19%
Sector priority	HIGH: high GHG emissions and high mitigation potential level	

Source: Own elaboration

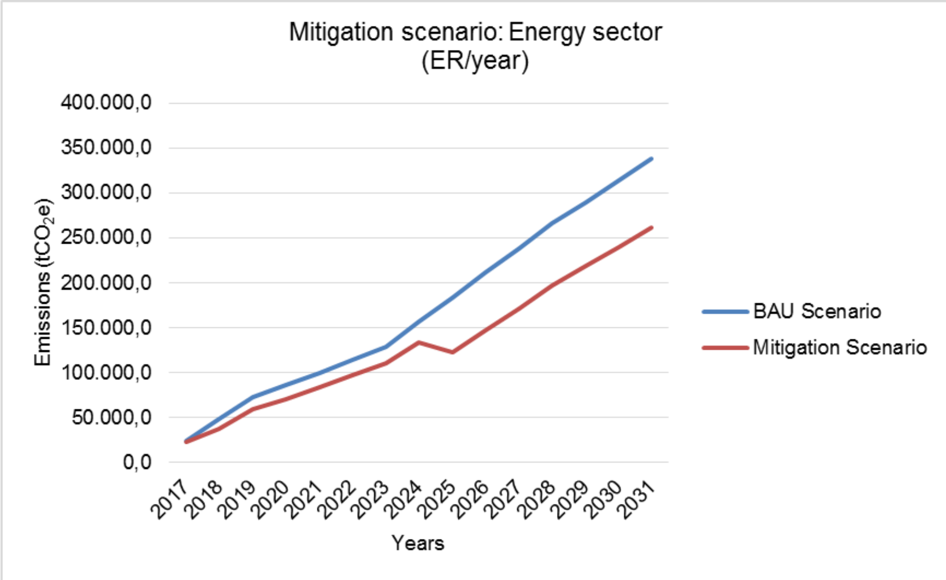


Figure 37: Mitigation scenario in the energy sector (yearly basis)[36]

Table 33: Energy sector ER target setting (yearly basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU	24.260,5	48.521,1	72.781,6	86.393,4	100.005,1	114.566,5	129.127,9	156.478,0	183.828,1	211.178,2	238.528,2	265.878,3	289.944,7	314.011,1	338.077,5	-
Overall GHG ER	1.579,7	11.232,5	13.222,7	15.523,0	16.621,2	17.899,6	19.176,5	22.568,8	61.437,4	63.625,4	67.012,6	69.196,9	71.133,8	74.269,7	76.202,8	100,0%
Mitigation Scenario	22.680,8	37.288,6	59.558,9	70.870,4	83.383,9	96.666,9	109.951,4	133.909,2	122.390,6	147.552,8	171.515,7	196.681,4	218.811,0	239.741,4	261.874,7	**Average (2017-2031)**
GHG ER ratio	6,5%	23,1%	18,2%	18,0%	16,6%	15,6%	14,9%	14,4%	33,4%	30,1%	28,1%	26,0%	24,5%	23,7%	**22,5%**	**21,0%**

Source: Own elaboration

[36] The sudden variation between years 2024 and 2025 in the Mitigation Scenario is due to the commissioning of the geothermal power plant which provides a significant GHG ER reduction from 2025 onwards.

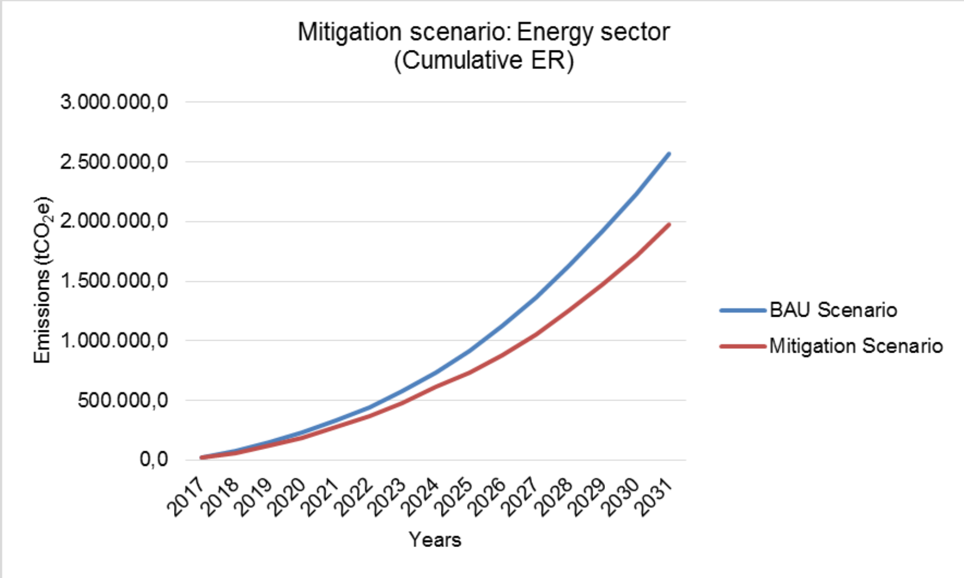


Figure 38: Mitigation scenario in the energy sector (cumulative basis)

Table 34: Energy sector ER target setting (cumulative basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU	24.260,5	72.781,6	145.563,3	231.956,6	331.961,7	446.528,2	575.656,1	732.134,1	915.962,1	1.127.140,3	1.365.668,5	1.631.546,9	1.921.491,6	2.235.502,7	2.573.580,2	-
OVERALL GHG ER	1.579,7	12.812,2	26.034,9	41.557,9	58.179,0	76.078,6	95.255,1	117.823,9	179.261,3	242.886,6	309.899,2	379.096,1	450.229,9	524.499,6	600.702,4	100,0%
Mitigation Scenario	22.680,8	59.969,4	119.528,4	190.398,8	273.782,7	370.449,6	480.401,0	614.310,2	736.700,8	884.253,6	1.055.769,3	1.252.450,7	1.471.261,7	1.711.003,1	1.972.877,9	**Average (2017-2031)**
GHG ER ratio	6,5%	17,6%	17,9%	17,9%	17,5%	17,0%	16,5%	16,1%	19,6%	21,5%	22,7%	23,2%	23,4%	23,5%	**23,3%**	**19,0%**

Source: Own elaboration

- **Industrial sector**

The industrial sector, as an energy subsector, has the most relevant role in terms of GHG emissions and mitigation potential within SEZ Bitung.

The following table summarises the GHG ER that can be achieved in the industry sector per LCM:

Table 35: Summary of GHG ER that can be achieved in the industry sector per LCM

Sector	Subsector	LCMs assessed	GHG ER achieved in 2031 (tCO_2e)	Cumulative GHG ER achieved in 2031 (tCO_2e)
Energy	Industry	Utilisation of Geothermal Energy	32,257.22	225,800.55
	Industry	Use of Photo Voltaic (PV) panels on buildings	1,659.33	12,631.46
	Industry	Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater	5,916.78	81,633.26
	Industry	Thermal energy generation from agricultural waste	6,003.69	49,230.22
	Industry	Comprehensive EE Program for the Industry Buildings, Appliances and Processes	18,740.18	140,601.51
	TOTAL		64,577.19	509,897.00

Source: Own elaboration

According to the BAU scenario, the industry sector will represent 90% of GHG emissions from the energy sector and 78% of overall GHG emissions in the SEZ Bitung development by 2031.

The GHG ER potential of each of the LCMs detailed above has been assessed under the Mitigation scenario.

The mitigation potential of the energy sector equates to a reduction in GHG emissions of up to 22.5% below BAU levels on a yearly basis (2031) and an average of up to 21% below BAU levels throughout the project's development (2017-2031) (see Figure 37 and Table 33). The cumulative mitigation potential is up to 23% on a yearly basis and 19% on average compared to BAU levels (see Figure 38 and Table 34).

Mitigation potential was assessed by comparing the Mitigation scenario with the BAU scenario. The mitigation potential of the industry sector equates to a reduction in GHG emissions of up to 21.2% below BAU levels on a yearly basis (2031) and an average of up to 19.8% below BAU levels throughout the project's development (2017-2031) (see Figure 39 and Table 37).

Moreover, on a cumulative basis, the mitigation potential is up to 22% and 17.7% below BAU levels respectively (see Figure 40 and Table 38).

The following table shows a summary of proposed ER targets in the industry sector.

Table 36: Summary of proposed ER targets in the industry sector

ER targets	End of SEZ Bitung development (2031) % below BAU	Average during the SEZ Bitung development (2017-2031) % below BAU
Yearly basis	21%	20%
Cumulative basis	22%	18%
Sector priority	HIGH: high GHG emissions and high mitigation potential level	

Source: Own elaboration

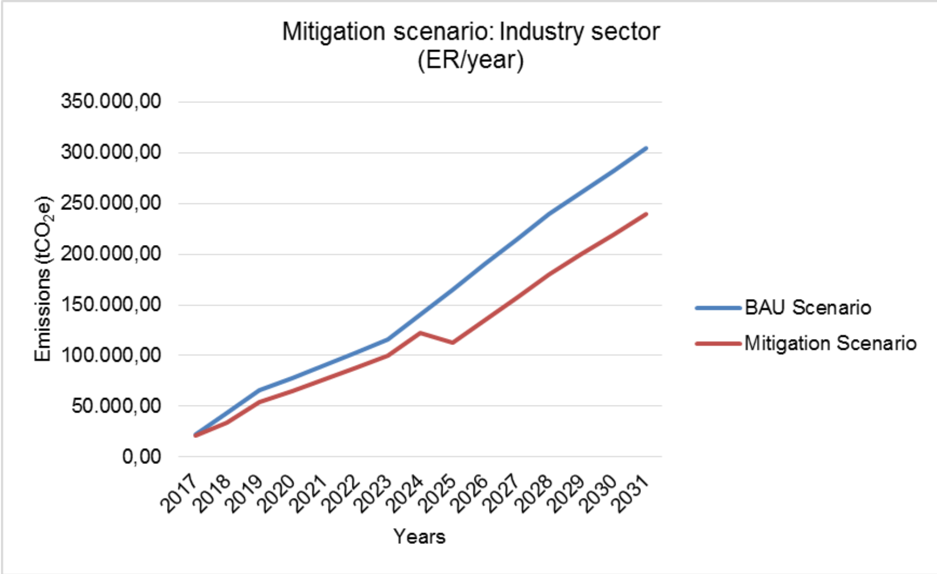


Figure 39: Mitigation scenario in the industry sector (yearly basis) [37]

Table 37: Industry sector ER target setting (yearly basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	21.827,43	43.654,87	65.482,30	77.728,90	89.975,50	103.076,52	116.177,53	140.784,66	165.391,79	189.998,91	214.606,04	239.213,17	260.865,92	282.518,67	304.171,42	-
OVERALL GHG ER	1.121,08	9.532,85	11.060,83	13.100,59	13.938,40	14.938,71	15.937,72	18.810,15	52.737,66	54.406,45	57.274,45	58.940,10	60.420,64	63.100,19	64.577,19	100,0%
Mitigation Scenario	20.706,35	34.122,01	54.421,47	64.628,31	76.037,10	88.137,81	100.239,82	121.974,52	112.654,13	135.592,47	157.331,59	180.273,07	200.445,28	219.418,48	239.594,24	**Average (2017-2031)**
GHG ER ratio	5,1%	21,8%	16,9%	16,9%	15,5%	14,5%	13,7%	13,4%	31,9%	28,6%	26,7%	24,6%	23,2%	22,3%	21,2%	**19,8%**

Source: Own elaboration

[37] The sudden variation between years 2024 and 2025 in the Mitigation Scenario is due to the commissioning of the geothermal power plant which provides a significant GHG ER reduction from 2025 onwards.

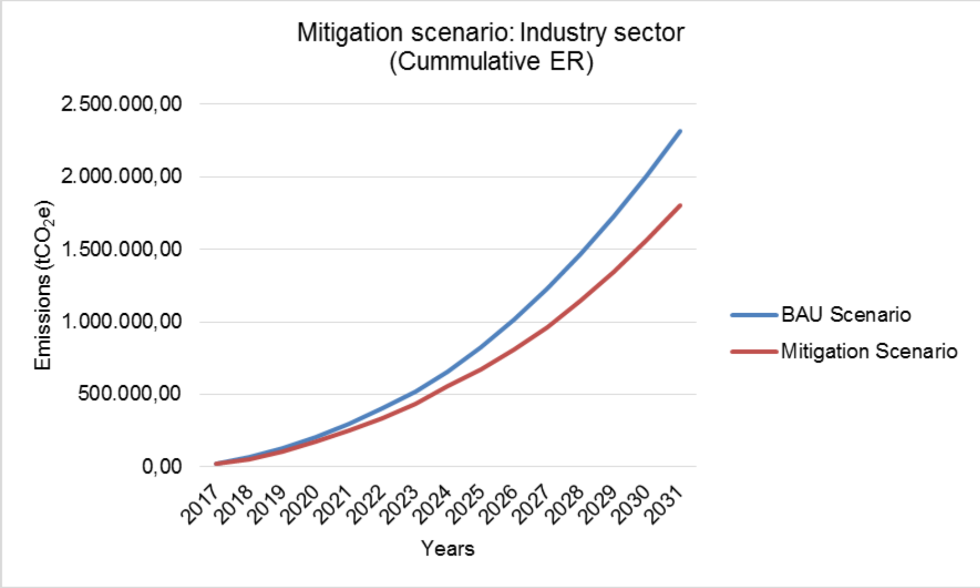


Figure 40: Mitigation scenario in the industry sector (cumulative basis)

Table 38: Industry sector ER target setting (cumulative basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	21.827,43	65.482,30	130.964,60	208.693,49	298.669,00	401.745,52	517.923,05	658.707,71	824.099,50	1.014.098,41	1.228.704,45	1.467.917,62	1.728.783,54	2.011.302,21	2.315.473,64	-
OVERALL GHG ER	1.121,08	10.653,93	21.714,76	34.815,36	48.753,76	63.692,47	79.630,19	98.440,34	151.177,99	205.584,44	262.858,89	321.798,99	382.219,62	445.319,82	509.897,00	100,0%
Mitigation Scenario	20.706,35	54.828,37	109.249,83	173.878,14	249.915,24	338.053,05	438.292,86	560.267,38	672.921,51	808.513,98	965.845,56	1.146.118,64	1.346.563,92	1.565.982,40	1.805.576,63	**Average (2017-2031)**
GHG ER ratio	5,1%	16,3%	16,6%	16,7%	16,3%	15,9%	15,4%	14,9%	18,3%	20,3%	21,4%	21,9%	22,1%	22,1%	22,0%	**17,7%**

Source: Own elaboration

- **Commercial sector**

The commercial sector, as an energy subsector, is of limited importance regarding its GHG ER potential when compared with the industry sector.

The following table summarises the GHG ER that can be achieved in the commercial sector per LCM.

Table 39: Summary of GHG ER achieved in the commercial sector per LCM

Sector	Subsector	LCMs assessed	GHG ER achieved in 2031 (tCO_2e)	Cumulative GHG ER achieved in 2031 (tCO_2e)
Energy	Commercial	Utilization of Geothermal Energy	2,552.95	17,870.66
	Commercial	Use of Photo Voltaic (PV) panels on buildings	350.20	2,665.86
	Commercial	Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater	468.27	6,460.75
	Commercial	Comprehensive Energy Efficiency (EE) Program for the Residential and Commercial Buildings and Appliances	3,155.10	24,017.10
	TOTAL		6,526.53	51,014.37

Source: Own elaboration

According to the BAU scenario, the commercial sector will account for 5.5% of GHG emissions in the energy sector and 4.7% of overall GHG emissions in the SEZ Bitung development (2031). The GHG ER potential of each of the LCMs detailed above has been assessed under the Mitigation Scenario.

Mitigation potential was assessed by comparing the Mitigation scenario with the BAU scenario. The mitigation potential of the commercial sector equates a reduction in GHG emissions of up to 35.3% below BAU levels on a yearly basis (2031) and an average of up to 33.5% below BAU levels throughout the project's development (2017-2031) (see Figure 41 and Table 41). Moreover, on a cumulative basis, the mitigation potential is up to 36.2% and 31.1% below BAU levels respectively (see Figure 42 and Table 42).

The following table shows a summary of proposed ER targets in the commercial sector.

Table 40: Summary of proposed ER targets in the commercial sector

ER targets	End of SEZ Bitung development (2031) % below BAU	Average during the SEZ Bitung development (2017-2031) % below BAU
Yearly basis	35%	33%
Cumulative basis	36%	31%
Sector priority	MID: mid GHG emissions and high mitigation potential level	

Source: Own elaboration

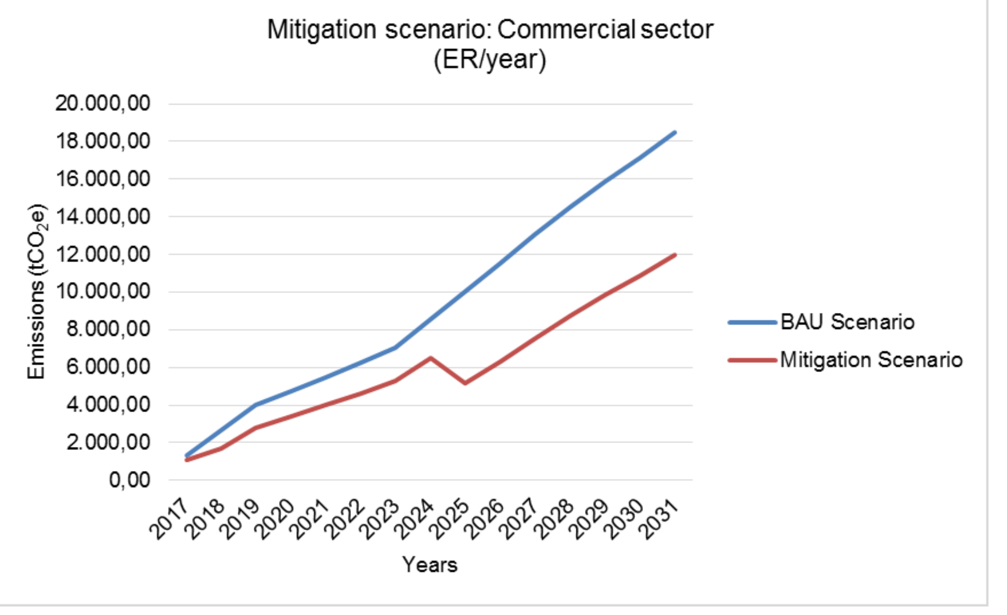


Figure 41: Mitigation scenario in the commercial sector (yearly basis) [38]

Table 41: Commercial sector ER target setting (yearly basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	1.326,75	2.653,49	3.980,24	4.724,63	5.469,02	6.265,34	7.061,66	8.557,37	10.053,07	11.548,78	13.044,48	14.540,19	15.856,32	17.172,44	18.488,57	-
OVERALL GHG ER	251,48	954,66	1.208,21	1.351,16	1.494,01	1.646,59	1.799,07	2.084,17	4.921,95	5.206,67	5.491,42	5.775,89	6.026,14	6.276,41	6.526,53	100,0%
Mitigation Scenario	1.075,26	1.698,83	2.772,03	3.373,47	3.975,00	4.618,75	5.262,60	6.473,20	5.131,12	6.342,11	7.553,06	8.764,30	9.830,18	10.896,04	11.962,04	**Average (2017-2031)**
GHG ER ratio	19,0%	36,0%	30,4%	28,6%	27,3%	26,3%	25,5%	24,4%	49,0%	45,1%	42,1%	39,7%	38,0%	36,5%	35,3%	**33,5%**

Source: Own elaboration

[38] The sudden variation between years 2024 and 2025 in the Mitigation Scenario is due to the commissioning of the geothermal power plant which provides a significant GHG ER reduction from 2025 onwards.

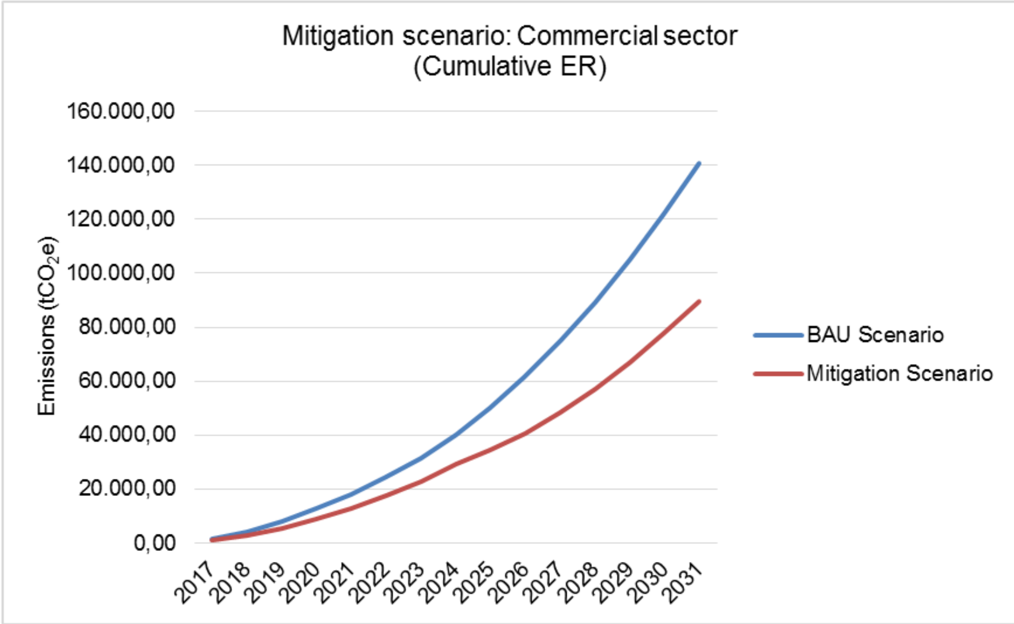


Figure 42: Mitigation scenario in the commercial sector (cumulative basis)

Table 42: Commercial sector ER target setting (cumulative basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	1.326,75	3.980,24	7.960,47	12.685,10	18.154,12	24.419,46	31.481,12	40.038,49	50.091,57	61.640,34	74.684,83	89.225,02	105.081,33	122.253,78	140.742,35	-
OVERALL GHG ER	251,48	1.206,14	2.414,35	3.765,51	5.259,53	6.906,12	8.705,19	10.789,36	15.711,32	20.917,99	26.409,41	32.185,30	38.211,44	44.487,84	51.014,37	100,0%
Mitigation Scenario	1.075,26	2.774,09	5.546,12	8.919,58	12.894,59	17.513,33	22.775,93	29.249,13	34.380,25	40.722,35	48.275,42	57.039,72	66.869,89	77.765,93	89.727,98	**Average (2017-2031)**
GHG ER ratio	19,0%	30,3%	30,3%	29,7%	29,0%	28,3%	27,7%	26,9%	31,4%	33,9%	35,4%	36,1%	36,4%	36,4%	36,2%	**31,1%**

Source: Own elaboration

- **Residential sector**

The residential sector, as an energy subsector, is similar to the commercial sector in that it is of limited importance regarding its GHG ER potential when compared with the industry sector.

The following table summarises the GHG ER achieved in the residential sector per LCM.

Table 43: Summary of GHG ER achieved in the residential sector per LCM

Sector	Subsector	LCMs assessed	GHG ER achieved in 2031 (tCO_2e)	Cumulative GHG ER achieved in 2031 (tCO_2e)
Energy	Residential	Utilization of Geothermal Energy	1,868.88	13,082.15
	Residential	Use of Photo Voltaic (PV) panels on buildings	256.36	1,951.54
	Residential	Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater	342.80	4,729.57
	Residential	Comprehensive Energy Efficiency (EE) Program for the Residential and Commercial Buildings and Appliances	2,631.02	20,027.72
	TOTAL		5,099.06	39,790.98

Source: Own elaboration

According to the BAU scenario, the residential sector will account for 4.6% of energy sector GHG emissions and 4% of the overall GHG emissions in the SEZ Bitung development (2031). The GHG ER potential of each of the LCMs detailed above has been assessed under the Mitigation Scenario.

Mitigation potential was assessed by comparing the Mitigation scenario with the BAU scenario. The mitigation potential of the residential sector equates to a reduction of up to 33.1% below BAU levels on a yearly basis (2031) and an average of up to 31.5% below BAU levels throughout the project's development (2017-2031) (see Figure 43 and Table 45). Moreover, on a cumulative basis, the mitigation potential is up to 33.9% and 29.4% below BAU levels respectively (see Figure 44 and Table 46).

The following table shows a summary of proposed ER targets in the residential sector.

Table 44: Summary of proposed ER targets in the residential sector

ER targets	End of SEZ Bitung development (2031) % below BAU	Average during the SEZ Bitung development (2017-2031) % below BAU
Yearly basis	33%	31%
Cumulative basis	34%	29%
Sector priority	MID: mid GHG emissions and high mitigation potential level	

Source: Own elaboration

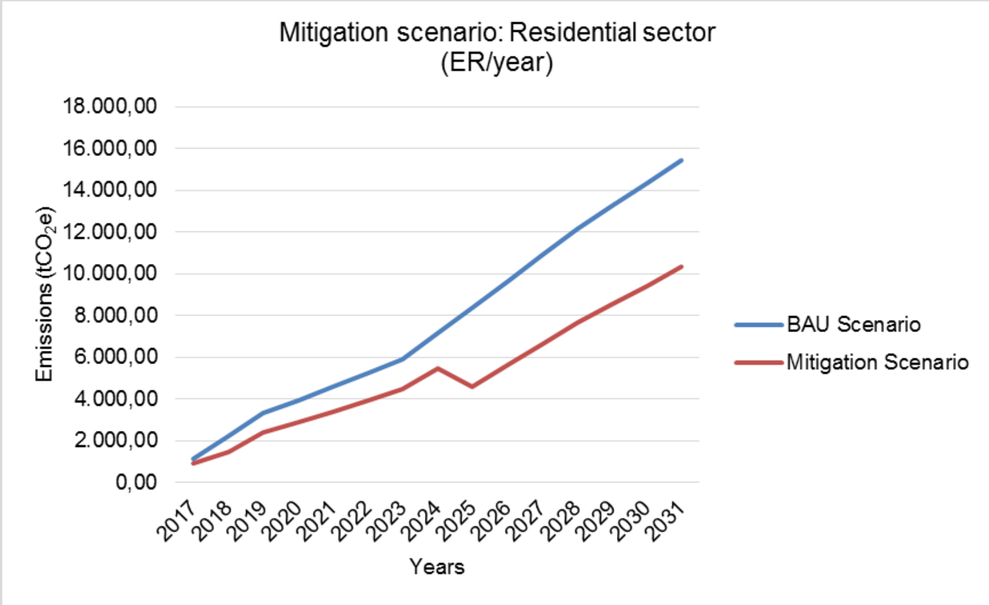


Figure 43: Mitigation scenario in the residential sector (yearly basis) [39]

Table 45: Residential sector ER target setting (yearly basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	1.106,37	2.212,73	3.319,10	3.939,84	4.560,58	5.224,63	5.888,68	7.135,94	8.383,20	9.630,46	10.877,72	12.124,98	13.222,49	14.320,00	15.417,51	-
OVERALL GHG ER	207,15	744,96	953,64	1.071,22	1.188,74	1.314,27	1.439,73	1.674,44	3.777,82	4.012,24	4.246,70	4.480,93	4.686,99	4.893,08	5.099,06	100,0%
Mitigation Scenario	899,22	1.467,77	2.365,45	2.868,61	3.371,84	3.910,36	4.448,95	5.461,50	4.605,38	5.618,22	6.631,02	7.644,05	8.535,50	9.426,92	10.318,45	**Average (2017-2031)**
GHG ER ratio	18,7%	33,7%	28,7%	27,2%	26,1%	25,2%	24,4%	23,5%	45,1%	41,7%	39,0%	37,0%	35,4%	34,2%	33,1%	**31,5%**

Source: Own elaboration

[39] The sudden variation between years 2024 and 2025 in the Mitigation Scenario is due to the commissioning of the geothermal power plant which provides a significant GHG ER reduction from 2025 onwards.

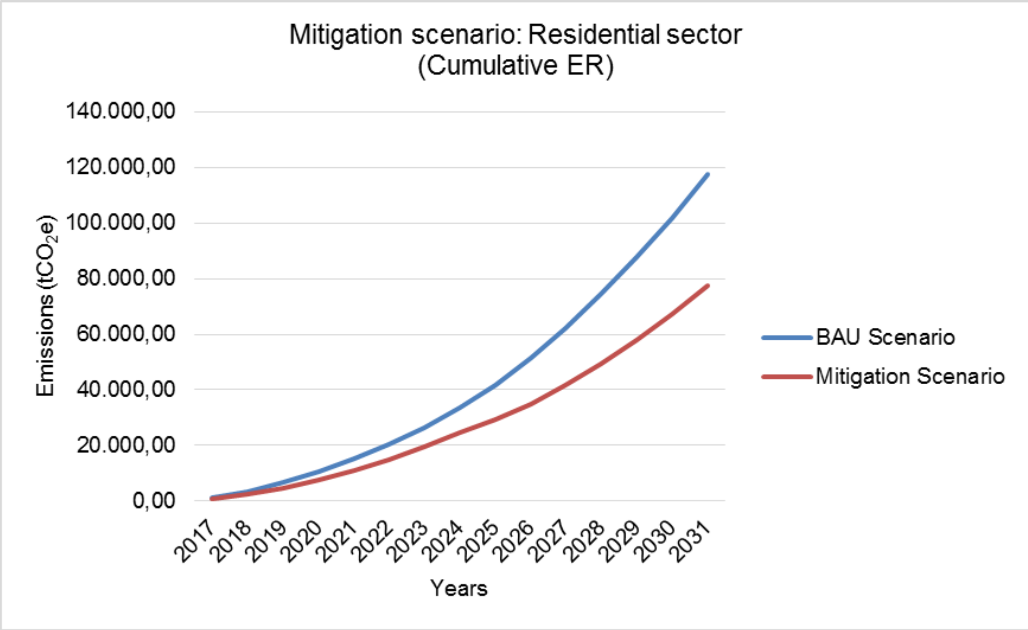


Figure 44: Mitigation scenario in the residential sector (cumulative basis)

Table 46: Residential sector ER target setting (cumulative basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	1.106,37	3.319,10	6.638,19	10.578,03	15.138,61	20.363,25	26.251,93	33.387,87	41.771,07	51.401,53	62.279,25	74.404,23	87.626,72	101.946,73	117.364,24	-
OVERALL GHG ER	207,15	952,11	1.905,76	2.976,98	4.165,72	5.479,99	6.919,72	8.594,16	12.371,98	16.384,22	20.630,92	25.111,84	29.798,84	34.691,91	39.790,98	100,0%
Mitigation Scenario	899,22	2.366,98	4.732,44	7.601,05	10.972,89	14.883,25	19.332,21	24.793,71	29.399,09	35.017,31	41.648,34	49.292,39	57.827,89	67.254,81	77.573,26	**Average (2017-2031)**
GHG ER ratio	18,7%	28,7%	28,7%	28,1%	27,5%	26,9%	26,4%	25,7%	29,6%	31,9%	33,1%	33,8%	34,0%	34,0%	33,9%	**29,4%**

Source: Own elaboration

- **Transportation sector**

A main environmental challenge of the transportation sector, besides the consumption of fossil fuels (i.e. diesel and gasoline) and the resulting GHG emissions, is the related air pollution. Other additional aspects that are relevant to this sector are the service coverage (for example, of public transport options) and the existing infrastructure, in addition to the range of means of transportation used (in particular, the split between private and public means).

LCMs relevant for the transportation sector (see "Impact and Cost Report of selected LCMs") are mainly focussed on facilitating a shift from individual private and motorised vehicles (i.e. passenger cars), to other environmental friendly means of transport such as articulated buses (i.e. BRT) and bicycles (i.e NMT), through improvement of the overall transport infrastructure (i.e. Transit-Oriented-Development (TOD)). The implementation of these LCMs will therefore decrease energy demand in the transportation sector by reducing its dependence on fossil fuels (i.e. diesel and gasoline) and providing GHG ER and SD benefits as a result.

The following table summarises the GHG ER that can be achieved in the transportation sector per LCM:

Table 47: Summary of GHG ER achieved in the transportation sector per LCM

Sector	LCMs assessed	GHG ER achieved in 2031 (tCO_2e)	Cumulative GHG ER achieved in 2031 (tCO_2e)
Transportation	Bus Rapid Transit (BRT)	1,120.83	7,939.87
	Non-Motorised Transport (NMT) and Transit-Oriented-Development (TOD)	251.76	1,292.86
	TOTAL	1,372.59	9,232.73

According to the BAU scenario, the transportation sector will account for 8% of overall GHG emissions by the end of the SEZ Bitung development (2031). The GHG ER potential of each of the LCMs detailed above has been assessed under the Mitigation Scenario.

Mitigation potential was assessed by comparing the Mitigation scenario with the BAU scenario. The mitigation potential of the transportation sector equates to a reduction of up to 4.4% below BAU levels on a yearly basis (2031) and an average of up to 3.5% below BAU levels throughout the project's development (2017-2031) (see Figure 45 and Table 49). Moreover, on a cumulative basis, the mitigation potential is up to 3.8% and 3.2% below BAU levels respectively (see Figure 46 and Table 50).

The following table shows a summary of proposed ER targets in the transportation sector:

Table 48: Summary of proposed ER targets in the transportation sector

ER targets	End of SEZ Bitung development (2031) % below BAU	Average during the SEZ Bitung development (2017-2031) % below BAU
Yearly basis	4%	3%
Cumulative basis	4%	3%
Sector priority	MID: high GHG emissions and low mitigation potential level	

Source: Own elaboration

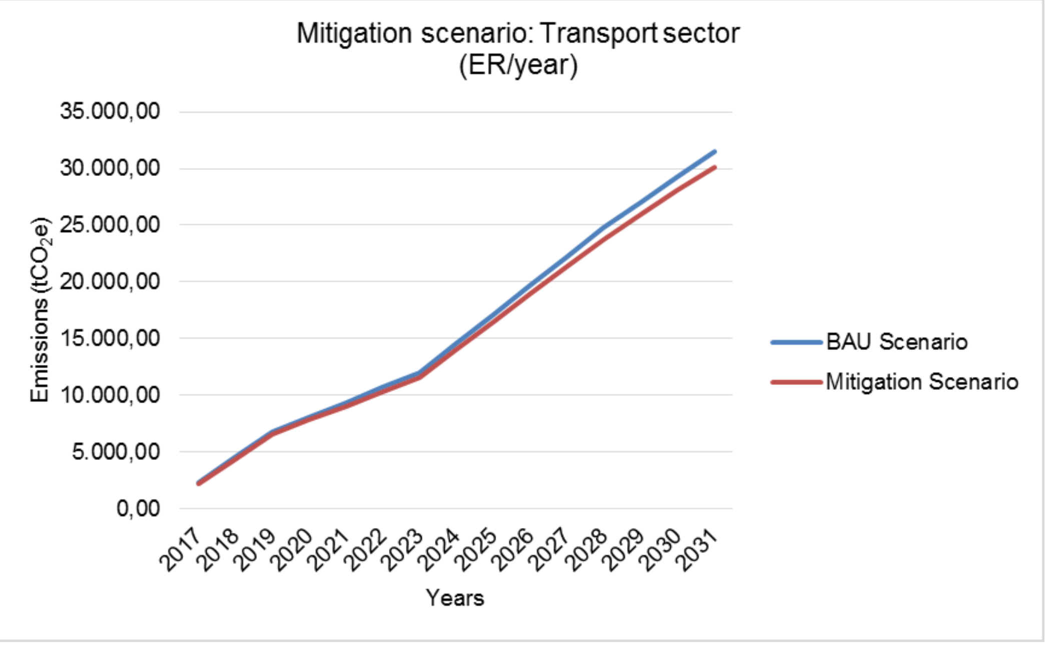


Figure 45: Mitigation scenario in the transport sector (yearly basis)

Table 49: Transport sector ER target setting (yearly basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	2.260,72	4.521,44	6.782,16	8.050,57	9.318,98	10.675,88	12.032,79	14.581,41	17.130,02	19.678,64	22.227,26	24.775,88	27.018,51	29.261,14	31.503,76	-
OVERALL GHG ER	12,27	164,54	226,57	236,67	296,61	358,55	421,83	544,38	668,93	748,99	879,56	1013,46	1099,53	1188,26	1372,59	100,0%
Mitigation Scenario	2.248,45	4.356,90	6.555,59	7.813,90	9.022,37	10.317,33	11.610,96	14.037,03	16.461,09	18.929,65	21.347,71	23.762,42	25.918,98	28.072,87	30.131,17	**Average (2017-2031)**
GHG ER ratio	0,5%	3,6%	3,3%	2,9%	3,2%	3,4%	3,5%	3,7%	3,9%	3,8%	4,0%	4,1%	4,1%	4,1%	4,4%	**3,5%**

Source: Own elaboration

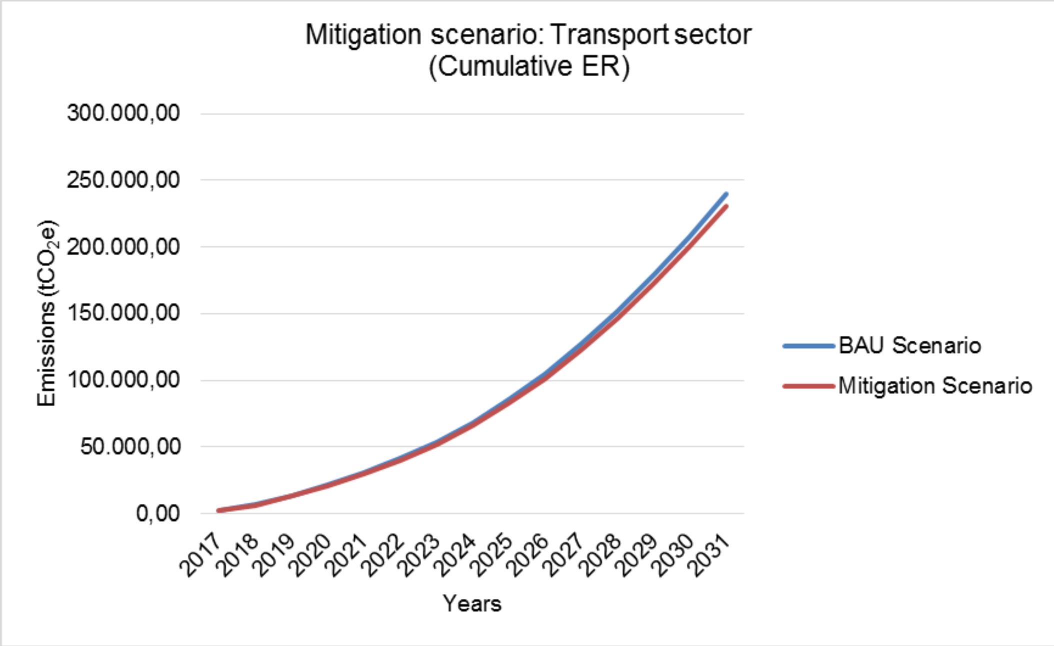


Figure 46: Mitigation scenario in the transport sector (cumulative basis)

Table 50: Transport sector ER target setting (cumulative basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	2.260,72	6.782,16	13.564,32	21.614,89	30.933,86	41.609,75	53.642,53	68.223,94	85.353,96	105.032,61	127.259,87	152.035,75	179.054,26	208.315,40	239.819,16	-
OVERALL GHG ER	12,27	176,81	403,38	640,04	936,65	1295,20	1717,03	2261,41	2930,34	3679,33	4558,89	5572,35	6671,87	7860,14	9232,73	100,0%
Mitigation Scenario	2.248,45	6.605,35	13.160,94	20.974,84	29.997,22	40.314,55	51.925,51	65.962,53	82.423,62	101.353,27	122.700,98	146.463,40	172.382,39	200.455,26	230.586,43	**Average (2017-2031)**
GHG ER ratio	0,5%	2,6%	3,0%	3,0%	3,0%	3,1%	3,2%	3,3%	3,4%	3,5%	3,6%	3,7%	3,7%	3,8%	3,8%	**3,2%**

Source: Own elaboration

- **Waste sector:**

The waste sector is connected with other sectors such as the industrial commercial and residential energy use sub-sectors. The main parameters that need to be taken into account are: the waste generation ratio per capita (SWM/inhabitant); the type of sorting the waste (e.g. recycling, composting, etc.); and the waste disposal technologies and management systems in place (e.g. open burning, landfill, etc.). The main source of GHG emissions is the decomposition of organic waste transported to landfill (i.e. methane).

The LCM assessed for this sector is an integrated solid waste management system and 3R strategies (see "Impact and Cost Report of selected LCMs"), which includes the generation of compost, recycling of waste and the generation of electricity from biomass. The implementation of this LCM will stop the release of methane into the atmosphere (which has 25 times more GWP), and lead to an increase in energy independence, security and supply within the SEZ Bitung. This reduced dependence on fossil fuels and use of the power grid will provide relevant GHG ER and SD benefits.

The following table summarises the GHG ER achieved in the waste sector per LCM:

Table 51: Summary of GHG ER achieved in the waste sector per LCM

Sector	LCMs assessed	GHG ER achieved in 2031 (tCO_2e)	Cumulative GHG ER achieved in 2031 (tCO_2e)
Waste	Integrated Solid Waste Management System and 3R strategies	5,963.23	36,861.76
	TOTAL	5,963.23	36,861.76

Source: Own elaboration

According to the BAU scenario, the waste sector will account for 5% of overall GHG emissions by the end of SEZ Bitung development (2031). The GHG ER potential of each of the LCMs detailed above has been assessed under the Mitigation Scenario.

Mitigation potential was assessed by comparing the Mitigation scenario with the BAU scenario. The mitigation potential of the waste sector equates to up to 30.7% below BAU levels on a yearly basis (2031) and an average of up to 21.4% below BAU levels throughout the project's development (2017-2031) (see Figure 47 and Table 53). Moreover, on a cumulative basis, the mitigation potential is up to 25.2% and 17.8% below BAU levels respectively (see Figure 48 and Table 54).

The following table shows a summary of proposed ER targets in the waste sector:

Table 52: Summary of proposed ER targets in the waste sector

ER targets	End of SEZ Bitung development (2031) % below BAU	Average during the SEZ Bitung development (2017-2031) % below BAU
Yearly basis	31%	21%
Cumulative basis	25%	18%
Sector priority	HIGH: high GHG emissions and high mitigation potential level	

Source: Own elaboration

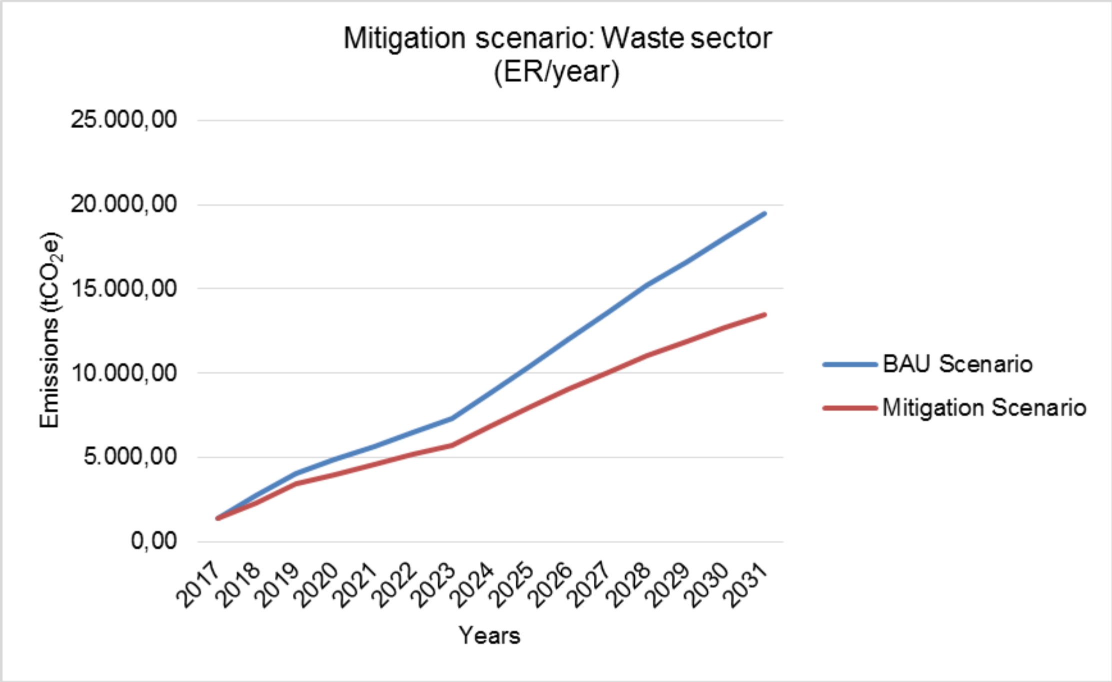


Figure 47: Mitigation scenario in the waste sector (yearly basis)

Table 53: Waste sector ER target setting (yearly basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	1.352,17	2.709,83	4.073,13	4.845,04	5.620,37	6.452,71	7.288,90	8.852,55	10.423,57	12.002,18	13.588,57	15.182,97	16.597,63	18.019,82	19.449,75	-
OVERALL GHG ER	0,00	414,80	671,55	855,99	1.059,31	1.292,36	1.545,89	1.982,05	2.456,89	2.970,73	3.523,91	4.116,76	4.696,46	5.311,84	5.963,23	100,0%
Mitigation Scenario	1.352,17	2.295,03	3.401,59	3.989,05	4.561,06	5.160,35	5.743,01	6.870,50	7.966,69	9.031,44	10.064,66	11.066,21	11.901,18	12.707,99	13.486,52	**Average (2017-2031)**
GHG ER ratio	0,0%	15,3%	16,5%	17,7%	18,8%	20,0%	21,2%	22,4%	23,6%	24,8%	25,9%	27,1%	28,3%	29,5%	30,7%	**21,4%**

Source: Own elaboration

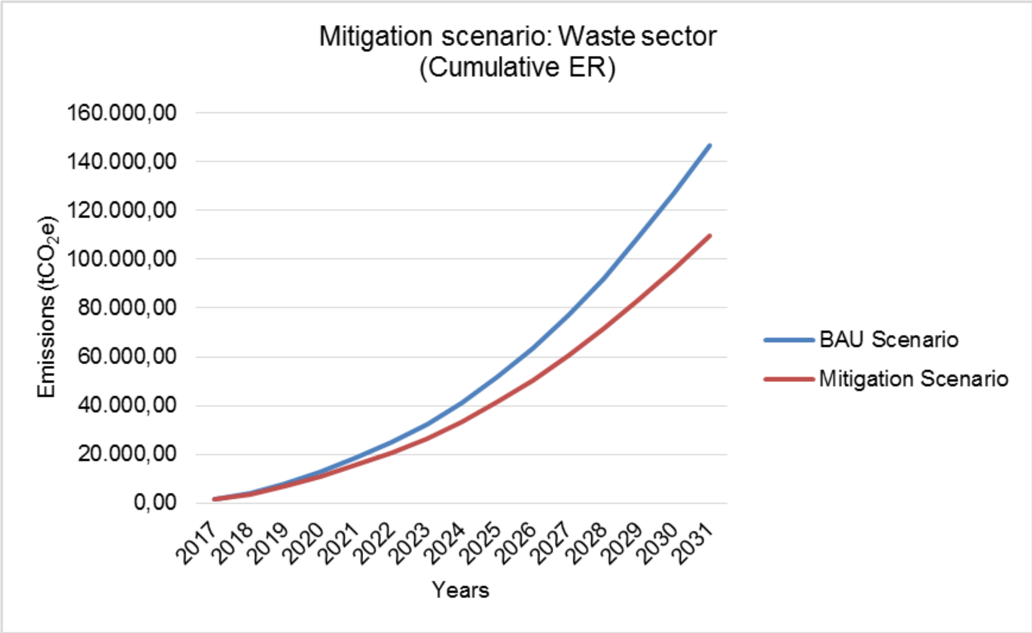


Figure 48: Mitigation scenario in the waste sector (cumulative basis)

Table 54: Waste sector ER target setting (cumulative basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	1.352,17	4.062,00	8.135,13	12.980,17	18.600,55	25.053,26	32.342,16	41.194,71	51.618,28	63.620,46	77.209,03	92.392,01	108.989,64	127.009,46	146.459,22	-
OVERALL GHG ER	0,00	414,80	1.086,34	1.942,34	3.001,65	4.294,00	5.839,89	7.821,94	10.278,83	13.249,56	16.773,47	20.890,23	25.586,69	30.898,53	36.861,76	100,0%
Mitigation Scenario	1.352,17	3.647,20	7.048,79	11.037,84	15.598,90	20.759,25	26.502,27	33.372,77	41.339,46	50.370,90	60.435,56	71.501,77	83.402,95	96.110,93	109.597,45	**Average (2017-2031)**
GHG ER ratio	0,0%	10,2%	13,4%	15,0%	16,1%	17,1%	18,1%	19,0%	19,9%	20,8%	21,7%	22,6%	23,5%	24,3%	25,2%	**17,8%**

Source: Own elaboration

- **AFOLU sector**

The AFOLU sector includes the following land uses and specific areas: settlements (27 ha), dry land agriculture (107 ha), mixed/dry land agriculture (80 ha), agroforestry use (27 ha) and other land uses (294 ha). It is important to note that, compared to the baseline, GHG emissions will be much higher once the SEZ Bitung has been constructed, as the construction itself will ultimately involve many of these areas being cleared for the construction of industrial, commercial or residential buildings, in addition to transport and energy infrastructure, etc. The LCM identified aims to enhance urban green spaces, which will act as carbon sinks and will therefore perform important preservation functions.

The following table summarises the GHG ER achieved in the AFOLU sector per LCM:

Table 55: Summary of GHG ER achieved in the AFOLU sector per LCM

Sector	LCMs assessed	GHG ER achieved in 2031 (tCO_2e)	Cumulative GHG ER achieved in 2031 (tCO_2e)
AFOLU	Urban Forestry and Urban Greening	222.99	1,707.21
	TOTAL	222.99	1,707.21

Source: Own elaboration

According to the BAU scenario, the AFOLU sector will account for 0.1% of overall GHG emissions by the end of SEZ Bitung development (2031). The GHG ER potential of each of the LCM detailed above has been assessed under the Mitigation Scenario.

Mitigation potential was assessed by comparing the Mitigation scenario with the BAU scenario. The mitigation potential of the AFOLU sector equates to up to 87.2% below BAU levels on a yearly basis (2031) and an average of up to 72.7% below BAU levels throughout the project's development (2017-2031) (see Figure 49 and Table 57). Moreover, on a cumulative basis, the mitigation potential is up to 66.8% and 48.3% below BAU levels respectively (see Figure 50 and Table 58).

The following table shows a summary of proposed ER targets in the AFOLU sector:

Table 56: Summary of proposed ER targets in the AFOLU sector

ER targets	End of SEZ Bitung development (2031) % below BAU	Average during the SEZ Bitung development (2017-2031) % below BAU
Yearly basis	87%	73%
Cumulative basis	67%	48%
Sector priority	MID: low GHG emissions and high mitigation potential level	

Source: Own elaboration

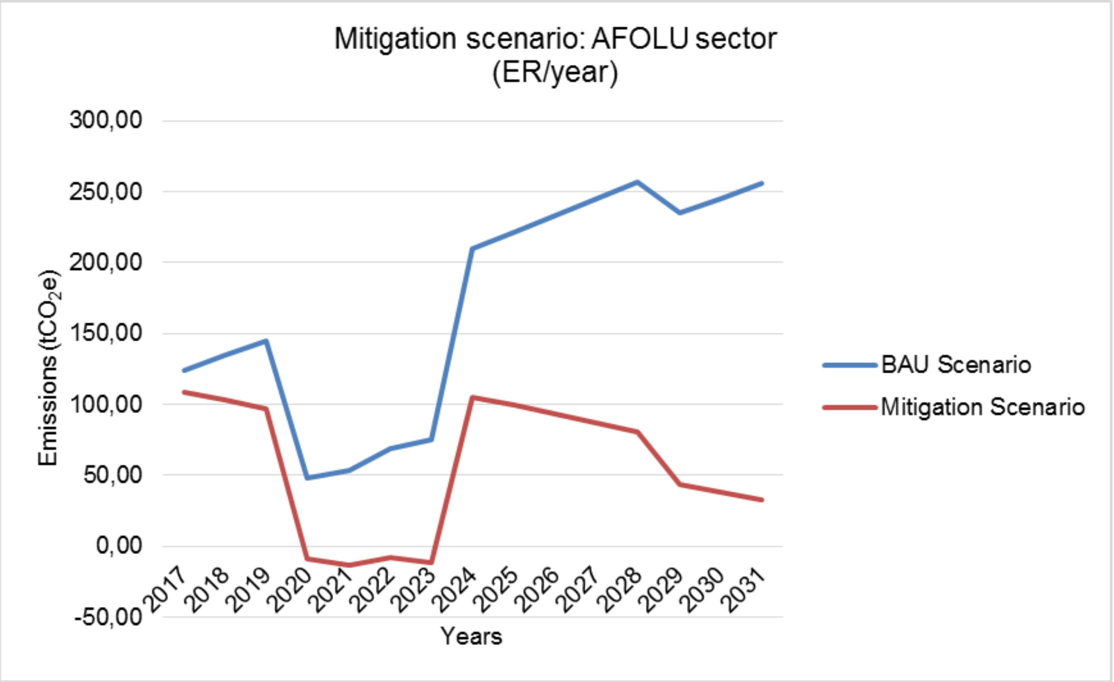


Figure 49: Mitigation scenario in the AFOLU sector (yearly basis)

Table 57: AFOLU sector ER target setting (yearly basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	124,41	134,71	145,01	48,18	53,96	69,29	75,47	210,30	221,91	233,51	245,12	256,73	235,30	245,52	255,73	-
OVERALL GHG ER	15,87	31,75	47,62	57,26	66,90	77,10	87,30	104,98	122,66	140,34	158,03	175,71	191,47	207,23	222,99	100,0%
Mitigation Scenario	108,54	102,96	97,39	-9,08	-12,94	-7,81	-11,83	105,32	99,24	93,17	87,09	81,02	43,84	38,29	32,74	**Average (2017-2031)**
GHG ER ratio	12,8%	23,6%	32,8%	118,8%	124,0%	111,3%	115,7%	49,9%	55,3%	60,1%	64,5%	68,4%	81,4%	84,4%	87,2%	**72,7%**

Source: Own elaboration

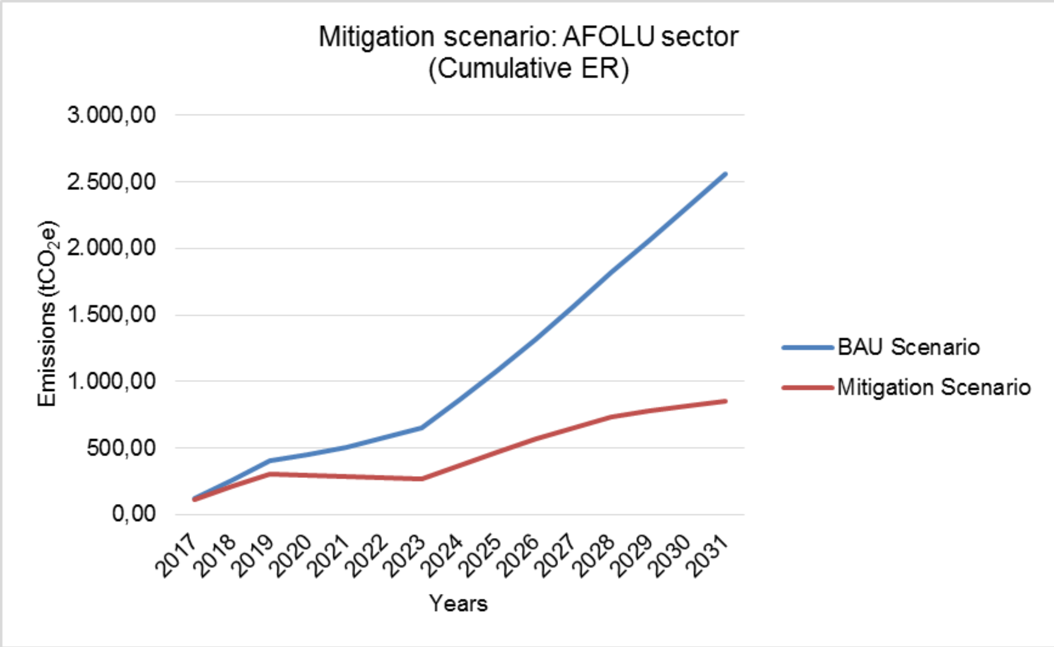


Figure 50: Mitigation scenario in the AFOLU sector (cumulative basis)

Table 58: AFOLU sector ER target setting (cumulative basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	124,41	259,13	404,13	452,32	506,28	575,57	651,04	861,33	1.083,24	1.316,75	1.561,87	1.818,60	2.053,90	2.299,42	2.555,15	-
OVERALL GHG ER	15,87	47,62	95,24	152,51	219,41	296,51	383,81	488,78	611,45	751,79	909,82	1085,52	1276,99	1484,22	1707,21	100,0%
Mitigation Scenario	108,54	211,50	308,89	299,81	286,87	279,06	267,23	372,55	471,79	564,96	652,06	733,08	776,91	815,20	847,94	**Average (2017-2031)**
GHG ER ratio	12,8%	18,4%	23,6%	33,7%	43,3%	51,5%	59,0%	56,7%	56,4%	57,1%	58,3%	59,7%	62,2%	64,5%	66,8%	**48,3%**

Source: Own elaboration

2.3.3 Overall SEZ Emission Reduction Target

It should be noted that the ER target has to be aligned with the "North Sulawesi's Action Plan on Reducing and Minimizing CO_2 Emission" and the "Bitung City – Healthy Living, Save the Environment" documents, hence complying with the Local Regulation number 14 year 2013 on Environmental Management.

According to the SEZ Bitung Master Plan, it is expected that several companies will be invited to occupy the green field defined for this area, including industrial companies (e.g. fisheries, coconuts, logistics, export processing), and commercial and institutional facilities, as well as those involved in the construction of residential properties and road infrastructure. These works will impact on GHG emissions when compared with the baseline, but can be mitigated by developing a Low Carbon Model City Strategy with appropriate countermeasures.

In absolute terms, it should therefore be assumed that GHG emissions will increase until work involved in the construction of the five phases of the SEZ Bitung development (up to 2031) are completed. Relative GHG ER targets will have to be set for each of those phases, and will have to be developed in terms of intensity of GHG emissions and GHG reductions compared to BAU scenario emissions, rather than compared to the baseline emissions.

Additionally, on a local level, Bitung City has declared its low carbon goal to reduce its CO_2 emissions by at least 10% from a BAU scenario by 2025, although the baseline has not been clearly defined.

According to the BAU scenario calculation described in Section 2.2, the overall GHG emissions at the end of SEZ Bitung development will account for 389,288 tCO_2e (yearly basis) and 2,962,414 tCO_2e (cumulative basis).

In terms of the Mitigation scenario, the GHG ER potential calculated from the all LCMs assessed show a mitigation potential on a yearly basis of up to 21.5% below BAU levels (2031) and an average of up to 19.7% below BAU levels throughout the project's development (2017-2031) (see Figure 51 and Table 60). Moreover, on a cumulative basis, the mitigation potential is up to 21.9% and 17.7% below BAU levels respectively (see Figure 52 and Table 61).

According to the analysis, the overall ER target has been set in a range of 18% to 22% below BAU levels. It should be noted that these figures are above the current low carbon goal planned in Bitung City of reducing ER to at least 10% from a BAU scenario by 2025.

The table below shows a summary of proposed ER targets in the overall SEZ Bitung.

Table 59: Summary of proposed ER targets in overall SEZ Bitung

ER targets	End of SEZ Bitung development (2031) % below BAU	Average during the SEZ Bitung development (2017-2031) % below BAU
Yearly basis	21%	20%
Cumulative basis	22%	18%

Source: Own elaboration

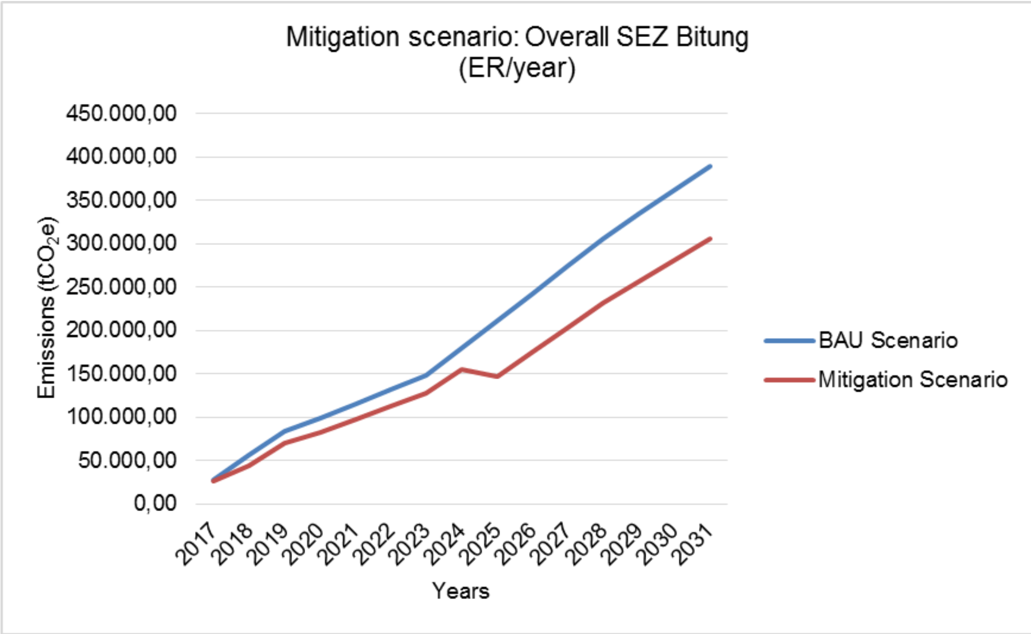


Figure 51: Mitigation scenario in the overall SEZ Bitung (yearly basis)

Table 60: Overall SEZ Bitung ER target setting (yearly basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	27.997,85	55.887,07	83.781,93	99.337,16	114.998,41	131.764,37	148.525,04	180.122,23	211.603,57	243.092,49	274.589,20	306.093,92	333.796,17	361.537,60	389.286,76	-
OVERALL GHG ER	1.607,85	11.843,57	14.168,42	16.672,90	18.043,98	19.627,59	21.231,53	25.200,16	64.685,92	67.485,43	71.574,06	74.502,84	77.121,22	80.977,01	83.761,59	100,0%
Mitigation Scenario	26.390,00	44.043,50	69.613,51	82.664,26	96.954,44	112.136,79	127.293,51	154.922,06	146.917,65	175.607,06	203.015,14	231.591,08	256.674,95	280.560,59	305.525,16	**Average (2017-2031)**
GHG ER ratio	5,7%	21,2%	16,9%	16,8%	15,7%	14,9%	14,3%	14,0%	30,6%	27,8%	26,1%	24,3%	23,1%	22,4%	21,5%	**19,7%**

Source: Own elaboration

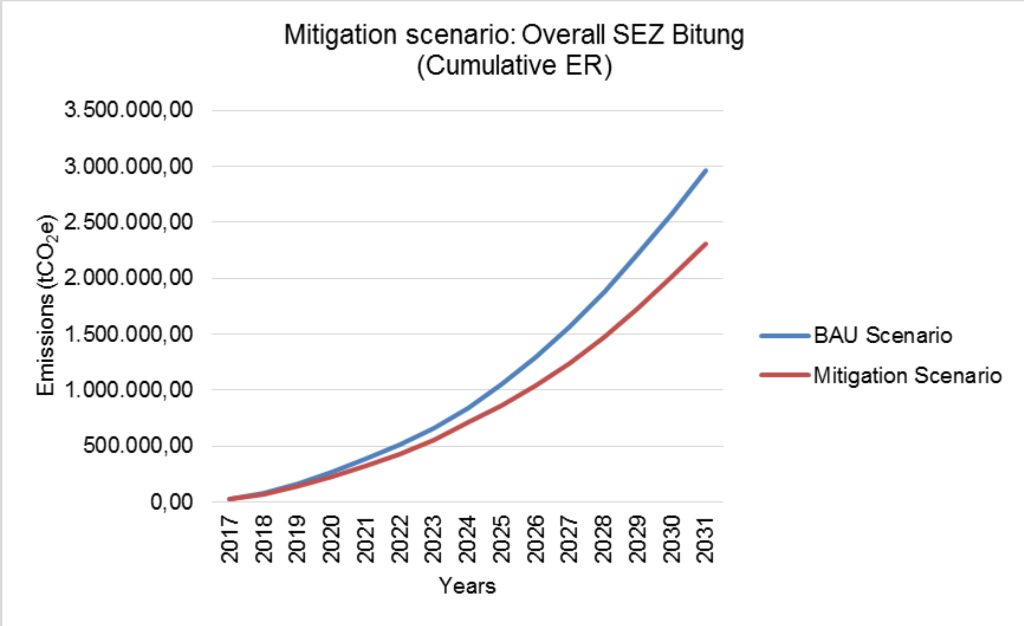


Figure 52: Mitigation scenario in the overall SEZ Bitung (cumulative basis)

Table 61: Overall SEZ Bitung ER target setting (cumulative basis)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	GHG ER share in 2031
BAU Scenario	27.997,85	83.884,91	167.666,84	267.004,00	382.002,41	513.766,79	662.291,83	842.414,05	1.054.017,62	1.297.110,11	1.571.699,31	1.877.793,23	2.211.589,40	2.573.127,00	2.962.413,76	-
OVERALL GHG ER	1.607,85	13.451,42	27.619,84	44.292,74	62.336,71	81.964,30	103.195,83	128.395,99	193.081,90	260.567,33	332.141,39	406.644,23	483.765,45	564.742,46	648.504,06	100,0%
Mitigation Scenario	26.390,00	70.433,50	140.047,00	222.711,27	319.665,70	431.802,49	559.096,00	714.018,07	860.935,72	1.036.542,78	1.239.557,92	1.471.148,99	1.727.823,95	2.008.384,54	2.313.909,70	**Average (2017-2031)**
GHG ER ratio	5,7%	16,0%	16,5%	16,6%	16,3%	16,0%	15,6%	15,2%	18,3%	20,1%	21,1%	21,7%	21,9%	21,9%	21,9%	**17,7%**

Source: Own elaboration

2.3.4 SEZ Sustainable Development Targets

The Low Carbon Model Town Strategy for SEZ Bitung will also have to create positive SD impacts, as co-benefits that will be derived from the implementation of the LCM actions in each sector.

In this context, the SEZ Bitung should be aligned with the guidelines of the post-2015 Development Agenda which identifies the Sustainable Development Goals (SDGs)[40] to be set and achieved by 2030 as the way forward to the Millennium Development Goals (MDGs) set in Indonesia by 2015.

The main relevant SDGs for the SEZ Bitung include, but are not limited to the following:

- Good health and well-being - Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Affordable and Clean Energy - Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all
- Decent work and economic growth - Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all
- Industry, innovation and infrastructure - Goal 9: Build resilient infrastructure, promote sustainable industrialisation and foster innovation
- Sustainable cities and Communities - Goal 11: Make cities inclusive, safe, resilient and sustainable
- Responsible Consumption and Production - Goal 12: Ensure sustainable consumption and production patterns
- Climate Action - Goal 13: Take urgent action to combat climate change and its impacts[41]
- Life and Land - Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss

As of today, there is still no national report in relation with the SDG in Indonesia[42], but there are several SD impacts that can be defined per domain (i.e. environmental, social, growth and development and economic), such as those shown in the table below:

Table 62: List of SD impacts per domain

Environmental	Social	Growth and Development	Economic
– Reduction in air / water / soil pollution – Noise reduction / Visibility improvement	– Health – Livelihood / Poverty alleviation – Affordability of electricity – Access to sanitation and water – Food security / sustainable agriculture – Quality of employment – Time savings – No child labor	– Access to clean energy – Education – Women empowerment – Access to sustainable technology – Energy security – Capacity enhancement – Equality in terms of job opportunity	– Income generation / expenditure reduction – Asset accumulation and investments – Job creation

Source: UNDP NAMA SD Tool, 2014

[40] Source: http://www.un.org/sustainabledevelopment/sustainable-development-goals/
[41] This SDG is cross-sectoral and is applied to all the target sectors in SEZ Bitung, but has not been assessed in this sub-section of the document because is comprehensibly developed in the sub-section 2.3.4.
[42] Source: https://sustainabledevelopment.un.org/index.php?page=view&type=6&nr=179&menu=139

Apart from the SD impacts, it is important to identify and select the relevant SD Indicators. These are a set of indicators that can measure the progress of SD benefits at national, regional or city level[43]. These indicators should be aligned with the SDGs at the national and sub-national levels and also cover the negative impacts, linked to proven existing SD tools and to current MRV systems. It is therefore suggested to define thresholds by SD indicators in order to track progress and identify which SD benefits are achieving the expected outcomes and goals set. In this regard, it is considered more important to focus on ex-ante assessment of the SD indicators rather than ex-post, which would require an independent review and the establishment of a common registry (amongst other things). It is recommended that all key stakeholders are fully involved in all stages of the process.

Additionally, according to the Bitung City's Long Term Planning 2005-2025, it is expected that a GHG inventory will be established soon. It is recommended to include SD indicators to track the achievement of the SD goals presented above.

The following are the SD impacts and indicators to be taken into account per sector (i.e. energy, transportation, waste, AFOLU). Each SD impact has been complemented with the following information (when available):

- Baseline value: the actual value for each indicator by 2015.
- BAU value: the value projected in the BAU scenario for each indicator by 2031.
- LCMs value: the value achieved from the aggregated LCMs implemented per sector by 2031.
- Target value: the goal set quantitatively per each SD indicator by 2031.
- Unit of measurement: specific unit which measures the SD indicator.

A qualitative and quantitative assessment per sector is presented below.

[43] Source: Sustainable Development Solutions Network, "Indicators and a monitoring framework for Sustainable Development Goals", November 2014.

Energy sector:

In the case of energy sector, the SD benefits cover three main domains (i.e. environment, growth and development and economic) and a wide range of SD specific impacts according to the 6 sector-related LCMs. On the one hand, the RE LCMs have a positive impact in terms of reduction in air pollution, but also by improving access to clean and sustainable energy, increased energy security, plus the generation of jobs. On the other hand, the EE LCMs have a positive impact with regards to reducing air pollution, increased energy security and creation of green jobs. Therefore, these SD benefits are aligned with the following SDG:

- Good health and well-being - Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Affordable and Clean Energy -Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all
- Decent work and economic growth - Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all
- Industry, innovation and infrastructure - Goal 9: Build resilient infrastructure, promote sustainable industrialisation and foster innovation
- Sustainable cities and Communities - Goal 11: Make cities inclusive, safe, resilient and sustainable
- Responsible Consumption and Production - Goal 12: Ensure sustainable consumption and production patterns

The following table shows a list of specific SD impacts and indicators for the energy sector:

Table 63: List of specific SD impacts and indicators for the energy sector

Sector	Domain	Specific impact	Indicator	Impact (+/-)	Baseline value	BAU value	LCMT Potential	Target Value[44]	Unit
Energy	**Environment**	Reduction in air pollution	PM_{10} SO_2 NO_2	+	54 76 43[45]	59 84 47 (+10% baseline value)[46]	48 68 39 (-10% baseline value)[38]	20 60 39[47]	μg/m^3
	Growth and Development	Access to clean and sustainable electricity	Share of people having access to clean and sustainable electricity	+	0% by 2014	0% by 2031[38]	50% by 2031	40% by 2031	% of people having access to clean and sustainable energy
		Energy Security	Share of total energy supply from RE	+	4% by 2014[48]	15% by 2031[38]	35% by 2031	28% by 2031	% renewable energy supplied
	Economic	Job creation	Number of jobs created	+	-	-	480 by 2031[38]	384 by 2031	Number of jobs

Source: Adapted from UNDP NAMA SD Tool, 2014

[44] Target values are set at 20% below LCS potential (except noted otherwise), following a bottom-up target setting approach. Official UN SDG have been analyzed but no concrete target values could be derived for this study.
[45] These numbers are not referred to Manado or Bitung, but to Makassar city in South Sulawesi. The exact values should be calculated specifically for Bitung by an official source which monitors and reports the air quality and pollution in Manado/Bitung. Source: http://www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/1528
[46] The assumptions are based on best professional understanding.
[47] Source: World Health Organisation (WHO) and Indonesia National Ambient Air Quality Standard (INAAQS). Retrieved from: http://www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/1528/1187
[48] Source: http://www.id.undp.org/content/indonesia/en/home/presscenter/articles/2015/07/22/the-state-of-indonesia-s-renewable-energy.html

Transportation sector:

Regarding the transportation sector, the SD benefits cover basically two domains: environment and social. The two sector-related LCMs (i.e. BRT and NMT/TOD) have several SD specific impacts including a reduction in air pollution, noise reduction, as well as time savings in journeys and the improvement of public health (see the table below for more details). Therefore, these SD benefits are aligned with the following SDG:

- Good health and well-being - Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Industry, innovation and infrastructure - Goal 9: Build resilient infrastructure, promote sustainable industrialisation and foster innovation
- Sustainable cities and Communities - Goal 11: Make cities inclusive, safe, resilient and sustainable

The following table shows a list of specific SD impacts and indicators for the transportation sector:

Table 64: List of specific SD impacts and indicators for the transportation sector

Sector	Domain	Specific impact	Indicator	Impact (+/-)	Baseline Value	BAU Value	LCMT Potential	Target Value[49]	Unit
Transportation	**Environment**	Reduction of air pollution	PM_{10} SO_2 NO_2	+	54 76 43[50]	+10% baseline value[51]	-20% baseline value	20 60 39[52]	µg/m³
		Noise reduction	Reduction of motorized vehicles used	+	-	3,764 passenger cars by 2031	390 vehicles avoided by 2031	312 vehicles avoided by 2031[42]	% of people shifting from passenger cars to public transport
	Social	Time savings	Average travel time saved	+	-	5[43]	15[43]	12	Minutes saved per journey

Source: Adapted from UNDP NAMA SD Tool, 2014

[49] Target values are set at 20% below LCS potential (except noted otherwise), following a bottom-up target setting approach. Official UN SDG have been analyzed but no concrete target values could be derived for this study.
[50] These numbers are not referred to Manado or Bitung, but to Makassar city in South Sulawesi. The exact values should be calculated specifically for Bitung by an official source which monitors and reports the air quality and pollution in Manado/Bitung. Source: http://www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/1528
[51] The assumptions are based on best professional understanding
[52] Source: World Health Organisation (WHO) and Indonesia National Ambient Air Quality Standard (INAAQS). Retrieved from: http://www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/1528/1187

Waste sector:

In terms of the waste sector, the SD benefits cover three main domains including the environment, social and growth and development. The waster sector related LCM (i.e. integrated waste management and 3R strategies) has several SD positive impacts such as the improvement of soil quality, the reduction of waste and the enhancement of education and knowledge in relation with 3R strategies (see the table below for more details). Therefore, these SD benefits are aligned with the following SDG:

- Good health and well-being - Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Decent work and economic growth - Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all
- Industry, innovation and infrastructure - Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation
- Sustainable cities and Communities - Goal 11: Make cities inclusive, safe, resilient and sustainable
- Responsible Consumption and Production - Goal 12: Ensure sustainable consumption and production patterns

The following table shows a list of specific SD impacts and indicators for the waste sector:

Table 65: List of specific SD impacts and indicators for the waste sector

Sector	Domain	Specific impact	Indicator	Impact (+/-)	Baseline value	BAU value	LCMT Potential	Target Value[53]	Unit
Waste	**Environment**	Soil pollution/quality	Production and use of compost, manure nutrient	+	-	60[54] (20% from LCS\MT Potential)	300	240	Tonnes of compost
	Social	Improved Livelihood	Amount of waste generated	+	0.5	0.58 (15% more than baseline)	0.40 (20% below BAU levels)	0.48	Kg/person/day
	Growth & Development	Education	Environmental promotion campaigns	+	0	0	15 (one campaign every year)	15[55]	Number of environmental campaigns

Source: Adapted from UNDP NAMA SD Tool, 2014

[53] Target values are set at 20% below LCS potential (except noted otherwise), following a bottom-up target setting approach. Official UN SDG have been analyzed but no concrete target values could be derived for this study.
[54] The assumptions are based on best professional understanding
[55] One environmental promotion campaign should be targeted for every year

AFOLU sector:

Regarding the AFOLU sector, the SD benefits cover basically three domains: environment, social and economic. The AFOLU sector-related LCM (i.e. urban forestry and urban greening) has several SD specific impacts such as the reduction of air pollution and improvement of soil quality, improvement of livelihoods due to more green recreation areas and the creation of green jobs to carry out tasks in relation with the land preparation, planting seeds and nursing. Therefore, these SD benefits are aligned with the following SDG:

- Good health and well-being - Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Decent work and economic growth - Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all
- Sustainable cities and Communities - Goal 11: Make cities inclusive, safe, resilient and sustainable
- Responsible Consumption and Production - Goal 12: Ensure sustainable consumption and production patterns
- Life and Land - Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss

The following table shows a list of specific SD impacts and indicators for the AFOLU sector:

Table 66: List of specific SD impacts and indicators for the AFOLU sector

Sector	Domain	Specific impact	Indicator	Impact (+/-)	Baseline Value	BAU Value	LCMT Potential	Target Value[56]	Unit
AFOLU	Environment	Production and use of compost, Manure nutrient	Production and use of compost, manure nutrient	+	-	60[57] (20% from LCS Potential)	300	240	Tonnes of compost
	Social	Livelihood	Number of green recreation areas, number of green outdoor activity offerings	+	-	102 (19% overall SEZ Bitung	115 (21.5% overall SEZ Bitung)	115[58] (21.5% overall SEZ Bitung)	ha
	Economic	Job creation	Number of jobs created	+	-	15[49]	40	32	Number of green jobs

Source: Adapted from UNDP NAMA SD Tool, 2014

[56] Target values are set at 20% below LCS potential (except noted otherwise), following a bottom-up target setting approach. Official UN SDG have been analyzed but no concrete target values could be derived for this study.
[57] The assumptions are based on best professional understanding
[58] The maximal LCMT potential for green areas should be set as target value

2.4 Low Carbon Strategy Design Challenges

The development and implementation of a low carbon strategy for the SEZ Bitung faces a number of issues, barriers and constraints that have the potential to either slow down, hamper or prevent the unlocking of the full low carbon and SD potential.

The list of challenges that is presented here has been compiled by analysing the most relevant policies for the design and future implementation of the LCMT Bitung (see Figure 10 for an overview of Bitung LCMT policy). In addition, the analysis has been expanded and advanced based on information and feedback received from key stakeholders during two project missions to Manado and Bitung[59] (see Figure 16 for the overview of key stakeholders and institutions) and experiences from relevant previous assignments in the Indonesian SD context.

The analysis comprises a comprehensive description of (i) political, institutional, regulatory and legal; (ii) technical; (iii) financial; and (iv) social challenges that are affecting (or may affect in the future) the development and implementation of a low carbon strategy for the SEZ Bitung.

2.4.1 Political, Institutional, Regulatory & Legal Challenges

The assessment of political, institutional, regulatory and legal issues provides an analysis of the overall institutional framework, the existing level of capacity and the split of roles & responsibilities, as well as the political, policy and regulatory environment with regard to industrial and SEZ Low Carbon Strategy (LCS) planning and implementation.

2.4.1.1 Lack of institutional coordination

Several governmental institutions at the national, provincial and city levels are involved in the planning and development of the SEZ Bitung. This has led to a planning overlap with different institutions currently working on uncoordinated development scenarios for the SEZ Bitung. The MoI has developed the only official development Masterplan for the SEZ Bitung (SEZ Masterplan 2008). The Indonesian Coordinating Ministry for Economic Affairs has initiated a Government-to-Government MoU with a Korean consortium for revision of the SEZ Masterplan 2008. However, this has not been coordinated with the MoI, nor with the Ministry of Public Works, which has developed yet another potential development study on the SEZ Bitung. Furthermore, the Governor of North Sulawesi has signed another MoU with a Chinese State-owned company (CCCC) for an SEZ Feasibility study, making it difficult to comprehensively and adequately project the future development of the SEZ Bitung[60]. The National Council for Special Economic Zones in Indonesia is yet another institution overseeing the development of the SEZ Bitung. A local SEZ Agency branch office, mandated with the management and coordination of the SEZ Bitung, has been legally established but is not yet operational. This adds to the lack of clear planning and development responsibilities.

2.4.1.2 Lack of enabling regulations and policies:

The overlap of institutional planning activities and ongoing studies on the SEZ Bitung (as described above) has led to a degree of regulatory uncertainty and a lack of clarity in relation to which SEZ Masterplan is to be used as the underlying SEZ development guideline. Furthermore, according to the Inception Report from the Korean Consortium (see page 26), the SEZ Masterplan 2008 faces several challenges such as inefficient land use due to district layout planning according to the existing road system (non-square alignment); inconsistency between facilities and consequential linkage deterioration; an insufficient traffic system including road hierarchy; an unarranged distribution of parks and green areas; and a lack of demand forecast for residency. In addition, Indonesia's government is heavily subsidising fuel and electricity (in

[59] A first kick-off and fact finding mission to North Sulawesi and Bitung have been carried out from 11 to 13 May 2015. This was followed by a second mission on 15 June to present initial findings and to receive official endorsement of the results.

[60] As the SEZ Masterplan 2008 is the only officially endorsed development plan for the SEZ Bitung to date, the SEZ Masterplan 2008 has been used as main reference for the APEC LCMT Feasibility study for Bitung.

2013, subsidies reached USD 9 billion, equivalent to 8% of all government spending[61]), making investments into energy and fuel efficiency and RE exploitation less feasible.[62]

2.4.1.3 Lack of Human Capacity

Generally speaking, there is limited human capacity in regard to low carbon development planning, with the key departments and institutions being currently understaffed. Also, existing staff's capacity is focusing on national and local economic development and growth, without systematically including sustainability and low carbon concepts into development planning.

2.4.2 Technical Challenges

Technical challenges refer to challenges with a technical cause such as the lack of technical planning and sufficient quality data; available low carbon technology and services, lack of adequate MRV procedures, methodologies and systems; and an overall lack of understanding of low carbon and sustainability concepts.

2.4.2.1 Lack of Data

An assessment of existing documents indicates that much of the required data for a detailed and comprehensive analysis of the current situation and future developments of the SEZ Bitung are either not available or not complete. The major reason for this is the current SEZ's status as "Green Development Area", where infrastructure development and construction work has not yet started and different feasibility studies and development planning activities are still ongoing. This therefore affects the ability to determine the current emission baseline, and conduct BAU scenario and emission target calculations and also influences the selection the most adequate ER measures for the SEZ Bitung. The lack of data with regards to the anticipated timeframe for each of the five SEZ development phases, the number and type of expected tenants and industries and the detailed land use planning for each phase in particular requires the application of assumptions based on the limited available information and best professional knowledge. Furthermore, no feasibility studies on RE viability and potential within the SEZ from sources such as biomass, solar, wind or hydro are available, making it difficult to conceptualise an independent mix of potential types of RE supply. The lack of reliable, consistent and updated time series data is also accompanied by a lack of transparency where the limited information available is often not disclosed to key public and private sector stakeholders.

2.4.2.2 Lack of data management/information system

The issue of lack of data is linked to an additional challenge which is the lack of a centralised data management system, which would greatly facilitate the assessment of the SEZ Bitung and the development of a customised and specific SEZ low carbon strategy. The possibility to collect, manage, store and analyse historical and actual data related to energy generation and energy use, solid waste, waste water generation, water use etc. is one crucial factor in establishing sectoral baseline levels and BAU scenarios.

2.4.2.3 Lack of adequate MRV procedures (city, provincial, national)

Besides the data gap and the data management issue, the SEZ and the planning agencies will face an additional challenge linked to a lack of understanding, data management practices, monitoring capabilities and reporting and verification guidelines that are necessary under a comprehensive LCDS. To be able to measure, report and verify the GHG ERs and the SD benefits, the planning agency will need to set up an adequate MRV system and related procedures, so the impacts of the LCMs can be tracked in a transparent, centralised and credible way. The Low Carbon Model Strategy can only be effectively implemented once such a system is in place, allowing its successes to be properly evaluated and measured.

---

[61] Source: International Institute for Sustainable Development; http://www.iisd.org/sites/default/files/publications/impact-fossil-fuel-subsidies-renewable-electricity-generation.pdf

[62] Recently the Government of Indonesia has periodically reduced national electricity and fossil fuel subsidies, showing the Government's work in progress on overcoming this challenge. Source: www.jakartaglobe.com; http://thejakartaglobe.beritasatu.com/business/electricity-hike-knock-seen-indonesia/ (last accessed: 1st June 2015)

2.4.2.4 Lack of technical capacity

Besides the lack of human resources, there is also a capacity gap in relation to the required technical know-how of the existing staff, in particular that which is linked to an understanding of SD, LCMs, RE technologies, rural electrification and EE alternatives.

2.4.3 Financial Challenges

The analysis of the financial challenges for the SEZ LCS development and implementation focusses on related financial issues such as the general availability of finance, the coordination of finance activities and financing flows, the current framework of enabling financing mechanisms, and low carbon investment incentives.

2.4.3.1 Lack of an appropriate enabling financial architecture

In order to achieve a significant impact of the LCS, an overarching financial architecture will have to be developed to provide an enabling financial environment for the development and implementation of the selected LCMs. This financial architecture will have to look at the overall financial feasibility of the LCMs, establishing the financial business case and incentive structures that will be at the basis of their financial governance. Additionally, the financial architecture will establish the general financial management practices; the disbursement, replenishment, cash-flow management, fiduciary and guarantee procedures; the financial requirements for successful implementation; and a strategy for engaging potential domestic and international, public and private partners so they can provide additional finance if needed.

2.4.3.2 Lack of financial resources

Besides the lack of an overarching financial architecture, no specific public financial budget has been allocated for the SEZ, bringing into question the amount of public budget for SEZ development and low carbon activity financing that will be made available. National, provincial and city level budgets are expected to be made available for the next mid-term budget planning period (2016-2020), but no further details are currently available. Besides public sources, the private sector, i.e. companies moving into the SEZ to benefit from special economic conditions, will also have to be involved in implementing the SEZ low carbon strategy. Private sector participation will include the application of energy efficient technology for production, processing and building design purposes, sustainable water and waste principles and respective awareness raising activities for their staff. However, it is currently not clear how many tenants are going to be located within the SEZ, nor what kind of investment volume can be expected. A clear understanding of the overall amounts and distribution of financial resources for the LCS SEZ Bitung is therefore currently unavailable.

2.4.3.3 Lack of a clear set of financial incentives

Although companies setting up businesses within the SEZ will be granted financial and economic incentives, such as exemption on several tax categories (VAT, income, import, property) and simplified employment, land acquisition and other permit application processes, no explicit financial incentives for low carbon and sustainable investments exist. For example, a private company within the SEZ seeking concessional or soft loan lending from financial institutions for EE investments will have difficulties as there is still limited experience on the side of the financial institution regarding EE financing, project risk evaluation, and standardised loan products and arrangements.

2.4.4 Social Challenges

2.4.4.1 Lack of public awareness and green behaviour

Public awareness of environmental challenges is generally still low and “green” and sustainable behaviour at consumer and corporate level is still underdeveloped[63]. This represents a challenge for the low carbon development of the SEZ Bitung as individual and corporate behaviour is fundamental to the successful implementation of any low carbon and sustainability strategy.

[63] Low Carbon Support Programme to Ministry of Finance, Indonesia. Design of an Energy Efficiency Financing Scheme.

2.5 Selection of Low Carbon Measures (LCMs) for the LCMT

2.5.1 Identification and Analysis of Potential LCMs

The process of the identification and analysis of potential LCMs for the SEZ Bitung has to be systematic and structured while remaining practical.

A stepwise methodological approach is strongly advisable to ensure transparency, ease of use and replicability of the identification methodology. This approach also aims to present a standard methodology that can easily be assimilated by the host APEC member economy stakeholders and that could be replicated in future urban low carbon development activities in Bitung, Indonesia and beyond.

The main purpose of this exercise is to distil a prioritised short list of potential LCMs in the following identified LCMT target sectors and sub-sectors[64] for the SEZ Bitung:

(i) Energy

- a. Energy Generation
- b. Industry
- c. Commercial
- d. Residential

(ii) Transportation

(iii) Agriculture, Forestry and Other Land Use (AFOLU)

(iv) Waste

The proposed step-wise approach to identify, analyse and select the most feasible LCMs for the LCMT Bitung will consist of the following steps:

1) **Identification of possible LCMs -** this step aims at identifying all potential low carbon opportunities for the SEZ Bitung based on (i) the existing information on the LCDS for the SEZ Bitung; and (ii) recommendations based on professional expertise and international best practices. This exercise will generate a long list of potential LCMs that will be then analysed.

2) **Qualitative Analysis of possible LCMs –** The long list composed in the first step will go through a qualitative assessment that will assess the potential of each LCM in relation to three key criteria that a LCM has to fulfil in order to be feasible, sustainable and achieve significant impacts. This qualitative analysis will narrow down the long list of possible measures to a short list of high-potential LCMs that will be then analysed in more depth under the APEC LCMT initiative for Bitung.

3) **Quantitative Analysis of short-listed LCMs**[65] –This third and final step will consist of a thorough, quantitative assessment of the short-listed LCMs, that will look at GHG ER potential, SD impact potential, alignment to the domestic policy framework, the cost-effectiveness of the measure, and the technical, financial and institutional/regulatory feasibility. The final result will be a prioritised list of LCMs with concrete potential and feasibility estimations for each of the low carbon target sectors of the SEZ Bitung that can then be taken forward for development and implementation.

---

[65] Please note that from this chapter onwards the Waste sector is listed AFTER the AFOLU sector in order to be aligned with the eventual prioritisation of LCMs at the end of this LCM selection.

2.5.1.1 Identification of potential LCMs

During this first identification phase, the existing low carbon development plan for the SEZ Bitung has been reviewed, and all proposed LCMs from the national and local government have been compiled.

As an additional step of the identification phase, the initial list of LCMs has been expanded with supplementary measures that could be undertaken for each of the sectors, based on professional knowledge of urban low carbon strategy development and experience delivering and implementing low carbon solutions across the whole range of sectors and sub-sectors mentioned above, while always taking into account the local and national development context of Bitung and Indonesia.

The table below represents the long list of potential LCMs for the SEZ Bitung, categorised according to the GPC sectors and subsectors for city GHG emission sources[66]. This long list has been presented to the local project counterparts and key stakeholders during the first and second project mission to Bitung[67] to ensure that it is aligned and in accordance with their understanding and expectations.

[66] Several LCMs proposed in the APEC LCMT Nomination Documents have been regrouped, renamed and reallocated in alignment with GPC's low carbon sector categorization. Section 2.2 explains the mapping of sectors and subsectors and how the list of sectors of the LCMT Nomination Documents has been modified to follow GPC categorization.

[67] The first project mission took place from 11-13 May 2015 and included the official kick-off meeting with the Vice-Mayor and was followed by more than a dozen fact finding meetings with the Bitung City & Provincial Government as well as with the SEZ Secretariat.

The second project mission took place from 15-16 June and resulted in the endorsement of the potential LCMs proposed.

Table 67: Long List of potential LCMs for the SEZ Bitung

LCMT Target Sectors	Sub Sector	Type/ Technology of LCM	Specific LCM
Energy	Energy Generation	Utilization of Clean Energy	• Utilization of Geothermal Energy (Geothermal Power Plant)
		Solar Energy Generation	• Use of photo voltaic (PV) panels on buildings • Concentrated Solar Power (CSP) utilization (CSP Power Plant)
		Hydro Energy Generation	• Utilization of small-scale Hydro Power (Mini/Micro Power Plants)
		Wind Energy Generation	• Utilization of wind energy (Wind Power Plant)
		Ocean Energy Generation	• Utilization of Wave Energy (Wave Energy Converter) • Utilization of Tidal Energy (Tidal Mill)
		Waste-to-Energy Generation	• Methane capture system from Solid Waste Landfill • Methane capture system from wastewater treatment plan
		Biomass Thermal Energy Generation	• Thermal energy generation from agricultural waste
		Bio-fuel-based Energy Generation	• Utilization of Bio-fuel for generator use
		Energy Efficiency in Energy Generation and Energy Use	• Smart Grid • Energy Efficient LED Lighting for Outdoor Public Areas • Demand Side Management
	Industry	Energy Efficiency in Equipment and Appliances	• Industrial Refrigeration & Air Conditioning (RAC) • Heating • Lighting • Building Energy Management System (BEMS) • Introduction of minimum energy performance standards (MEPS)
		Energy Efficiency in Industrial Processes	• Intelligent scheduling to reduce standby time and changeovers • Behaviour change and maintenance practises • Process controls and measurement • Reducing thermal energy losses from heating processes • Industrial Processes and Product Use (IPPU)
		Industrial Low Carbon Building Design	• Natural Cooling • Natural Lighting • Natural Ventilation • Building Insulation
	Commercial	Energy Efficiency in Equipment and Appliances	• Commercial Refrigeration & Air Conditioning (RAC) • Heating • Lighting • Building Energy Management System (BEMS)

LCMT Target Sectors	Sub Sector	Type/ Technology of LCM	Specific LCM
		Commercial Low Carbon Building Design	• Natural Cooling • Natural Lighting • Natural Ventilation • Building Insulation
	Residential	Energy Efficiency in Equipment and Appliances	• Commercial Refrigeration & Air Conditioning (RAC) • Heating • Lighting • Building Energy Management System (BEMS)
		Residential Low Carbon Building Design	• Natural Cooling • Natural Lighting • Natural Ventilation • Building Insulation
Transportation	Shift	• Bus Rapid Transit (BRT) • Light Rail Transit (LRT) • Intra-city community bicycle system • Non-Motorized Transport (NMT) Infrastructure Development	
	Avoid	• Transit-Oriented-Development (TOD) • Car Sharing System	
	Improve	• High Quality Roads • Replacement of fossil-fuel-based vehicles with electric vehicles • Alternative Fuels • Improving Energy Efficiency Performance Standards for Vehicles	
AFOLU	Land Use Management	• Forestry and other Land Use Preservation	
	Urban Greening	• Greening of parks, pedestrian walkways, streets and roads, building façades, and watersides	
Waste	Solid Waste	Solid Waste Landfill Management	• Waste Collection • Waste Storage • Waste Recycling • Waste Treatment • Methane Capture in Solid Waste
		Solid Waste Recycling	• Introduction of waste recycling in the Industrial, commercial and residential sector
	Wastewater	Wastewater Treatment	• Water Purification • Water Reclamation • Methane Capture in Wastewater

2.5.1.2 Qualitative Analysis of identified LCMs

The long list of potential LCMs for the SEZ Bitung included above will now be further analysed to identify which of them have the highest feasibility, so the long list of LCMs for the SEZ Bitung can be narrowed down to a short list of high-potential LCMs.

The following qualitative criteria to identify the most appropriate and highest potential measures to achieve a significant, sustainable and feasible urban low carbon strategy are based on best professional experience and know how.

Three main criteria have been considered under this step:

- <u>GHG Mitigation potential</u>: the LCM has to achieve significant and measureable GHG ERs. This criterion refers to the potential for the measure to contribute to the overall GHG ER target of the LCMT.
- <u>Sustainable Development (SD) potential</u>: the LCM has to be sustainable, i.e. it has to bring social, economic and environmental benefits besides the GHG ER assessed above. This criterion measures whether the LCM analysed can contribute to the local, regional and national SD objectives by improving the overall quality of life, local livelihoods and general local development standards.
- <u>Implementation potential (general feasibility)</u>: the LCM has to be feasible, i.e. it has to be implementable given the national and local context. This criterion will assess qualitatively relevant aspects of the measure's feasibility in relation to the local conditions: the policy and political environment; the regulatory and legal framework; the technical/technological status (i.e. availability and familiarity with the technology); the economic effectiveness and financial feasibility; and the institutional and human capacity and know-how.

Only when all these three qualitative criteria are assessed and the measure's potential is considered generally high on all accounts will the LCM will be retained and carried forward to the quantitative analysis, as otherwise it would not comply with the high level vision of the SEZ Bitung and related basic low carbon development principles.

2.5.1.2.1 Energy Sector

The scope of the energy sector includes: the generation of energy from different renewable sources and technologies; the management of energy supply, energy demand and energy distribution, and the EE and GHG ER measures in the Industrial, Commercial and Residential sectors.

While the geographical area of the SEZ Bitung is only 534 ha, this sector will also have to consider potential energy generation that takes place outside the strict geographical boundaries of the SEZ, as those outside sources may provide energy to the SEZ via transmission lines and therefore have to be included in the long list of potential LCMs.

2.5.1.2.1.1 <u>Energy Generation</u>

Energy generation is the process of generating electric power from fossil energy sources (e.g. coal, petroleum, natural gas, kerosene, propane) or from RE sources such as geothermal, solar, biomass etc. The distribution of generated electricity can generally be divided into (i) on-grid electricity distribution, i.e. distribution via the national interconnected electrical grid which delivers electricity from its source to the end user via large-scale transmission and distribution lines; and (ii) off-grid electricity distribution, i.e., in which the electricity user is not connected to the main electrical grid network but uses an autonomous and independent stand-alone power system from a nearby energy source (which can also comprise transmission and distribution lines). On-grid electricity in Indonesia is mostly generated from large fossil-based power plants, leading to significant emissions through the combustion of fossil fuels during the electricity generation process. Off-grid electricity is generally generated through the use of standalone generators that supply electricity through combustion of highly carbon-intensive fuels, such as diesel.

The SEZ Bitung is currently not connected to the main power grid (North and Central Sulawesi Power Grid). According to the SEZ Masterplan 2008, basic infrastructure developments will be carried out during the first phase of development of the SEZ (2017-2019). It should be noted that the current North and Central Sulawesi Power Grid is characterised by significant and frequent power shortages (PLN Report for North Sulawesi).

In general, RE generation, as it entails replacing fossil fuel-based electricity, will provide significant GHG ER potential, and could lead to a wide range of sustainable development benefits such as local job creation, increased energy availability, energy security and sustainable energy access, and ultimately could lead to an overall reduction in fuel imports. Other benefits of RE generation include better air quality, improved health, education (as a reliable energy supply allows for extended hours of study), etc. However, different sources of RE will require different pre-existing enabling conditions. Firstly, the specific RE source must be available in the surrounding area; secondly, the available RE source should also be feasible, i.e. the potential has to be big enough to cover peak demand throughout exploitation (planning, land and permit acquisition, power plant construction etc.), the technology also has to be available, the required know-how locally available, and all while taking into account economic, environmental and social considerations.

Unfortunately, no official data on RE source availability and feasibility for the SEZ Bitung with regards to geothermal, wind, solar, hydro, biomass, waste or ocean power generation was available for this study. Comprehensive RE potential studies by the public and/or private sector for individual RE sources are required to accurately and reliably assess the current potential of RE utilisation. The following qualitative evaluation of potential ER resources are based on discussions with local key stakeholders and related experience of RE power generation under consideration of the local characteristics and conditions of the SEZ Bitung.

2.5.1.2.1.1.1 Geothermal Energy Generation

Geothermal energy is heat energy stored within the earth. Electricity can be generated by capturing and harnessing that heat energy. Geothermal power plants can produce electricity through controlling the behavior of steam and using it to drive electrical generators. Excess water vapor at the end of each process is condensed and returned to the ground where it is reheated for later use.

A geothermal energy potential of approx. 120 MW from the nearby mountain “Dua Saudara” has been estimated for this study[68]. The geothermal power plant (GPP) is expected to start generate RE energy in 2025. This RE source could be used as a primary energy source for the SEZ Bitung (and also Bitung City) in its long-term vision, replacing the use of diesel generators and the regular North and Central Sulawesi Power Grid as major power sources. The potential ER and SD benefits through this LCM are considered very high. Furthermore, the fact that increasing the utilisation of geothermal energy is one of the national priorities as expressed in the National Energy Policy combined with the fact that there is political will and that this measure would be strongly supported by the local government make its actual implementation very probable. Electricity generation from geothermal energy has therefore been retained as a high potential LCM for the SEZ Bitung[69].

Note: The development and construction of the GPP itself is outside the scope of the SEZ Bitung since its impact and investment requirements are far beyond the SEZ development scenario. Nevertheless, this option has been included into the assessment of high potential LCMs as the development of a GPP has been clearly stated as long-term vision for the region. Also, the impact and potential contribution to the future low carbon development path of SEZ Bitung is

[68] This potential is based on a feasibility study that was mentioned in the LCMT concept presentation of the vice mayor of Bitung City during the official kick-off meeting on 11 May 2015 in Bitung, but that is not publicly available.

[69] Since actual operability of a potential geothermal power plant is not expected in the near future, potential ER and SD benefit impacts will be considered only for the last two phases of development of the SEZ Bitung, i.e. phase 4 (2024 – 2028) and phase 5 (2029 – 2031).

considered significant and the results of a detailed quantitative analysis presents a strong argument for the local and national authorities to further support the GPP development.

2.5.1.2.1.1.2 Solar Energy Generation

Electricity from solar energy can be produced through two major technology systems: (i) Photovoltaic (PV) and (ii) Concentrated Solar Power (CSP). PV technology uses solar panels and modules to absorb and directly convert sunlight into electricity. Solar panels and modules can either be decentralised installations on individual industrial, commercial and residential buildings to feed electricity to the national power grid from various small-scale source; or be centralised in the form of a large scale PV system (solar farm outside of the SEZ boundaries) for a larger, utility level, power supply.

CSP systems generate solar power by using mirrors or lenses to concentrate a large area of sunlight onto a small area. Electricity is generated when the concentrated light is converted to heat, which drives a heat engine connected to an electrical power generator. As with a solar farm, such a system would also be installed outside of the SEZ Bitung as it requires large open space for its operation.

Given the equatorial location and high regional solar radiation intensity (South Sulawesi: approx. 5.57 kWh/m^2/day[70]), solar energy utilisation is believed to be a high potential measure for the SEZ Bitung. Decentralised PV panel systems on buildings within the SEZ are considered easily implementable, can significantly reduce GHG ERs and create SD benefits. Large-scale power generation through PV or CSP, however, are very complex undertakings, and require substantial investment and infrastructure development efforts. Therefore, despite having a high GHG ER and SD impact potential, large-scale power generation is not retained as a high potential LCM.

2.5.1.2.1.1.3 Hydro Energy Generation

Hydro energy generation refers to the production of electrical power on micro, small or large scale through the use of either gravitational force or flowing water, powering a water turbine connected to a power generator.

This form of RE generation is not considered viable for the SEZ Bitung, as no comprehensive feasibility study for hydro has been carried out in the area, and some of the required pre-conditions (such as sufficient height to utilise kinetic energy, or a sufficient volume and speed of river water flow) could not be met.

2.5.1.2.1.1.4 Ocean Energy Generation

Ocean Energy based electricity generation, i.e. utilisation of wave energy or tidal energy, has been excluded from the high potential short list, as no comprehensive feasibility study was available, and the related technology is not yet considered mature enough to be applied at scale in Indonesia due to high investment costs and lack of availability of technology and related know-how.

2.5.1.2.1.1.5 Biomass Thermal Energy Generation

Thermal energy from biomass energy is generated through the combustion of plant material and organic waste. Generated heat from biomass can replace conventional thermal power fuels such as diesel, fuel oil or propane.

Biomass thermal energy can lead to significant ERs and SD benefits, for example optimum use of energy resources, reducing air pollution associated with fossil fuel consumption (coal, HFO/MFO, etc.), as well as increasing local job opportunities in biomass waste collection and management. Additionally, biomass thermal energy generation is a well-tested technology that is relatively mature, and could be combined with waste management and sustainable forest

[70] B. Sudia, A. Rachman and Kadir, “The Assessment of Solar Radiation Intensity in Southeast Sulawesi Based on the Relative Position of the Sun”, Journal of Metropilar, vol. 9, (2011), pp. 115- 120.

management measures, which would increase the GHG ER and SD impacts. On this basis, biomass thermal has also been shortlisted.

2.5.1.2.1.1.6 Waste-to-Energy Generation

Waste produces biogas through biological processes such as agriculture and anaerobic digestion (often to be found at landfills and wastewater treatment plants) and can serve as alternative fuel in the electricity generation process.

The replacement of fossil-based fuels with biogas for electricity generation can potentially significantly reduce GHG emissions, while delivering high SD benefits such as improved air quality and reduced dependency on fossil fuel. This LCM is also considered viable, as biogas can be captured and utilised from a potential nearby landfill and wastewater treatment plant, and therefore has been also retained for further analysis.

2.5.1.2.1.1.7 Bio-fuel-based Energy Generation

Bio-fuel is produced through biological processes such as agriculture and anaerobic digestion, and can serve as alternative fuel in the electricity generation process.

Off-grid electricity generation within the SEZ Bitung is expected to be dominated by small-scale generators using highly carbon-intensive diesel as their main fuel. The replacement of fossil-based fuels with bio-fuel for electricity generation provides the potential to significantly reduce GHG emissions while delivering high SD benefits such as improved air quality and reduced dependency on fossil fuel. However, Pertamina is the only state-owned company that sells fuels including biofuel in Indonesia (B10 with a 10% bio fuel component) and policy and regulation coordination are solely the responsibility of the national government. Given the current institutional and regulatory context, this LCM would be difficult to implement or could not be implemented effectively. Therefore bio-fuel-based energy generatio has not been included as high potential LCM.

2.5.1.2.1.2 Energy Efficiency in Energy Generation and Energy Use

Apart from the utilisation of RE sources as described above, several EE measures within energy generation, overall energy management and energy use can lead to additional GHG ERs and SD benefits.

2.5.1.2.1.2.1 Smart Grid

A smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. This system allows for monitoring, analysis, control and communication within the supply chain to help improve efficiency, reduce energy consumption and cost, limit peak power demand, stabilise electric power supply and maximise the transparency and reliability of the energy supply chain.

Smart grids can have significant GHG ER potential for very mature and complex grids and in environments where there is a complex energy mix. In such cases, the implementation of a comprehensive smart grid system will be beneficial. In the context of the SEZ Bitung, however, as it will mostly be a “green field” development, this measure will be limited to develop the grid and transmission lines that will have to be built along with the development of the SEZ itself by using first generation technologies and good practices, such as smart metering and an efficient grid design. This will have to be accompanied by relevant policies that support and incentivise the use of smart metering and high efficiency transmission technologies. As the policy assessment for the SEZ Bitung will be part of the third step of the APEC LCMT project, smart grids have not been further analysed under the scope of this Feasibility study.

2.5.1.2.1.2.2 Energy Efficient LED Lighting for Outdoor Public Areas

Using light-emitting diode (LED) technology to provide lighting for outdoor public areas such as parks, parking lots, bus stations, sport areas and other recreational areas as well as roadways can lead to a significant reduction in energy consumption and related GHG emissions compared to conventional lighting such as high pressure sodium (HPS) and metal halide (MH). It also creates SD benefits by providing increased safety and security during evening, night, and early morning times; extending the hours of recreational and commercial activities; and adding to the general aesthetic sense of urban areas. The implementation of LED lighting in the SEZ Bitung is considered very viable. Therefore, LED lighting in outdoor public areas has been shortlisted as a high potential LCM.

2.5.1.2.1.2.3 Introduction of minimum energy performance standards (MEPS)

The introduction of MEPS for equipment and appliances is another potential LCM to be considered. However, as introducing MEPS is more a policy than a measure, and an in-depth policy assessment for the SEZ Bitung will be part of the third step of the APEC LCMT project, energy performance standards have not been further analysed under the scope of this study.

2.5.1.2.1.3 Industry

The energy sub-sector “Industry” covers all energy and end-use related measures in small, medium and large industries that are expected to be developed in the SEZ Bitung. According to the SEZ Masterplan, expected types of SEZ industries include fishery, agricultural processing (coconut) and logistics. However, at this moment, neither the type of industries nor the size of their operation is known or can be confirmed. As a consequence, proposed LCMs in the industry sector are based on the above-mentioned assumed industries without more specification of their magnitude of operation, or estimations of the expected production volume or productivity ratios.

Potential LCMs in the industry sector are centered on EE in (i) industrial equipment and appliances; (ii) industrial processes; and (iii) industrial building design.

As described under the energy sector, electricity generation within the SEZ Bitung is expected to rely heavily on on-grid power supply and partly on off-grid diesel generators. Using energy efficient technology and taking advantage of low carbon building design opportunities, significant reduction of energy consumption compared to conventional technology and building designs can be achieved. Moreover, SD benefits such as improved air quality, reduced dependency on fossil fuels, reduced energy costs and a generally more comfortable and pleasant indoor environment can be created. Considering that the SEZ Bitung will be dominated by activities in the industrial sector, related LCMs are particularly interesting and hold significant opportunities to contribute to the low carbon vision of the SEZ Bitung.

2.5.1.2.1.3.1 Energy Efficiency in Industrial Equipment and Appliances

Industrial equipment and appliances under this study are anticipated as basic energy-based technologies which enable the operation of an industrial facility. They include Refrigeration & Air Conditioning (RAC), heating and lighting.

- Energy Efficient RAC

The basic function of RAC technology is the regulation of temperature (cooling) and humidity of indoor spaces such as warehouses, production, processing and packaging halls and industrial freezers. RAC applications require electricity input for operation. Depending on the type of industry, energy demand for individual cooling processes can vary from low to high, potentially contributing significantly to overall energy use and related GHG emissions. Using energy efficient RAC technology can lead to a significant reduction of energy consumption compared to conventional RAC technology. Applying energy efficient RAC technology can achieve high ERs and SD benefits and no major implementation challenges are expected. Hence, this LCM is considered of high potential and has been retained.

- Heating

In the industrial sector heating takes many forms and often plays a very important role in production and processing activities. We will see below that heating has been shortlisted because it can involve several sub-measures that could be combined to achieve significant GHG ERs, SD impacts and can be feasibly implemented. Some of the specific measures that could be looked at include:

- *Solar Water Heating (SWH):* SWH uses a solar thermal collector to convert sunlight into thermal energy. This renewable thermal energy can then be utilised for water heating and no conventional water heating is necessary. Conventional water heating uses natural gas, propane, fuel oil or electricity as water heater fuel source, all of which generate emissions during the heating process. The demand for water heating in the fishery, agriculture processing and logistics industry is potentially high.
- *Use of multi-boiler control systems:* industrial processes often require different amounts of thermal energy input (steam supply), adjusted to the level of production during a certain period of time. A single boiler might have limited flexibility with regards to producing different amounts of steam. Should the level of production decrease, excess steam might be wasted (and the boiler efficiency decreases when operated at part-load). Using a multi-boiler control system would enable different amounts of steam production, operating either one or more number of boilers at their full design capacity (and hence leading to high efficiency). Multi-boiler control systems can therefore have high GHG ER and SD potential, and are considered feasible, so they have been short-listed as a high potential LCM.
- *Flue Gas Heat Exchanger:* significant amount of heat is released in the flue gas flow from industrial process. Installing a proper heat exchanger system in the flue gas stream has the potential to replace the amount of fuel required for thermal processes in industry. Often, when using water circulation systems, the hot water produced can be used for diverse applications in preheating equipment, feed water heater (FWH) systems, air dryers, etc. Flue gas heat exchanger systems can therefore have high GHG ER and SD potential, and are considered feasible, so they have been short-listed as a high potential LCM.
- *Waste Heat Recovery:* similar to the flue gas heat exchanger, a waste heat recovery system may be installed at different intervals throughout an industrial process. Application of the hot water produced can also be quite diverse. Waste heat recovery systems can therefore have high GHG ER and SD potential, and are considered feasible, so they have been short-listed as a high potential LCM.

• Energy Efficient Lighting

This measure has already been described under the LCM "Energy Efficient LED Lighting for Outdoor Public Areas" under "Energy Efficiency in Energy Generation and Energy Use". Energy efficient lighting in industrial buildings could be coupled with a global LED lighting programme that encompasses outdoor public areas, industrial buildings, and commercial and residential buildings as well, under a SEZ-wide LED programme that will be included in the short-list of high-potential LCMs.

• Building Energy Management System (BEMS)

A BEMS aims to monitor and manage building energy demand in order to improve building energy performance and to reduce energy consumption. RAC, lighting and other electrical devices are usually connected to the BEMS. Complementary to the BEMS, a dedicated Building Energy Manager usually operates the BEMS to process the acquired data and develop energy consumption optimisation strategies.

BEMS can lead to significant energy consumption reductions, reducing GHG emissions and creating SD benefits. Implementation will be handled by individual industry owner themselves. Therefore, besides the positive environmental impact, considerable energy cost reductions can be achieved, making BEMS a viable, high potential LCM that will be included in the short-list.

2.5.1.2.1.3.2 Energy Efficiency in Industrial Processes

Besides EE improvements through the application of energy efficient equipment and appliances, industrial facilities can also significantly reduce energy demand through the optimisation and improvement of industrial process. Significant GHG ERs and SD benefits could be easily achieved by reducing energy consumption based on fossil fuel (as described above). Below are some examples of LCMs for industrial process improvements:

- Reducing thermal energy losses from heating processes

Conduction & convection heat losses, steam flow leakage, and redesign of inefficient pumping / compression works are some of the potential process improvements to reduce thermal energy losses. Various technologies are currently available in the market.

- Intelligent scheduling to reduce standby time and changeovers

These measures address issues of machine loading, tool allocation, and part type grouping with the intent of developing an operation sequencing technique capable of optimising operation time, non-productive tool change times, and orientation change times when processing a group's design features.

- Behavior change and maintenance practices

EE training for industrial workers and management, as well as improved maintenance works on industrial machinery can have a high effect on the energy consumption patterns within industrial facilities.

- Process controls and measurement

This measure can be compared to the BEMS evaluated above. Through measuring monitoring, and controlling of industrial processes, inefficient practices can be identified and efficiency improved.

- Industrial Process and Product Use (IPPU) Sector

This subsector comprises: (i) Industrial Processes that chemically or physically transform materials releasing GHG, and (ii) products such as refrigerators, foams or aerosols that may release GHG through use[71]. IPPU-related LCMs will focus on emissions reductions and SD impacts that may be achieved by some of the following activities:

  - *Capture and abatement at plants:* industrial processes in the chemical, mineral, metal and electronic industries sometimes release nitric acid (N_2O), a GHG with significant global warming potential (GWP). As none of the abovementioned industry types are expected in SEZ Bitung, this measure is not considered of relevance.
  - *Use of alternative refrigerants, or HFC recovery:* HFC, which is a GHG with a very high GWP, is the standard conventional refrigerant used in most cooling systems in the industrial sector. By replacing HFC with natural refrigerants, which have only a very small or zero GWP, significant ERs can be achieved. Since there is no industry currently in operation in the SEZ Bitung, initialliy installing such refrigerants at the very start of individual SEZ developments presents a good opportunity for implementation. Similarly, introducing recovery practices at the end of a product or equipment’s life, so they can be either recycled or destroyed (i.e., HFCs in refrigerators), will have significant GHG ER potential while ensuring environmental sustainability, and is aligned with international standards and the phase-out of HFC under the Montreal protocol. Therefore, the use of alternative refrigerants is considered of high potential and will be retained for further analysis.

If a combination of industrial process improvements as described above is properly implemented in the industrial facilities of the SEZ, overall plant efficiency could be highly increased, while at the same time reducing energy consumption and related GHG emissions, and creating significant SD benefits. Therefore, industrial process improvements have been short-listed as a combined set of LCMs for Industry.

[71] Significant time can elapse between the manufacture of the product and the release of GHG. The delay can vary from a few weeks (e.g., for aerosol cans) to several decades (e.g., rigid foams). In refrigeration a fraction of GHG used in the products can be recovered at the end of product’s life and either recycled or destroyed.

2.5.1.2.1.3.3 Industrial Low Carbon Building Design

Within industrial low carbon building design, local climate characteristics (temperature, wind, humidity, rainfall, solar radiation, and positioning) are taken into account to reduce building energy demand and to maximize the livelihood and comfort of industrial indoor spaces.

In comparison with the above-described LCMs of EE improvements in industrial equipment, appliances and processes, natural phenomena instead of mechanical systems are used to increase EE. Low carbon building design includes (i) natural lighting; (ii) natural cooling; (iii) natural ventilation and (iv) insulation.

- Natural Lighting

Natural lighting design places windows and openings and reflective surfaces in such a way that natural light provides effective lighting within a building. As a result, electric lighting and energy consumption can be reduced.

- Natural Cooling

Natural cooling is focusing on (i) natural shading by building elements such as overhangs, exterior or interior blinds; and (ii) landscape shading such as plants or trees. Through natural shading solar radiation from the sun is prevented from entering a building, reducing the demand for active cooling systems.

- Natural Ventilation

Natural ventilation utilises the differences in air density or air pressure for natural ventilation, hence reducing the need for artificial cooling through air conditioning.

- Building Insulation

Through the application of internal and/or external insulation materials in buildings, insulation can reduce unwanted heat gain (or loss), decrease the energy demand of cooling systems (or heating systems) and increase thermal comfort for occupants.

If low carbon building design measures are considered as stand-alone measures in the industrial sector, they have limited GHG ER and SD potential. However, when considered as complementary activities to be combined to the industrial LCMs described above, they can create synergies and have a multiplier effect at a low incremental cost, and therefore will be considered as high-potential LCMs to be shortlisted.

2.5.1.2.1.4 Commercial

The commercial energy sub-sector covers all energy related activities in commercial buildings including in businesses, public services and institutional buildings. In terms of land use distribution, commercial areas will occupy significantly less land (12.13%) than the industrial sector (57.45%). Similarly, as seen in the industrial sector, potential LCMs in the commercial sector include (i) EE commercial equipment and appliances; and (ii) commercial low carbon building design. Process improvements are not applicable for the commercial sector.

Conventional energy supply systems for commercial buildings are expected to be the same as for the industrial sector (i.e. off-grid diesel generators and on-grid power supply).

2.5.1.2.1.4.1 Energy Efficiency in Commercial Equipment and Appliances

Commercial EE equipment and appliances are very similar to the ones already described under the industrial sector, with the major differences being their smaller scope/magnitude and industrial-specific technology demands. As with the industrial sector, equipment and appliances under the commercial sector will also be classified in RAC, heating and lighting. All of these have been retained for the short list, as in the case of industry.

2.5.1.2.1.4.2 Commercial Low Carbon Building Design

Commercial Low Carbon Building Design measures are very similar to those already described under industry; a detailed explanation of low carbon building design measures can be found under the industrial sector. As above, if low carbon building design measures are considered as stand-alone measures, they have very limited GHG ER and SD potential. However, when considered as complementary activities to be combined with the industrial LCMs and the RAC, heating and lighting measures, they can create synergies and have a multiplier effect at a low incremental cost, and therefore will be considered as high-potential LCMs to be shortlisted.

2.5.1.2.1.5 Residential

The residential sector contains all households and residential buildings within the SEZ Bitung. In terms of land use distribution, residential areas will occupy the smallest area (8.8%) compared to the commercial (12.13%) and industrial (57.45%) sector.

As with the commercial sector, residential LCMs are divided into (i) residential EE equipment and appliances; and (ii) residential low carbon building design.

The conventional energy supply systems for residential buildings are the same as for the industrial and commercial sectors (i.e. off-grid diesel generators and on on-grid power supply).

2.5.1.2.1.5.1 Energy Efficiency Equipment and Appliances

Residential EE equipment and appliances are very similar to those in the commercial sector, with the only difference being their smaller scope/magnitude. As with the industrial and commercial sectors, equipment and appliances under the residential sector will also be classified in RAC, heating and lighting. All of these have been retained for the short list, as in the abovementioned cases.

2.5.1.2.1.5.2 Residential Low Carbon Building Design

Residential low carbon building design measures are very similar to those already described under the industrial sector, and considered also for commercial buildings. Please refer to the industrial sector for a detailed explanation of low carbon building design measures. As with the above categories of building, if low carbon building design measures are considered as stand-alone measures, they have very limited GHG ER and SD potential. However, when considered as complementary activities to be combined with the industrial and commercial LCMs and the RAC, heating and lighting measures for residential buildings, they can create synergies and have a multiplier effect at a low incremental cost, and therefore will be considered as high-potential LCMs to be shortlisted.

2.5.1.2.2 Transportation Sector

The transportation sector for LCMT Bitung includes all means of transportation (motorised and non-motorised) and the underlying mobility infrastructure within the SEZ Bitung. This section looks at the role and the meaning of the transportation sector in the development of an urban low carbon strategy and how the application of low carbon principles can add to the overall sustainability vision of the SEZ Bitung.

A low-carbon transportation sector which follows the principles of sustainable development not only mitigates emissions but can achieve significant co-benefits such as increased energy security through reduced reliance on oil imports, which will also have a positive impact on environmental conditions; human health (through the reduction of air pollution and noise); and increased competitiveness and attractiveness of the SEZ Bitung as potential business location for investors.

The most comprehensive framework to identify and assess LCMs for transport is the called Shift/Avoid/Improve[72] approach. This approach defines three main ways of reducing GHG emissions in transport:

- Shift: where travel is shifted to more environmentally-friendly modes;
- Avoid: where transportation infrastructure is organised in such a way that future travel demand is reduced or avoided; and
- Improve: where technological measures improve the vehicle fleet, used fuel and supporting infrastructure, so emissions are reduced.

The current status of transportation infrastructure in the SEZ Bitung consists only of small dirt roads used mainly by motorcycles. No tarred road infrastructure, public transportation, public lighting systems or other infrastructure elements exist. This provides the opportunity to integrate transport-related LCMs right from the beginning of the development of the SEZ Bitung.

Following the Shift/Avoid/Improve approach, the paragraphs below provide an evaluation of the long-list of potential LCMs for the transportation sector of SEZ Biting.

2.5.1.2.2.1 Shift

2.5.1.2.2.1.1 Bus Rapid Transit (BRT)

A BRT system is considered the ideal means of urban public transportation for the SEZ Bitung, as it will facilitate a shift from travel in private cars and motorcycles to the use of public buses. Significant GHG ER and SD benefits can be achieved with medium implementation efforts.

2.5.1.2.2.1.2 Light Rail Transit (LRT)

Compared with the BRT as a public transport system for the SEZ, the railed-vehicle-based LRT requires significant implementation efforts in terms of infrastructure development and investment costs. In addition, transportation routes are fixed and do not provide much flexibility to adapt to a potential changing environment (e.g. shift in industrial activity areas) within the SEZ. Therefore, the Light Rail Transit has not been chosen as a high potential measure while the BRT system has been short-listed.

2.5.1.2.2.1.3 Non-Motorised Transportation (NMT) Infrastructure Development

The development of specific supporting infrastructure is crucial to achieve a large-scale shift towards NMT usage. Supporting infrastructure development includes the following:

- Sidewalks, crosswalks, paths, bicycle lanes
- Pedestrian oriented land use and building design,
- Increase road and path connectivity with special non-motorised shortcuts
- Bicycle parking
- Bicycle integration in transit systems (e.g. racks on bus)
- Traffic calming through traffic speed reductions, vehicle restrictions and road space reallocation

As an infrastructure supporting measure, the GHG ER potential is limited and difficult to specifically allocate. However, significant SD benefits such as air quality improvement, congestion and noise reduction, increase of social equity, reduced travel times and a general higher quality of livelihood can be achieved, while implementation is regarded as viable.

[72] GIZ, “Beyond the Fossil City: Towards low Carbon Transport and Green Growth”, August 2010, http://www.sutp.org/documents/PPR-GTZ-EST-230810-EN.pdf

2.5.1.2.2.1.4 Intra-City Community Bicycle System

One potential option to shift travel patterns from conventional car and motorcycle use to NMT usage is the introduction of an intra-city community bicycle system within the boundaries of the SEZ. This concept would provide free or affordable access to bicycles to be used on designated bicycle lanes for short-distance trips in the SEZ area as an alternative to motorised public transport or private vehicles. With an ER potential considered moderate, and significant potential SD benefits such as reducing traffic congestion, noise, and air pollution, as well as improvement of personal health through regular physical exercise, this LCM is considered a high potential action for the SEZ Bitung.

2.5.1.2.2.2 Avoid

2.5.1.2.2.2.1 Transit Oriented Development (TOD)

TOD aims to develop a smart infrastructure concept in which residential and commercial facilities are located in short distance to each other and close to public transportation hubs. This encourages the use of public and NMT and leads to the reduction of GHG emissions through the avoidance of conventional vehicle use. It also increases comfort and ease for local residents when planning daily activities, therefore presenting a promising LCM for the SEZ Bitung.

2.5.1.2.2.2.2 Public Car Sharing System

A public car sharing system is yet another means of reducing the ownership and individual use of private cars and motorcycles by promoting community-based utilisation of publicly accessible vehicles. Although widely used in developed countries, this concept is not considered a priority for the SEZ Bitung. Given the limited target area of the SEZ and the coverage area of such a public car sharing system, the potential GHG ER is low and no significant SD benefits are generated.

2.5.1.2.2.3 Improve

2.5.1.2.2.3.1 Good Quality Roads

By constructing good quality roads, only marginal potential for ER or SD benefits exist. Furthermore, as the SEZ Bitung is a Greenfield Development where all roads will be built new, no road quality challenges are expected in the short and medium term. Therefore, this LCM has not been short listed as high potential.

2.5.1.2.2.3.2 LED lighting for urban transportation areas

LED street lighting in areas such as roadways, bus stations, bicycle and walkways, as well as parking lots, can provide increased safety and security during evening, night, and early morning times through increased illumination and improved visibility. This LCM has already been included under the energy sector as the LED for public areas, industrial commercial and residential uses, and therefore is already retained on the high potential LCMs short-list for the SEZ Bitung (will not be listed under transport to avoid unnecessary repetitions).

2.5.1.2.2.3.3 Use of Alternative Fuels

The replacement of conventional fuels such as diesel and gasoline in motorised vehicles with alternative fuels with a lower carbon-intensity is a potential measure for additional ERs and SD benefits in the SEZ transportation sector. With regard to public transportation, as described above, a BRT System is considered the ideal form of public transportation for the SEZ Bitung. Through the use of butane or liquefied petroleum gas (LPG) fuel systems for public buses, additional ERs and SD benefits could be realised. For other vehicles such as cars, motorcycles and trucks, the blending of bio-fuel with conventional fuel has been identified as additional opportunity. However, Pertamina is the only state-owned company that sells fuels including biofuel in Indonesia (B10 with a 10% bio fuel component) and policy and regulation coordination are solely the responsibility of the national government. Given the current institutional and regulatory context, this LCM would be difficult to implement or could not be implemented effectively. Therefore the use of alternative fuels has not been included in the potential LCM list.

2.5.1.2.2.3.4 *Replacement of fossil-fuel-based vehicles with electric vehicles*

The replacement of conventional diesel or gasoline based vehicles with electric vehicles (charged through solar PV power stations) is a very ambitious LCM and would require a high level of investment and a very determined effort in terms of policy, infrastructure, institutional and operational assistance. In turn it would bring only limited impacts in terms of absolute GHG ER and SD potential as only a very small fleet of such vehicles is expected to be operated within the SEZ. Therefore, this LCM is not considered of high potential.

2.5.1.2.2.3.5 *Increasing energy performance standards in vehicles*

Increasing energy performance standards for vehicles is another potential LCM to be considered in the future development of the SEZ Bitung LCDS. However, as an in-depth policy assessment for the SEZ Bitung will be part of the third step of the APEC LCMT project activities, this LCM has not been further analysed under the scope of this feasibility study.

2.5.1.2.3 Agriculture, Forestry and Other Land Use (AFOLU) Sector

The AFOLU sector looks at land use changes from agriculture, forestry and other activities and related emission and development impacts.

Proposed LCMs in the AFOLU sector of the SEZ Bitung focus on the avoidance and minimisation of emissions from land use changes during the SEZ development and urban greening. Agriculture activities are not planned for the SEZ Bitung and are thus not considered.

2.5.1.2.3.1 *Land Use Management*

Managing land use and more importantly land use change, i.e. how the use of certain areas is converted to serve a different purpose, is an important measure and can lead to substantial emission avoidance and high SD benefits. Land use change of areas with high GHGs stored within the ground (potentially to be released into the air during land use change activities) and areas which create high recreational, social or environmental benefits for the public should be managed properly during SEZ land development and operation. The revision of land-zone usage or additional reforestation activities are implementable land use management activities with a high potential impact. Land Use Management is hence short-listed as a high potential LCM.

2.5.1.2.3.2 *Urban Greening*

Urban greening includes the development of green spaces (parks), green pedestrian walkways, green roadways, green building façades and green watersides. It offers only marginal GHG ER potential but it creates significant SD benefits such as increasing urban shade cover and cooling, improving air quality and providing outdoor activity opportunities for residents of the SEZ Bitung. Since its implementation is also fairly easy and is high visibility and helps build a positive feeling, urban greening is retained as a high potential LCM.

2.5.1.2.4 Waste Sector

The waste sector focusses on any substance which is discarded after primary use, or is worthless, defective or can no longer be used as originally intended. This study differentiates between solid waste and wastewater.

LCMs within a low carbon and sustainable waste management system comprise of the treatment, disposal and management of solid waste and wastewater and can lead to substantial GHG ERs through the avoidance of aerobic or anaerobic decomposition and incineration. High potential LCMs in the waste sector can also lead to an improvement in local livelihoods and local health as air and water pollutants are avoided, controlled or absorbed.

2.5.1.2.4.1 Solid Waste

Solid waste within the SEZ Bitung is generated through industrial, commercial and residential activities and includes materials such as paper, plastic, metal, glass, textiles, electronics, organic waste and potentially hazardous waste (paints, chemicals etc.). Solid waste can generate high GWP GHG emissions through anaerobic digestion (usually from organic waste). Solid waste that is not managed or is poorly managed can have serious environmental, social and economic impacts including air and water pollution, facilitation of the spread of diseases, disruption to wildlife and reduced local property values. A good solid waste management system is therefore critical for urban low carbon and sustainable development.

2.5.1.2.4.1.1 Solid Waste Recycling

So far, no solid waste recycling system has been conceptualised for the SEZ Bitung. One proposed high potential LCM is the introduction of solid waste recycling activities in residential, commercial and industrial buildings, as well as in other public areas. Recycling reduces the need for conventional waste disposal (waste dumping is a common practise in Indonesia). Recycling prevents the waste of potentially useful materials and reduces energy consumption, air pollution and water pollution. Actual recycling activities should be accompanied by recycling education activities for residential and commercial communities and individual industries. The ER potential of solid waste recycling within the SEZ Bitung is medium, but high SD benefits can be realised. This LCM is considered of high potential.

2.5.1.2.4.1.2 Solid Waste Landfill Management

This practise includes the collection, storage, consolidation and processing of solid waste material at a dedicated landfill site. No landfill within the SEZ or surrounding area exists yet, leaving a lack of clarity on where and how solid waste from SEZ activities will be disposed of. A well-managed landfill (i.e. not just a dump site) confines the waste to a small area, reduces waste volume and constantly covers the waste with layers of soil or alternative materials such as wood or agricultural waste. Additional activities may include resource recovery & recycling, waste incineration or landfill gas collection and utilisation (i.e. flaring or utilisation of methane gas emitted by decaying organic waste). Potential GHG ERs and SD benefits from this LCM are high. The construction and management of such a facility, depending on its scope of operations, will require substantial efforts and investments. Despite these implementation efforts, solid waste landfill management is regarded a high potential LCM and has been short-listed.

2.5.1.2.4.2 Wastewater

Wastewater is any water that has been adversely affected in quality by human influence. Wastewater can originate from industrial, commercial and residential activities. In Indonesia, polluted wastewater is often simply discharged into nearby surface water (rivers, lakes or the ocean) or ground water without prior treatment. This can cause air and water pollution, increased health risks and a reduction in the quality of recreational activities in public areas.

2.5.1.2.4.2.1 Wastewater Treatment

A potential LCM in the waste sector is the removal of pollutants from residential, commercial and industrial wastewater through physical, chemical, and biological processes at a wastewater treatment plant. Treated and purified wastewater can be discharged into the environment without risk, or reused for agriculture, aquaculture or industrial purposes. GHGs resulting from anaerobic digestion can either be avoided through flaring or captured and used for electricity generation through a methane capture system. The potential GHG ERs and environmental and social SD benefits are regarded as being high; the wastewater treatment LCM is therefore retained in the LCM short list.

2.5.1.3 Summary of the Qualitative Assessment

The list below summarises the qualitative assessment conducted above. LCMs highlighted in green are considered to have high potential whereas those highlighted in red will not be considered further for the SEZ Bitung at this moment.

Table 68: Summary of Qualitative Assessment

Measure	GHG ER	SD	Implementation
EG: Utilization of Geothermal Energy	++	+	+
EG: Photo Voltaic (PV)	+	+	+
EG: Concentrated Solar Power (CSP)	++	++	--
EG: Utilization of small-scale Hydro Power	+	+	--
EG: Utilization of wind energy	+	+	--
EG: Utilization of Wave Energy	+	+	--
EG: Utilization of Tidal Energy	+	+	--
EG: Methane capture from Solid Waste	+	+	+
EG: Methane capture from wastewater	+	+	+
EG: Thermal energy generation from biomass	+	+	+
EG: Use of Bio-fuel for generators	+	+	--
EG: Smart Grid			
EG: Energy Efficient LED	+	+	+
Industry: RAC	+	+	+
Industry: Process Improvements	+	+	+
Industry: Heating	+	+	+
Industry: Lighting	+	+	+
Industry: BEMS	+	+	+
Commercial: RAC	+	+	+
Commercial: Heating	+	+	+
Commercial: Lighting	+	+	+
Commercial: BEMS	+	+	+
Residential: RAC	+	+	+
Residential: Heating	+	+	+
Residential: Lighting	+	+	+
Residential: BEMS	+	+	+
Transport: BRT	++	++	++
Transport: LRT	++	++	-
Transport: NMT	++	++	++
Transport: TOD	++	++	+
Transport: Car Sharing	-	-	--
Transport: High Quality Roads	+	+	--
Transport: LED Street Lighting	+	+	+
Transport: Electric Vehicles	+	+	--
Transport: Alternative Fuels	++	++	--
AFOLU: Land Use Management	+	++	+
AFOLU: Urban Greening	+	++	++
Waste: Solid Waste Landfill Management	+	++	+
Waste: Solid Waste Recycling	+	+	+
Waste: Wastewater Treatment	+	+	+

EG = Energy Generation; Source: Own elaboration

The short list below shows all final high potential LCMs resulting from the qualitative LCM evaluation. Certain homogenous groups of LCMs have been clustered, as they should be implemented as comprehensive programmes rather than individually. In the next step of the SEZ Bitung Feasibility study, the final listed LCMs will be subject to a detailed impact, cost and implementation analysis.

Table 69: Final LCM Short List after Qualitative Assessment

LCMT Target Sectors	Sub Sector	Type/ Technology of LCM	Specific LCM
Energy	Energy Generation	Utilisation of Clean Energy	• Utilization of Geothermal Energy (Geothermal Power Plant)
		Solar Energy Generation	• Use of Photo Voltaic (PV) panels on buildings
		Waste-to-Energy Generation	• Methane capture system for Solid Waste and Wastewater
		Biomass Thermal Energy Generation	• Thermal energy generation from agricultural waste
		Bio-fuel-based Energy Generation	• Utilization of Bio-fuels for generator use
		EE in Energy Generation and end-use	• EE LED Program (Public, Industrial, Commercial & Residential Buildings)
	Industry	EE in Equipment and Appliances & Building Design	• Comprehensive EE Program for the Industrial Buildings and Appliances
		EE in Industrial Processes and Product Use (IPPU)	• Comprehensive EE Program for IPPU
	Commercial	EE in Equipment and Appliances & Building Design	• Comprehensive EE Program for the Commercial Buildings and Appliances
	Residential	EE in Equipment and Appliances & Building Design	• Comprehensive EE Program for the Residential Buildings and Appliances
Transportation	Shift	• Bus Rapid Transit (BRT) • Intra-city community bicycle system • Non-Motorized Transport (NMT) Infrastructure Development	
	Avoid	• Transit-Oriented-Development (TOD)	
	Improve	• High Quality Roads • Alternative Fuels	
AFOLU	Land Use	• Forestry and other Land Use Preservation	
	Urban Greening	• Comprehensive Urban Greening Measures	
Waste	Solid Waste	Solid Waste Landfill Management	• Comprehensive Solid Waste Landfill Management System
		Solid Waste Recycling	• Waste recycling in the Industrial, commercial and residential sector
	Wastewater	Wastewater Treatment	• Comprehensive Wastewater Treatment System

Source: Own elaboration

3 Impact and Cost Report of selected LCMs

This Impact and Cost Report is presented as the second activity under the LCMT Feasibility Study for the SEZ Bitung. The report includes a detailed impact and cost assessment of the high priority LCMs that were identified, prioritised and selected in task 1.5.

The first section of the impact and cost report presents the approach used and explains the Multi-Criteria Assessment (MCA) methodology that has been applied to evaluate the selected LCMs. The MCA uses a set of criteria in order to evaluate the overall impact and associated costs of each LCM.

The second section provides the impact and cost assessment, and starts by introducing the shortlist of selected LCMs and the rationale for regrouping them, followed by a comprehensive impact and cost assessment of each LCM. Each individual assessment is structured across the different criteria of the MCA, along the following sub-sections:

- (i) SEZ-specific Context: contains the description of the LCM;
- (ii) Alignment with Domestic Policy Framework: qualitative assessment and scoring;
- (iii) GHG ER Calculation: assumptions, calculation methodology, result and scoring;
- (iv) Cost Effectiveness: assumptions, calculation methodology, result and scoring;
- (v) Sustainable Development: mixed qualitative / quantitative assessment and scoring;
- (vi) Technical Feasibility: qualitative assessment and scoring;
- (vii) Financial Feasibility: mixed qualitative / quantitative assessment with assumptions, calculation methodology, result and scoring;
- (viii) Political/Legal/Regulatory Viability: qualitative assessment and scoring; and
- (ix) Summary: the scoring summary of each LCM, including the scoring per criteria and the overall weighted average score.

The third part includes the final results of the LCM impact and cost assessment in a comprehensive table, arranged from the highest to the lowest MCA scores. This table represents the final, prioritised list of selected and regrouped LCMs that will be retained for further analysis.

Finally, and building on the previous results, the fourth section summarises the conclusions of the detailed impact and cost assessment.

3.1 Approach and Methodology

This section describes the approach and methodology applied to conduct the MCA for each of the selected LCMs.

The MCA methodology is carried out through the use of a simple, yet effective MCA tool. The MCA tool is used to: (i) assess the feasibility of each LCM with regards to how promising/successful it can be; and (ii) assess, score and prioritise the different measures against each other (which is required when narrowing down a long list to a shortlist of priority measures or mitigation actions).

The MCA approach will consist of scoring the LCM according to a set of criteria, each of which will have a relative weight depending on how important each specific criterion is in relation to the national development context of Indonesia.

The individual criteria are aligned to and built around the most relevant success factors and requirements currently being adopted in most international screening and evaluation initiatives in relation to mitigation (i.e. Green Climate Fund and NAMA Facility project screening and selection; CDM feasibility methodologies; WB NAMA Rating tool; etc.).

The proposed weightage is based on the best professional understanding of national strategic development priorities, the most appropriate technologies given the domestic context, and the importance for achieving significant GHG emission reductions (ERs), but also significant SD impacts.

While the assessment criteria and relative weightage has been proposed, both the weight and the specific scores can be modified for each LCM collaboratively and in consultation with key national stakeholders.

To evaluate each criterion, a scoring between 1 and 5 will be applied (1 being the lowest and 5 being the highest). This is done for all criteria for standardisation and comparability purposes. The weighted average score of all criteria will therefore be a number between 1 and 5, and will determine the overall feasibility of the measure and an evaluation of the LCM's potential.

Each single evaluation criteria can be divided into quantitative, qualitative, and combined criteria:

- **Quantitative criteria** are represented by absolute numbers (i.e. GHG ER potential in tCO2e saved, or marginal abatement cost in USD/tCO2e). These absolute numbers will have to be proportionally translated onto the 1 to 5 scale so that they can be incorporated into the weighted average. The resulting score will therefore be a relative score based on their absolute number when compared with the quantitative assessment result of the other selected LCMs.
- **The qualitative criteria** encompass those that cannot be calculated by absolute, objective numbers. In order to evaluate them, a number of guiding questions, building on past experience on low carbon strategy design and development, and based on best professional understanding, have been developed. The methodology allows for a more standardised, rigorous and comparable approach to scoring/evaluation, but is not intended to be taken as an official or standard questionnaire. The questions will be answered with "Yes", "No" or "Partially", resulting in scoring 1 point for YES, 0 points for NO and 0.5 points for PARTIALLY. When a question is considered very important, a 2-point scoring is also possible in some cases. The final scoring after all the questions have been replied to will determine the evaluation of the respective qualitative criterion.
- A third type of criteria will be the **combined quantitative and qualitative criterion**. Scoring for these criteria will be carried quantitatively and qualitatively as described above. A relative weight to each the quantitative and the qualitative scores will then be assigned, which will result in a final weighted score from 1 to 5.

The evaluation criteria and weightage proposed for this LCM Feasibility Assessment are detailed in the table below:

Table 70: LCM Feasibility Assessment Criteria including proposed Weighting Factors

LCM Feasibility Assessment Criteria	Criteria Description	Proposed Evaluation Weighting Factor
Alignment and Coherence with Domestic Policy Framework	This qualitative criterion tries to reflect how much the LCM is (or could be) aligned with the national development objectives and priorities, which is very important in ensuring a successful LCM development process (as an LCM that creates win-win opportunities for the government, the private sector, potential donors, and the beneficiaries will be more valuable and have a bigger impact than one that acts in isolation).	15%
GHG ER Potential	GHG ER potential is a quantitative measure of the actual GHG reduction potential of the LCM (in terms of tCO_2e avoidance potential). The absolute numbers will be proportionally reflected on a scale of 1 to 5.	20%
Cost-effectiveness (economic effectiveness)	Cost-effectiveness (CE) is a quantitative measure of the Marginal Abatement Cost (MAC) of the measure (i.e. cost in USD or equivalent monetary terms per tCO_2e reduced). It represents a scoring built on an estimation of the amount of money necessary to achieve GHG ER. When the specific MAC are not available, the closest approximation available will be used (either national MAC data, or international generic MAC data if nation-specific data is not available) at this stage,	15%

LCM Feasibility Assessment Criteria	Criteria Description	Proposed Evaluation Weighting Factor
	while a strong recommendation will be issued to calculate context specific MACs during implementation[73]. The absolute numbers will be proportionally reflected on a scale of 1 to 5.	
Technical Feasibility	Technical feasibility is a qualitative criterion that will measure the availability of technology, related know-how, data and technical requirements that are linked to the implementation of the LCM being evaluated. It will also include an initial consideration on the MRV System requirements, but the actual sketching of the MRV System will be done only at the design stage.	10%
Legal / Regulatory / Institutional / Political / Social Feasibility	This qualitative criterion will analyse whether the LCM is well aligned and compliant with the local institutions, the regulatory environment, and is generally acceptable/feasible given the domestic political context.	10%
Financial Feasibility	This quantitative/qualitative criterion measures the financial feasibility, i.e. costs and benefits, of LCM development and investment plans. Ideally, a qualitative approach should be applied, such as a cost-benefit analysis (CBA) ratio[74] or a Net Present Value (NPV) calculation (whenever possible). The absolute numbers will be proportionally reflected on a scale of 1 to 5. If the financial ratios are not available, a qualitative (i.e. scoring questions) approach will have to be used. A combination of both a qualitative and quantitative approach is possible if quantitative data are available but lack completeness or accuracy.	10%
SD Benefits (beyond GHG ER)	This mainly qualitative criterion will look into how the LCM supports or contributes to the achievement of additional SD goals (economic, social, growth and development, and environmental co-benefits). The assessment will look at the different co-benefits and will assess them qualitatively. In addition, each identified SD benefit will be given a specific relevance, complementing the previous qualitative assessment with a quantifiable approach (please see the detailed description of the methodology below).	20%

Source: Own elaboration

3.1.1 Alignment and Coherence with Indonesia's Domestic Policy Framework

As described in sub-section 2.1.3 the following national, local and city level polices have been identified for the evaluation of the LCM's alignment and coherence with Indonesia's domestic policy framework.

- **National policies:**
    - Indonesia's National Development Strategy (RPJPN & RPJMN)
    - Masterplan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI)
    - Indonesia's National Action Plan for Greenhouse Gas Mitigation (RAN-GRK)
    - National Energy Policies

[73] Dedicated MACs for each option are beyond the scope of this assessment as they are very challenging and complex endeavors. However, they will be recommended for the detailed design and implementation phase as they will be key to have a solid and robust estimation of the measure's costs to achieve the intended GHG emission reductions.
[74] The CBA ratio is the result of the division of the overall net cost discounted by the overall net benefit discounted.

- **Provincial policies**
  - North Sulawesi Province Development Strategy (Rencana Pembangunan Jangka Menengah Daerah, RPJMD Provinsi Sulawesi Utara)
  - North Sulawesi Province Spatial Planning (Rencana Tata Ruang Wilayah Provinsi, RTRWP)
  - North Sulawesi Province Action Plan for GHG Emissions Reduction (RAD-GRK)
- **City-level policies**
  - Bitung City Development Strategy (Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung)
  - Bitung Detailed City Planning (Rencana Detail Tata Ruang, Bitung)
  - City Government Work Plan (Rencana Kerja Pemerintah Daerah, Bitung)
- **Special Economic Zone (SEZ) Policies**
  - SEZ Masterplan 2008
  - Study on the revision of the SEZ Bitung Masterplan, Inception Report (Korea – Indonesia partnership)
  - Study on SEZ Bitung Expansion (2,000 hectare)
  - Feasibility Study on SEZ Expansion (2,000 hectare, China – Indonesia partnership)

For the actual assessment, the objectives of the LCMs are measured against the objectives of the above-mentioned policies. The following questions are being applied for the evaluation and scoring for this criterion.

1st Question: Do policies in place have the same objective or explicitly promote the LCM?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: policies are in place that explicitly promote the LCM.

Yes, partially: policies are in place that indirectly support the LCM as they aim at achieving its general objectives, without explicitly referring to the LCM itself.

No: no policy in place that supports or promotes the LCM, directly or indirectly.

2nd Question: Do these policies have a numeric GHG ER target?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: policies are in place that include a numeric GHG ER target.

Yes, partially: policies are in place that include a GHG ER target, but it's not numeric, or it is relative to other policies, or it is not clear how much the policy should contribute to its achievement.

No: no policy in place has a specific GHG ER target.

3rd Question: Do these policies have a numeric sustainable benefits target?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: policies are in place that include a numeric SD target.

Yes, partially: policies are in place that include an SD target, but it's not numeric, or it is relative to other policies, or it is not clear how much the policy should contribute to its achievement.

No: no policy in place has a specific SD target.

4th Question: Does the LCM contribute directly to the numeric GHG ER target of the country/sector?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: the LCM would directly contribute to achieving the GHG ER target of the policy (if there is no GHG ER target, this is a No).

Yes, partially: the LCM would indirectly contribute to achieving the GHG ER target of the policy (if there is no GHG ER target, this is a No).

No: the LCM would not contribute to achieving the GHG ER target of the policy (or there is no GHG ER policy target).

5th Question: Does the LCM contribute directly to numeric sustainable development targets of the country/sector

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: the LCM would directly contribute to achieving the SD target of the policy (if there is no SD target, this is a No).

Yes, partially: the LCM would indirectly contribute to achieving the SD target of the policy (if there is no SD target, this is a No).

No: the LCM would not contribute to achieving the SD target of the policy (or there is no SD policy target).

The final score will be a number between 1 and 5.

3.1.2 GHG Emission Reduction Potential

The GHG ER potential calculation for each LCM will include remarks on specific assumptions (based on data availability) and the calculation methodology, which may vary for individual LCMs.

Once the absolute GHG ER potential (expressed in tCO_2e, absolute or yearly) is known for each LCM, individual GHG ER potentials for each LCM will be assigned a proportional score on a scale of 1 to 5, using a simple rule of three[75].

The potential GHG ER have been estimated as follows:

- Cumulative GHG ER achieved over the entire SEZ Bitung development phase (2017-2031); i.e. the sum of GHG ER achieved each year over a time period of 15 years.

For the final score, the cumulative GHG ER from the assessed LCM will be compared to the individual cumulative GHG ER results of the other selected LCMs. The LCM with the highest ER potential will be given the maximum score of 5. The LCM with the lowest GHG ER potential will be being given the minimum score of 1. In order to assign a relative score between 1 and 5 to the remaining LCMs, a "rule of 3" will applied, scoring each LCM relatively to the highest and lowest amount of GHG ER achieved by all LCMs analysed. The final score will be a number between 1 and 5.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(Highest\ GHG\ ER - Lowest\ GHG\ ER)}) * (GHG\ ER\ i - Lowest\ GHG\ ER)]$$

Where:

Highest GHG ER = Highest cumulative amount of GHG ER achieved among all LCMs analysed.

Lowest GHG ER = Lowest cumulative amount of GHG ER among all LCMs analysed.

[75] Source: https://en.wikipedia.org/wiki/Cross-multiplication

GHG ER i = Cumulative amount of GHG ER achieved from the specific LCM currently assessed.

3.1.3 Cost Effectiveness (CE)

CE expresses the cost for reducing one additional unit of pollution (one tonne of CO_2e). The Net Present Value (NPV) calculated during the respective LCM financial feasibility assessment will be used as the financial cost parameter.

In order to calculate the overall CE of the LCM, the achieved GHG ER will be calculated proportional to the assumed investment lifetime. This allows for an accurate comparison between the costs incurred to reduce GHG emissions and the actual ER achieved through the LCM. The calculation of the CE for each LCM will include remarks on specific assumptions (based on data availability), and the calculation methodology, which may vary for individual LCMs.

The CE has been estimated following the formula shown below:

$$\text{Cost} - \text{effectiveness} = -(\frac{NPV}{LCM\ cumulative\ GHG\ ER\ over\ investement\ l})$$

Where:

NPV = Net Present Value calculated for the LCM assessed[76].

LCM cumulative GHG ER = Amount of GHG ER achieved over the duration of the LCM investment lifetime.

For the final score, the absolute marginal abatement cost (MAC, expressed USD/ tCO_2eq) from the assessed LCM will be compared with the absolute MAC of the other selected LCMs. The LCM with the lowest MAC will be given the maximum score of 5. The LCM with the highest mitigation abatement costs will be given the minimum score of 1. In order to assign a relative score between 1 and 5 to the remaining LCMs, a "rule of 3" will applied, scoring each LCM relative to the lowest and highest mitigation abatement costs achieved by all LCMs analysed.

The final score will be a number between 1 and 5 following the calculation shown in the formula below:

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(Highest\ CE - Lowest\ CE)}) * (CEi - Lowest\ CE)]$$

Where:

Highest CE = Maximum value of CE from a LCM among the overall LCMs analysed.

Lowest CE = Minimum value of CE from a LCM among the overall LCMs analysed.

CE_i = Value of CE from the specific LCM assessed.

3.1.4 Sustainable Development Benefits

LCMs not only contribute to GHG ER, but are an important and valuable source of long-term sustainable development benefits for the society. The detailed evaluation of potential SD benefits is carried out using the NAMA SD Tool[77] (developed by the South Pole Group for UNDP). For the purpose of this prioritisation exercise, a weighted average approach, as explained below, is used to score the SD benefits. To recognise the potential SD benefits for each of the LCM options, the following long list of potential SD benefits is provided as guidance:

[76] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)
[77] http://www.undp.org/content/undp/en/home/librarypage/environment-energy/mdg-carbon/NAMA-sustainable-development-evaluation-tool.html

Table 71: Long List of SD Benefits

Domain	SD benefits (expressed as indicators)
1. Environment	Reduction in air / water / soil pollution Noise reduction / Visibility improvement
2. Social	Health Livelihood / Poverty alleviation Affordability of electricity Access to sanitation and water Food security / sustainable agriculture Quality of employment Time savings No child labor
3. Growth and Development	Access to clean energy Education Women empowerment Access to sustainable technology Energy security Capacity enhancement Equality in terms of job opportunity
4. Economic	Income generation / expenditure reduction Asset accumulation and investments Job creation

Source: UNDP NAMA SD Tool, 2014

For each LCM option, the relevant SD benefits are identified. These SD benefits are then scored on a scale of 1 to 5 based on a qualitative assessment (experience and relative improvements expected).

The scoring is done according to the following classification: low impact = 1; low / medium impact = 2; medium impact = 3; medium / high impact = 4; high impact = 5.

Secondly, each impact will be assigned a specific relevance (i.e. weighting), depending on the underlying designated purpose of the individual impact.

For practical reasons, the relevance is evaluated on a scale of 3, with 1 representing low relevance, 2 representing medium relevance and 3 representing high relevance.

The final score of the SD benefit criterion for each individual LCMs will be the result of the weighted average based on the score and relevance of the identified SD benefits. The applied final score formula can be seen below:

Formula for calculating final SD benefit score = $\frac{\sum_i (\text{Score}_i \times \text{Relevance}_i)}{\sum_i \text{Relevance}_i}$

3.1.5 Technical Feasibility

Assumptions regarding the LCM technology (i.e. technologies to be applied, required know-how, capacity, anticipated MRV system, etc.) are included for each LCM assessment.

For the actual assessment, the technical feasibility is measured qualitatively in accordance with the following questions:

1st Question: Is the related LCM technology available in the country and region?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: the LCM technology is available in the region.

Yes, partially: the LCM technology is available in the country, but not in the region.

No: the LCM technology is not available.

2nd Question: Are the technology measures currently already being used in the sector?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: the LCM technology is being used in the sector and it's an established practice.

Yes, partially: the LCM technology is being used in the sector but not as an established practice (i.e. has been piloted but it's not established).

No: the LCM technology is not being used in the sector.

<u>3rd Question: Is the necessary capacity to apply and use the LCM technology available in the country?</u>

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: the know-how is there.

Yes, partially: the know-how is there in very few academic centres but is not well-spread across technology users.

No: the know-how is not available.

<u>4th Question: Are technology related MRV activities feasible in terms of time and cost of the envisaged LCM? (2-Point-Question)</u>

Answer: YES (2 Points) / YES, partially (1 Point) / NO (0 points)

Yes: the MRV is feasible in terms of time and cost.

Yes, partially: the MRV is feasible but will need changes (institutional, regulatory) to adapt the national system to MRV requirements (or to "ease" the MRV to the national context).

No: the MRV is too expensive or too lengthy to make sense for the LCM.

The final score will be a number between 1 and 5.

3.1.6 Financial Feasibility

The assessment of the financial feasibility of individual LCMs includes a quantitative as well as a qualitative scoring exercise.

The quantitative financial feasibility assessment for each LCM includes remarks on specific assumptions (i.e. depending on the data availability), the calculation methodologies (i.e. NPV, Internal Rate Return (IRR), and CBA ratio) and the results and quantitative scoring.

Once the absolute CBA ratio is known for each LCM, the LCM with the highest CBA ratio will be given the maximum score of 5. The LCM with the lowest CBA ratio will be being given the minimum score of 1. In order to assign a relative score between 1 and 5 to the remaining LCMs, a "rule of 3" will applied, scoring each LCM relative to the highest and lowest CBA ratio achieved by all LCMs analysed. The final score will be a number between 1 and 5.

$$\text{Quantiative Financial Score Calculation} = 1 + [(\frac{4}{(Highest\ CBA\ ratio - Lowest\ CBA\ ratio)}) * (CBA\ ratio\ i - Lowest\ CBA\ ratio)]$$

Where:

Highest CBA ratio = Highest CBA ratio achieved among all LCMs analysed.

Lowest CBA ratio = Lowest CBA ratio achieved among all LCMs analysed.

CBA ratio i = CBA ratio achieved from the specific LCM currently assessed.

In the second step, a qualitative assessment will be conducted, applying the following evaluation questions:

<u>1st Question: Has the LCM faced high upfront costs problems?</u>

Answer: YES (0 Point) / YES, partially (0.5 Points) / NO (1 points)

Yes: high upfront costs occur.

Yes, partially: medium / high upfront costs occur.

No: no or only low upfront costs occur.

2nd Question: Has the LCM faced lack of adequate/sufficient financial incentives?

Answer: YES (0 Point) / YES, partially (0.5 Points) / NO (1 points)

Yes: there is a lack of adequate/sufficient financial incentives.

Yes, partially: financial incentives exist but their impact to incentivise investments is only limited.

No: adequate/sufficient financial incentives are in place.

3rd Question: Has the LCM faced lack of enabling finance/guarantee mechanisms?

Answer: YES (0 Point) / YES, partially (0.5 Points) / NO (1 points)

Yes: there is a lack of enabling finance/guarantee mechanisms.

Yes, partially: enabling finance/guarantee mechanisms exist but face difficulties in actual application.

No: enabling finance/guarantee mechanisms exist.

4th Question: Has the LCM already been successfully financed by domestic finance partners (i.e. domestic development banks, the government, or similar)?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: similar LCMs have already been successfully financed by domestic finance partners.

Yes, partially: similar LCMs have already been financed by domestic finance partners but faced difficulties.

No: similar LCMs have not been financed by domestic finance partners.

5th Question: Has the LCM already been successfully financed by international finance partners or related mechanisms (i.e. international development banks, public or private funds, donor governments, or similar)?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: similar LCMs have already been successfully financed by international finance partners or through related mechanisms.

Yes, partially: similar LCMs have already been financed by international finance partners or through related mechanisms but faced difficulties.

No: similar LCMs have not been financed by international finance partners or through related mechanisms.

The sum of points achieved through the application of the above listed questions represent the qualitative LCM scoring result.

For the final score, the individual weightage of both the quantitative and qualitative results will be applied, reflecting the quality and accuracy of the available quantitative data (i.e. the more and the higher the accuracy of available financial data, the higher the weightage for the results of the quantitative assessment; conversely the less and the lower the accuracy of available financial data, the lower the weightage for the results of the quantitative assessment and the higher the weightage of the qualitative assessment).

Calculation formula with an assumed quantitative weightage of 80% and a qualitative weightage of 20% $= (\text{Quantiative Score} * 0.8) + (\text{Qualitative Score} * 0.2)$

The final score will be a number between 1 and 5.

3.1.7 Political / Legal / Regulatory Viability

For this assessment, the political, legal and regulatory viability is measured qualitatively against the following questions:

1st Question: Is the LCM suited to the existing legal & regulatory environment? (2 Point question)

Answer: YES (2 Point) / YES, partially (1 Points) / NO (0 points)

Yes: the LCM is suited 100% to the existing legal framework.

Yes, partially: the LCM is suited to the existing legal framework, but small changes will be required to ensure its success.

No: the LCM is not suited.

2nd Question: Is the LCM suited to the existing institutional framework? (2 Point question)

Answer: YES (2 Point) / YES, partially (1 Points) / NO (0 points)

Yes: the LCM is suited 100% to the existing institutional framework.

Yes, partially: the LCM is suited to the existing institutional framework, but small changes will be required to ensure its success.

No: the LCM is not suited.

3rd Question: Is the LCM suited to the existing political landscape?

Answer: YES (1 Point) / YES, partially (0.5 Points) / NO (0 points)

Yes: the LCM is suited 100% to the existing political landscape.

Yes, partially: the LCM is suited to the existing political landscape, but small changes will be required to ensure its success.

No: the LCM is not suited.

The final score will be a number between 1 and 5.

3.2 Detailed Impact and Cost Assessment of the LCMs

The detailed impact and cost assessment has been carried out by applying an MCA for each LCM following the approach and methodology described in section 2.1.

The main result of this assessment is a prioritised list of all previously selected LCMs, arranged according to the scoring result of each LCM for each sector (energy, industry, residential and commercial buildings, transportation, AFOLU and waste).

3.2.1 Regrouped Shortlist of selected LCMs

In this sub-section several previously shortlisted LCMs have been regrouped to maximize synergies and restrict the selected LCMs to their most effective combination. The regrouping has been done on a sectoral basis, i.e. regrouping of LCMs within the energy OR transportation OR waste sector etc. This approach allows for a more focussed and efficient application of the MCA tool since individual evaluation steps can be reduced and bundled. In addition, this lead to a more programmatic implementation strategy, simplifying and optimising implementation processes such as budgeting and institutional set-up.

The assessment has been carried out in each sector and for all LCMs in order to achieve a final selection of shortlisted LCMs to be subject to the MCA.

3.2.1.1 Rationale for each regrouped LCM

Firstly, the shortlist of LCMs identified in section 2.5 can be seen in the following table:

Table 72: Shortlist of LCMs identified in section 2.5

LCMT Target Sectors	Sub Sector	Type/ Technology of LCM	Specific LCM
Energy	Energy Generation	Utilisation of Clean Energy	• Utilization of Geothermal Energy
		Solar Energy Generation	• Use of Photo Voltaic (PV) panels on buildings
		Waste-to-Energy Generation	• Methane capture system for Solid Waste and Wastewater
		Biomass Thermal Energy Generation	• Thermal energy generation from agricultural waste
		Bio-fuel-based Energy Generation	• Utilization of Bio-fuels for generator use
		EE in Energy Generation and end-use	• EE LED Program (Public, Industrial, Commercial & Residential Buildings)
	Industry	EE in Equipment and Appliances & Building Design	• Comprehensive EE Program for the Industrial Buildings and Appliances
		EE in Industrial Processes and Product Use (IPPU)	• Comprehensive EE Program for IPPU
	Commercial	EE in Equipment and Appliances & Building Design	• Comprehensive EE Program for the Commercial Buildings and Appliances
	Residential	EE in Equipment and Appliances & Building Design	• Comprehensive EE Program for the Residential Buildings and Appliances
Transportation	Shift	• Bus Rapid Transit (BRT) • Intra-city community bicycle system • Non-Motorized Transport (NMT) Infrastructure Development	
	Avoid	• Transit-Oriented-Development (TOD)	
	Improve	• High Quality Roads • Alternative Fuels	
AFOLU	Land Use	• Forestry and other Land Use Preservation	
	Urban Greening	• Comprehensive Urban Greening Measures	
Waste	Solid Waste	Solid Waste Landfill Management	• Comprehensive Solid Waste Landfill Management System
		Solid Waste Recycling	• Waste recycling in the Industrial, commercial and residential sector
	Wastewater	Wastewater Treatment	• Comprehensive Wastewater Treatment System

Source: Own elaboration

Secondly, the selected LCMs (in the table above) have been assessed in order to find additional commonalities. As a result, several LCMs have been regrouped and redefined. The regrouping overview including the underlying rationale can be seen in the following tables.

Energy sector:

The following specific LCMs have been regrouped in the energy sector:

Table 73: Regrouped LCMs in the Energy Sector

Previous selected LCMs	Regrouped LCMs	Rationale
- Utilisation of Geothermal Energy	1. Utilisation of Geothermal Energy	No further regrouping has been undertaken.
- Use of Photo Voltaic (PV) panels on buildings	2. Use of PV panels on buildings.	No further regrouping has been undertaken
- Methane capture system for Solid Waste and Wastewater - Comprehensive Solid Waste Landfill Management System - Comprehensive Wastewater Treatment System	3. Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater.	The regrouped LCM includes aspects from the three previous selected LCMs including: (i) constructing a sanitary landfill in the out-of-boundaries of SEZ Bitung to collect and treat the Municipal Solid Waste (MSW); and, (ii) complementing the sanitary landfill with an AD system to capture and use the methane from the MSW and wastewater to produce energy.
- Thermal energy generation from agricultural waste	4. Thermal energy generation from agricultural waste.	No further regrouping has been undertaken.
- Comprehensive EE Programme for Industrial Buildings and Appliances - Comprehensive EE Programme for Industry Processes and Product Use (IPPU) - EE LED Programme (Public, Industrial, Commercial & Residential Buildings	5. Comprehensive EE Programme for Industry Buildings, Appliances and Processes	The regrouped LCM includes aspects from the three previous selected LCMs including: (i) EE improvements in industrial buildings and appliances, including replacement of lighting with LEDs; (ii) EE improvements in industrial processes; and, (iii) Replacement of refrigerants with high GWP to natural ones with low GWP.
- Comprehensive EE Programme for Commercial Buildings and Appliances - Comprehensive EE Programme for Residential Buildings and Appliances - EE LED Programme (Public areas, streets, Industrial, Commercial & Residential Buildings	6. Comprehensive EE Programme for the Residential and Commercial Buildings and Appliances.	The regrouped LCM includes aspects from the three previous selected LCMs including: (i) EE improvements in the buildings and appliances, including replacement of lighting with LEDs in the commercial and residential sector.

Source: Own elaboration

Transportation sector:

The following specific LCMs have been regrouped in the transportation sector:

Table 74: Regrouped LCMs for the Transportation sector

Previous selected LCMs	Regrouped LCMs	Rationale
- Bus Rapid Transit (BRT)	7. BRT.	No further regrouping has been undertaken.
- Intra-city community bicycle system - Non-Motorised Transport (NMT) Infrastructure Development - Transit-Oriented-Development (TOD)	8. NMT and TOD.	The regrouped LCM includes aspects from the three previous selected LCMs including: (i) transport infrastructure aimed at enhancing environmentally friendly means of transport such as walking and the use of bicycles. (ii) activities which are strongly interrelated and similar.

Source: Own elaboration

AFOLU sector:

The following specific LCMs have been regrouped in the AFOLU sector:

Table 75: Regrouped LCMs for the AFOLU sector

Previous selected LCMs	Regrouped LCMs	Rationale
- Forestry and other Land Use Preservation - Comprehensive Urban Greening Measures	9. Urban Forestry and Urban Greening.	The regrouped LCM includes aspects from the two previous selected LCMs including: (i) implementing afforestation and reforestation measures in green open spaces; and, (ii) expanding urban green areas within the SEZ Bitung.

Source: Own elaboration

Waste sector:

The following specific LCMs have been regrouped in the waste sector:

Table 76: Regrouped LCMs for the Waste sector

Previous selected LCMs	Regrouped LCMs	Rationale
- Waste recycling in the industrial commercial and residential sectors - Comprehensive Solid Waste Landfill Management System - Comprehensive Wastewater Treatment System	10. Integrated Solid Waste Management System and 3R strategies.	The regrouped LCM includes aspects from the three previous selected LCMs: (i) facility to collect, sort and treat the waste to convert it into a resource; and, (ii) implement waste generation prevention, reutilisation and recycling through 3R strategies.

Source: Own elaboration

3.2.1.2 Final List of Regrouped LCMs

In accordance with the underlying rationale for the LCM regrouping exercise, the final selection of LCMs has been defined as shown in the table below. All listed LCMs have been subject to the detailed cost and impact assessment as described in the subsequent sections of this report.

Table 77: Final Shortlist applied for detailed LCM Assessment

LCMT Target Sectors	Sub Sector	Type/ Technology of LCM	Specific LCM
Energy	Energy Generation	Utilisation of Clean Energy	• 1. Utilisation of Geothermal Energy
		Grid Solar Energy Generation	• 2. Use of Photo Voltaic (PV) panels on buildings
		Waste-to-Energy Generation	• 3. Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater
		Biomass Thermal Energy Generation	• 4. Thermal energy generation from agricultural waste
	Industry	EE in Equipment and Appliances, Building Design and Industry Processes and Product Use (IPPU)	• 5. Comprehensive EE Program for the Industry Buildings, Appliances and IPPU
	Commercial	EE in Equipment and Appliances & Building Design	• 6. Comprehensive EE Program for the Residential and Commercial Buildings and Appliances
	Residential		
Transportation	Shift and avoid	• 7. Bus Rapid Transit (BRT) • 8. Non-Motorised Transport (NMT) and Transit-Oriented-Development (TOD)	
AFOLU	Land Use and Urban Greening	• 9. Urban Forestry and Urban Greening	
Waste	Solid Waste and wastewater	Solid Waste Management	• 10. Integrated Solid Waste Management System and 3R strategies

Source: Own elaboration

3.2.2 Utilisation of Clean Energy - Geothermal Energy

3.2.2.1 SEZ-specific Context

The main objective of this LCM is to develop a geothermal power plant (GPP) to supply electricity to both Bitung city and the SEZ.

This study assumes that the GPP will be installed out-of-boundary of the SEZ Bitung[78] with an overall power capacity of approximately 120 MW. The GPP will most likely be located in the mountain "Dua Saudara"[79] and will be the primary energy source (on-grid, power off-take by PLN-P3B dispatch for regional power consumer) for the SEZ Bitung in the long-term. This will ultimately mean that the GPP will progressively replace the two main existing energy supplies: (i) the use of diesel generators which support the SEZ Bitung electricity grid supply; and, (ii) PLN high-voltage power grids from North and Central Sulawesi (PLN Suluttenggo).

For the purpose of the ER calculation, the baseline scenario is based on the PLN Sulutenggo power grid. The use of diesel generators is assumed mainly for back-up, emergency, and other marginal power consumption and has not been further considered in this analysis.

Due to the nature of the electricity generation business, the financial analysis for the GPP has been addressed as a total project investment (instead of assigning financial costs and revenues proportionally to Bitung SEZ demand). This is necessary to provide a off-take guarantee for power plant developers, securing total project revenues to cover returns on total investment.

The final goal is to provide a major RE source to supply 100% clean electricity to industrial, residential and commercial buildings based in the SEZ Bitung.

The installation of the GPP is assumed to be completed at the end of Phase 4 (2025) and will therefore be operational until the end of the SEZ Bitung development and beyond.

3.2.2.2 Alignment and Coherence with Domestic Policy Framework

To assess how the utilisation of geothermal energy is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- National level policies:
    - National Action Plan for GHG ER (*RAN-GRK*);
    - Indonesia's National Medium and Long Term Development Plan (*RPJPN* & *RPJMN*);
    - National Energy Policy (*Kebijakan Energi Nasional, KEN*[80])
- Provincial level policies:
    - North Sulawesi Province Development Plan (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Provinsi Sulawesi Utara*);
    - North Sulawesi Province Spatial Planning (*Rencana Tata Ruang Wilayah Provinsi, RTRWP*);
    - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
    - Bitung City Medium Term Development Plan (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung*);
    - Bitung Detailed City Planning (*Rencana Detail Tata Ruang, Bitung*).

The result of the analysis is presented in the table below:

[78] No confirmed development plan for such a Geothermal Power Plant exists yet.
[79] This potential is based on a feasibility study that was mentioned in the LCMT concept presentation of the vice mayor of Bitung City during the official kick-off meeting on 11 May 2015 in Bitung. The study itself was not publicly available.
[80] Government Regulation No. 79/2014

Table 78: Scoring Summary: Utilisation of Geothermal Energy - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES, PARTIALLY: no policies that explicitly promote the construction of a GPP for Bitung City or the SEZ Bitung are in place. However, the RAN-GRK at the national level stresses the need to install new RE supplies and management. At the national level (*KEN)* underlines the relevance of shifting the primary energy mix of fossil fuel-based sources towards more diversified RE sources.	0.5
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions from the energy and transportation sectors up to 0.038 $GtCO_2e$ (+0.018 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES: policies that include a SD target are in place. Specifically, at the national level, the National Energy Policy (*KEN, RIKEN*) provides a set of indicators, baselines and targets in relation to the share of RE in the total energy consumption mix (up to 23% by 2025 and 31% by 2050 of total primary energy resource utilisation) and the electrification ratio (100% by 2020), among others.	1.0
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES: the LCM would directly contribute to achieving the SD target of the policy.	1.0
		FINAL SCORE	**4.5**

Final Score: 4.5 out of 5. Source: Own elaboration

3.2.2.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.2.3.1 Assumptions:

- **Installed power capacity**: the capacity installed is expected to reach 120MWe.
- **Electricity generation**: according to the installed power capacity and the number of operation hours estimated (7,446 hours)[81], a generation of up to 893,520 MWh of electricity (which represents a capacity factor of 0.85) has been assumed.
- **Grid emission factor**: 0.746 tCO_2e per MWh.

3.2.2.3.2 Calculation Methodology:

The GHG ER potential has been calculated following the UNFCCC-CDM Guidelines for grid-connected electricity generation from renewable sources (ACM0002)[82].

The electricity generated in the GPP will be used by Bitung City as well as by the SEZ Bitung. In order to assess only the emissions that have been reduced within the SEZ Bitung, the electricity demand (which is the determining factor of ER) of the SEZ has been assumed proportionally to the electricity demand of Bitung City. The applied proportional ratio increases over time from 0.27% - 3.55%, reflecting the SEZ's expected population growth and increased energy demand.

[81] Source: *Scaling-up renewable geothermal energy in Indonesia* (ESMAP, 2013).
[82] Source: https://cdm.unfccc.int/methodologies/DB/EY2CL7RTEHRC9V6YQHLAR6MJ6VEU83

3.2.2.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER achieved through the replacement of electricity generated from the regional power grid and local diesel generators with a geothermal RE source has been calculated as follows:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**256,753 tCO_2e**

For the final score, the cumulative calculated absolute GHG ER from the utilisation of geothermal energy has been compared with the individual cumulative GHG ER results of the 9 other selected LCMs. As is shown in the final evaluation summary table (section 2.3), utilisation of geothermal energy is the LCM with the highest GHG ER potential (256,753 tCO_2e) of all assessed LCMs, and has consequently been allocated the maximum score of 5.

Final Score: 5 out of 5

3.2.2.4 Cost Effectiveness

3.2.2.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV's discount rate. The discount rate has been estimated at 11.75%[83].

3.2.2.4.2 Calculation Methodology:

The LCM's CE represents the cost of reducing one additional unit of pollution (i.e. one tonne of CO_2e). The NPV calculated during the financial feasibility assessment of this LCM has been used as the financial cost parameter. However, in order to be able to compare the unbiased CE of individual LCMs, any kind of national or sectoral incentive scheme (e.g. Feed-in-Tariff - FiT) has been excluded from the NPV applied here.

In order to calculate the overall CE of the LCM, GHG ER which can be achieved have been calculated proportionally to the assumed lifetime of the investment. This allows for an accurate comparison between the costs incurred in reducing GHG emissions and the actual ER achieved through the LCM.

The cumulative GHG ER achieved over the duration of the investment for a geothermal power plant are shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: 30 years): **20,897,379 tCO_2e**[84]

The calculation of the CE was carried out by taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -\left(\frac{-379{,}818{,}736\ \text{USD}}{20{,}897{,}379\ \ \text{tCO2e}}\right)$$

3.2.2.4.3 Result & Scoring:

The abatement cost for mitigating one tonne of CO_2e from the utilisation of geothermal energy within the SEZ Bitung has been calculated up to **\$18.16/tCO_2e.**

For the final score, the CE of the utilisation of geothermal energy has been compared to the CE results of the 9 other selected LCMs. As is shown in the final evaluation summary table (section 2.3), other LCMs potentially have better CE. The LCM "Comprehensive EE programme for Industrial Buildings, Appliances and Processes" represents the LCM with the best CE (-\$28/tCO_2e),

[83] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)

[84] In this case the achieved GHG ER are rather high since the investment lifetime and related emission reductions are counted for 30 years.

consequently being given the maximum score of 5. The LCM "NMT & TOD" represents the lowest CE ($52/t$CO_2$e), and is consequently given the minimum score of 1.

In order to assign a relative score to this LCM of between 1 and 5, a "rule of 3" has been applied, scoring utilisation of geothermal energy relative to the lowest and highest mitigation abatement costs of all LCMs analysed.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(52\ USD\ per\ tCO2e - (-28\ \ USD\ per\ tCO2e)}) * (52\ USD\ per\ tCO2e - 13.72\ USD\ per\ tCO2e)]$$

Final Score: 2.7 out of 5

3.2.2.5 Technical Feasibility

Technical requirements for implementing GPP projects usually involve the following steps for feasibility assessment: (i) selection of geothermal prospect; (ii) surface study; (iii) exploration well drilling; (iv) geothermal reservoir simulation; (v) conceptual design for GPP; (vi) small-scale GPP construction; and (vii) GPP operation.

The necessary know-how and expertise is covered by national research institutions, as well as governmental and private project developers (e.g. WestJEC). The technology required is well-established and already provides solid results (the overall installed capacity of geothermal energy for electricity production in Indonesia accounts for more than 1,200 MW). MRV is also considered to be feasible, and is fully compliant with national requirements.

The results of the MCA are summarised in the table below:

Table 79: Scoring Summary: Utilisation of Geothermal Energy - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: the geothermal energy for electricity generation related technologies are available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES: the GPP technology is being used in the energy sector and it's an established practice in Indonesia.	1.0
3	Is the necessary capacity to apply and use the LCM technology available in the country?	YES: the know-how is there and it is endorsed by the establishment of the Geothermal Centre of Excellence and the own experiences from the Pertamina Geothermal Energy (PGE) and PLN.	1.0
4	Are technology-related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES: the MRV is feasible in terms of time and cost.	2.0
		FINAL SCORE	**5.0**

Final Score: 5 out of 5. Source: Own elaboration

3.2.2.6 Legal/Regulatory/Institutional/Political/Social Feasibility

The national energy policy and overall strategy is determined by the National Energy Council which acts as an independent council under the President of Indonesia. The Ministry of Energy & Mineral Resources (MEMR) sets the regulatory framework and procedures related to energy generation, transmission and distribution. The national electricity strategy is implemented by the Indonesian State Electricity Company (*Perusahaan Lositrik Nasional*, PT PLN), which is the largest Indonesian organisation responsible for energy transmission and distribution[85].

[85] PLN held a monopoly on energy transmission and distribution until 2012

Energy generation is the responsibility of PT Pertamina, a state-owned oil and gas exploration and exploitation company established in 1957. Pertamina is also involved in the development of geothermal energy through its drilling operations; Pertamina Geothermal Energy (PGE), a subsidiary of Pertamina, is the world's largest geothermal energy company. In this context, the MEMR has the authority to promote and supervise geothermal projects, with investment from either Pertamina or private investors. The national and sub-national governments also play a relevant role[86] in the coordination of geothermal exploration, in particular in relation to the Forestry Law and the issuance of licenses. The Bitung Town Council (in addition to the SEZ Bitung public officials) can also play a key role.

In summary, while the complex institutional environment makes the development of geothermal energy somewhat challenging, the implementation of this LCM has been considered relatively feasible given the existing regulatory framework and favourable political landscape. The results of the MCA are summarised in the table below:

Table 80: Scoring Summary: Utilisation of Geothermal Energy - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory framework, but minor changes will be required to ensure its success. A new geothermal law, Law No. 21 of 2014 (New Law), came into force on 17 September 2014, replacing Law No. 27 of 2003 (Old Law). Whilst the changes introduced are promising, there are still inconsistencies between the New Law and existing legislation and regulations that need to be addressed before the New Law can be effectively implemented. It should be stressed that Indonesia has a FiT in place for geothermal power generation, entered into force by the MEMR Regulation No. 22 (2012). However, it currently acts more like a price ceiling or a maximum allowable tariff that renewable energy facilities receive per kWh produced.	1.0
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing institutional framework, but changes will be required to ensure its success. Geothermal licensing procedures are currently the responsibility of the central government, resulting in longer and more bureaucratic institutional processes. This also leads to lower institutional capacity of local governments and to potential resistance of local communities within the municipality (as they might not be involved in the decision making process conducted at the national government level).	1.0
3	Is the LCM suited to the existing political landscape?	YES: the LCM is suited to the existing political landscape. However its success will depend on the Bitung local government contribution to the planning and provision of electricity directly to the region.	1.0
		FINAL SCORE	**3.0**

Final Score: 3 out of 5. Source: Own elaboration

3.2.2.7 Financial Feasibility

3.2.2.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.

[86] Geothermal licensing procedures and forestry permits and forest protection measures are currently the responsibility of the central government.

- **Capital investment**: includes one component as shown in the table below and considers typical wet steam characteristics of North Sulawesi geothermal resources (similar to Lahendong and Tompasso existing generation units) which requires a higher investment[87] estimate:

Table 81: Utilisation of Geothermal Energy - Financial Feasibility parameters

Parameter	Amount
(1) Cost of the GPP installation (USD 5,000,000 per MW installed)	$ 600,000,000
Overall capital investment = (1)	$ 600,000,000

Source: Own elaboration

- **Cost of Operation and Maintenance (O&M)**: includes the regular operation and maintenance activities and has been estimated at up to $20.83 per MWh produced[88]. In addition geothermal make-up wells drilling for every 4 – 6 years have been considered (estimated at 2 wells x USD 6,000,000 each time)
- **Assumed Investment lifetime**: 30 years.
- **Benefits**:
    - <u>Electricity generated with FiT</u>: for geothermal generation the FiT is $226 per MWh fed into the PLN Suluttenggo grid[89], and distributed by PLN-P3B to Bitung SEZ consumers (industry, commercial, residential).

3.2.2.7.2 Calculation Methodology:

The overall evaluation of financial feasibility includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M.

For the qualitative assessment, financial evaluation questions have been used (see 2.1.6 for the qualitative methodology explanation).

3.2.2.7.3 Result & Scoring:

The quantitative assessment shows that both the NPV and the CBA ratio have high positive values for this LCM, indicating that it is a sound and financially feasible investment over the investment lifetime of 30 years.

The main financial results from the quantitative assessment are shown in the table below:

Table 82: Utilisation of Geothermal Energy - Financial Feasibility results

Financial results for a 30 year investment lifetime	
Costs	
(1) Capital investment	$ 600,000,000
(2) O&M	$ 642,450,000
Overall Net Cost discounted	$ 478,131,253
Benefits	
(1) Electricity generated with FiT	$ 6,058,065,600
Overall Net Benefit discounted	$850,952,488
NPV	$ 376,433,858
IRR	20%
CBA ratio	1.8

Source: Own elaboration

[87] As example, Sarulla geothermal resources also have a considerably higher investment amount required (http://climatepolicyinitiative.org/wp-content/uploads/2015/03/Sarulla_CPI_Randy_20150227.pdf)
[88] Source: *Scaling-up renewable geothermal energy in Indonesia* (ESMAP, 2013).
[89] Source: MEMR Regulation No. 17 (2014) applicable for ceiling price from year 2024 onwards

To calculate the final score, the CBA ratio from the utilisation of geothermal energy has been compared to the individual CBA's of the 9 other selected LCMs. As is shown in the final evaluation summary table (section 2.3), this LCM has the highest CBA ratio (1.8) of all assessed LCMs, and has consequently been given the maximum score of 5.

Final Score - Quantitative assessment: 5 out of 5

The qualitative assessment shows that implementation of the utilisation of geothermal energy faces high capital investment costs and that no structured financial support system is in place. Despite these issues, several geothermal energy generation projects have been financed by public and private sector project developers and an incentive framework (i.e. geothermal energy FiT) is in place. The qualitative scoring summary is presented in the table below:

Table 83: Scoring Summary: Utilization of Geothermal Energy - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront cost problems?	YES	0.0
2	Has the LCM faced lack of adequate/sufficient financial incentives?	NO	1.0
3	Has the LCM faced lack of enabling finance/guarantee?	YES	0.0
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES	1.0
5	Has the LCM already been successfully financed by international financial partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES, PARTIALLY	0.5
		FINAL SCORE	**2.5**

Final Score - Qualitative assessment: 2.5 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with a 80% quantitative and 20% qualitative ratio as the quantitative parameters are regarded as being relatively complete and accurate.

$$\text{Final Score Calculation} = (5 * 0.8) + (2.5 * 0.2)$$

Final Score: 4.5 out of 5

3.2.2.8 Sustainable Development Benefits

The utilisation of geothermal energy for the SEZ Bitung will lead to SD benefits in the environmental, growth and development, and economic domains.

In terms of environmental impact, the utilisation of geothermal energy leads to the reduction of air pollution such as Particulate Matter (PM) 10 and 2.5[90], as well as nitrous oxides (NO_x) (which are caused by conventional diesel consumption from generators and the electricity generation processes used for grid power supply).

The sustainable growth and development of the SEZ Bitung and its surrounding areas will be strengthened through two specific SD impacts, namely direct access to clean and sustainable geothermal energy and increased energy security resulting from the local generation of energy which is independent from fossil fuel resources.

In addition, the construction, operation and maintenance of a geothermal power plant will require substantial and ongoing efforts. This will have a positive economic impact through the creation of job opportunities for local and national personnel, from high level management positions to engineering and facility management positions.

[90] The numbers refer to micrometres.

Table 84: Scoring Summary: Utilisation of Geothermal Energy - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Environment	Reduction in air pollution	PM10 and PM2.5, NOx	+	3	3
Growth and Development	Access to clean and sustainable energy	Share of people having access to sustainable electricity	+	2	3
	Energy Security	Share of imported oil (attributed to sector), share of total energy supply from RE	+	3	4
Economic	Job creation	Number of jobs created	+	2	4

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact by their respective score, as listed above. The resulting total score has then been divided by the sum of the relevance scores, providing one final weighted score of all listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 3*3+2*3+3*4+2*4}{\sum 3+2+3+2}$$

Final Score: 3.5 out of 5

3.2.2.9 Summary

The table below shows the summary of the MCA for the Utilisation of Geothermal Energy:

Table 85: Scoring Summary of Utilisation of Geothermal Energy

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Utilisation of Geothermal Energy	4.5	5.0	2.7	5.0	3.0	4.5	3.5	**4.0**

Source: Own elaboration

3.2.3 Use of Photo Voltaic (PV) panels on buildings

3.2.3.1 SEZ-specific Context

This LCM aims to install solar PV panels on rooftops in the industrial, residential and commercial sector.

It is expected that the owners of buildings will rent the available surface of the rooftops to an Independent Power Producer (IPP), who will then develop PV projects. According to current law[91], these types of installations are eligible for incentives for generating electricity from RE sources that then feeds into the grid. This monetary incentive is up to $0.30 per kWh generated (provided that more than 40% of local components are used in the PV module construction). This scheme is based on decentralised power generation, which can lead to a more reliable energy supply with less energy distribution and transmission losses.

As an alternative option, building owners can decide to install PV panels on their own to utilize potential electricity generated by PV panels independent from an IPP. These self-consumption PV installations will lead to instant energy savings from the power grid. However, the financial feasibility of this option when comparing the price of electricity with the actual price for generating a kWh with solar PV rooftop installations will also need to be considered.

It is important to note that a 1,000 island PV development plan is currently being implemented through a "quote, cap and location approach", which allows for a set number of IPPs to sign Power Purchase Agreements (PPAs)[92].

The installation of solar PV panels on rooftops will lead to high GHG ER being achieved as a result of electricity generated by the solar PV installations. Additional SD benefits include air quality improvements, enhanced access to clean energy, increased income generation and energy cost reduction possibilities.

The installation of PV panels on buildings is expected to take place from Phase 1 through to Phase 5 (2017-2031). The installations will therefore take place every year, depending on the type of land use area constructed (residential, commercial and industry), throughout the whole SEZ Bitung development period.

3.2.3.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- National level policies:
  - National Action Plan for GHG ER (*RAN-GRK*);
  - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*);
  - National Energy Policies (*Kebijakan Energi Nasional, KEN; Energi Baru Terbarukan, EBT*).
- Provincial level policies:
  - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
  - Bitung City Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung*);
  - Bitung Detailed City Planning (*Rencana Detail Tata Ruang, Bitung*).
- SEZ level policies:
  - SEZ Masterplan 2008.

[91] MEMR Regulation No 17, (2013)
[92] According to the presentation "Centralized photovoltaic development policy in Indonesia" (PT PLN, 2015), just one location has signed a PPA as of January 2015 from the 80 locations and 140MW estimated in the PV development plan.

The results of the analysis are presented in the table below:

Table 86: Scoring Summary: Use of PV panels on buildings - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES, PARTIALLY: no policies that explicitly promote the construction of on- and/or off grid PV systems for the SEZ Bitung are in place. However, the RAN-GRK at national level stresses the need to deploy new RE supplies and management. In addition, at the national level, the EBT and KE policies underline the relevance of shifting the primary energy mix from fossil fuel-based sources towards more diversified RE sources.	0.5
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions from the energy and transportation sector by up to 0.038 $GtCO_2e$ (+0.018 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES: policies that include a SD target are in place. Specifically, at the national level, the National Energy Policy (*KEN, RIKEN*) provides a set of indicators, baselines and targets in relation to the share of RE in the total energy consumption mix (up to 23% by 2025 and 31% by 2050 of total primary energy resources utilization) and the electrification ratio (100% by 2020), among others.	1.0
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES: the LCM would directly contribute to achieving the SD target of the policy.	1.0
		FINAL SCORE	**4.5**

Final Score: 4.5 out of 5. Source: Own elaboration

3.2.3.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.3.3.1 Assumptions:

- **Surface of rooftops per sector**: 5% of the overall land use in the industrial, residential and commercial sectors has been considered as rooftop.
- **Available surface of rooftops for the solar PV installations per sector**: 10% of the rooftop surface has been estimated as being available for solar PV installations for each sector.
- **Ratio of solar PV power modules per available surface**: 0.1 kWp per m^2.
- **Installed power capacity**: in the industrial, residential and commercial sectors an installation of 0.11, 0.02 and 0.02 MW respectively in 2017 (overall 0.15 MW) and a cumulative capacity of 1.53, 0.24 and 0.32 MW respectively in 2031 (overall 2.09 MW) is assumed.
- **Electricity generation:** according to the installed power capacity and the number of operation hours estimated (1,450 hours), a generation of electricity up to 3,037 MWh in 2031 is assumed.
- **PV rooftop installations**: the main assumption is that the industrial, residential and commercial sectors will install on-grid (FiT) installations.
- **Grid emission factor**: 0.746 tCO_2e per MWh.

3.2.3.3.2 Calculation Methodology:

The GHG ERs have been calculated following the UNFCCC-CDM Guidelines for grid-connected electricity generation from renewable sources (ACM0002)[93].

3.2.3.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER achieved through the replacement of electricity generated from the baseline sources (regional power grid and local diesel generators) with PV rooftop installations has been calculated as follows:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**17,249 tCO_2e**

For the final score, the cumulative absolute GHG ER from PV rooftop installations has been compared with the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest GHG ER potential (256,753 tCO_2e), and has consequently been given the maximum score of 5. The NMT and TOD LCM represents the lowest GHG ER potential (1,293 tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, scoring it relative to the highest and lowest score.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(256{,}753\ tCO2e - 1{,}293\ tCO2e)}) * (17{,}249\ tCO2e - 1{,}293\ tCO2e)]$$

Final Score: 1.3 out of 5

3.2.3.4 Cost Effectiveness

3.2.3.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV's discount rate. The discount rate has been estimated at 11.75%[94].

3.2.3.4.2 Calculation Methodology:

The LCM CE represents the cost of reducing one additional unit of pollution (i.e. one tonne of CO_2e). The NPV calculated during the financial feasibility assessment of this LCM has been used as the financial cost parameter. However, in order to be able to compare the unbiased CE of individual LCMs, any kind of national or sectoral incentive scheme (e.g. FiT) has been excluded from the NPV applied here.

In order to calculate the overall CE of the LCM, the achieved GHG ER have been calculated proportional to the assumed investment lifetime. This allows for an accurate comparison between the costs incurred in reducing GHG emissions and the actual ER achieved through the LCM.

The cumulative GHG ER achieved over the duration of the investment for PV panels on buildings are shown below:

Cumulative GHG ER achieved over the duration of the assumed investment lifetime (for this LCM: 10 years)[95]: **15,407 tCO_2e.**

[93] Source: https://cdm.unfccc.int/methodologies/DB/EY2CL7RTEHRC9V6YQHLAR6MJ6VEU83
[94] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)
[95] This figure represents the GHG ER achieved over the duration of the investment lifetime.

The calculation of the CE has been carried out taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectinevess} = -(\frac{-778{,}451\ USD}{15{,}407\ tCO2e})$$

3.2.3.4.3 Result & Scoring:

As a result, the abatement cost for mitigating one tonne of CO_2e from the use of PV panels on buildings within the SEZ Bitung has been calculated as up to **$50.53/tCO$_2$e.**

For the final score, the CE from the implementation of PV panels on buildings has been compared with the CE results of the other nine selected LCMs. As can be seen in the final evaluation summary table (section 2.3), other LCMs potentially lead to a better CE. The LCM "Comprehensive EE programme for Industrial Buildings, Appliances and Processes" represents the LCM with the best CE (-$28/tCO$_2$e), consequently being given the maximum score of 5. The LCM "NMT & TOD" represents the lowest CE ($52/tCO$_2$e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, scoring it relative to the lowest and highest mitigation abatement costs achieved by all LCMs analysed.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(52\ USD\ per\ tCO2e - (-28\ \ USD\ per\ tCO2e)}) * (52\ USD\ per\ tCO2e - 50.53\ USD\ per\ tCO2e)]$$

Final Score: 1 out of 5

3.2.3.5 Technical Feasibility

A wide range of grid-connected and off-grid solar PV systems have bee installed in Indonesia since the 1970's[96]. However, solar PV as a modern technology was only introduced in 2009 and 2010. Its contribution to the electricity energy mix is almost negligible, accounting for less than 0.005% of total generation in 2012.

The technical requirements for the deployment of small scale solar PV installations on rooftops should consider the following points: (i) physical conditions of the project site (geographical, irradiation, available area, electrical conditions, ways to access the project site, shading considerations and future structures); (ii) rooftop solar design (physical sizing, azimuth and tilt angles, structural design of support, key plan components - solar modules, inverters, electrical wiring and interconnections); (iii) rooftop solar performance; and, (iv) techno-financial model[97].

Whilst solar PV technologies are available in the region, they are not yet fully established and there is a need to build capacity to ensure their successful implementation. Although MRV is foreseen to be feasible, some changes will be necessary to adapt the national MRV system requirements.

The results of the analysis are presented in the table below:

Table 87: Scoring Summary: Use of PV panels on buildings - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: the solar PV related technologies are available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES, PARTIALLY: the solar PV technologies are being used in the energy sector but not as an established practice by the IPPs.	0.5

[96] Source: Hugh Outhred et al, *Insights from the Experience with Solar Photovoltaic Systems in Australia and Indonesia,* 2014.
[97] Source: Handbook for rooftop solar development in Asia (ADB, 2014).

Nº	Questions	Answers	Scoring
3	Is the necessary capacity to apply and use the LCM technology available in the country?	NO: the know-how is not available. There is insufficient technical expertise of issues related to the solar PV projects at the permitting authority level. In addition, the IPP is not always aware of the required procedures and technical guidelines that should be followed. In addition, in the operation phase the IPP faces a shortage of local operation and maintenance expertise[98].	0.0
4	Are technology-related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES, PARTIALLY: the MRV is feasible but will need changes (institutional, regulatory) to adapt to the national system regarding MRV requirements. The lack of coordination at different governmental levels and the quality of data collection is crucial for tracking the electricity outputs from the IPP's installations.	1.0
		FINAL SCORE	**2.5**

Final Score: 2.5 out of 5. Source: Own elaboration

3.2.3.6 Legal/Regulatory/Institutional/Political/Social Feasibility

According to the detailed explanation of the energy sector under the GPP LCM measure and taking into account the scope of solar PV rooftop installations and their specific context, the implementation of this LCM has been considered feasible in terms of the existing regulatory and political landscape, but only partially feasible regarding the institutional framework. The results of the MCA are presented in the table below:

Table 88: Scoring Summary: Use of PV panels on buildings - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory environment, but minor changes will be required to ensure its success. The MEMR issued a regulation for small scale RE projects in 2002 (*PSK Tersebar*). This regulation requires the PLN to purchase electricity generated from RE sources by non-PLN producers for projects of up to 1 MW capacity. The institutions eligible for participation are cooperatives, private companies and government-owned companies. The Government of Indonesia aslo issued a FiT which was entered into force by the MEMR Regulation No 17 (2013). This regulation provides attractive incentives for RE developers to develop solar rooftop installations. In addition, new regulations have been approved recently including: (i) MEMR Decree No. 17 Year 2013: Electricity Purchasing by PLN from Solar Photovoltaic Power Generation; (ii) General Directorate of NREEC Decree No. 979.K/29/DJE/2013: Quota of Location and Capacity Solar PV Year 2013; (iii) PLN's Director Regulation: No. 357.K/DIR/2014: Guidance of Renewable Energy Power Generation Connection into PLN's Distribution Line. However, the IPPs need a clearer regulatory framework to invest in these sorts of projects[99].	1.0
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing institutional framework, but minor changes will be required to ensure its success. The existing institutional framework for solar PV projects in urban areas includes: the MEMR; the Ministry of Finance (MoF); the Directorate General for New and Renewable Energies and Energy Conservation (NREEC); the BAPPENAS; and the National Energy Council (DEN). The main issue is that there is a lack of coordination between governmental institutions with regards to implementation of programmes, with variation in	1.0

[98] Source: Policy Brief, Small-scale IPPs in Indonesia (CDKN, ECN, 2014).
[99] Source: Centralized photovoltaic development policy in Indonesia (PT PLN, 2015).

Nº	Questions	Answers	Scoring
		procedures followed and the financing sources used.	
3	Is the LCM suited to the existing political landscape?	YES: the LCM is suited to the existing political landscape. Good examples of political will include the PLN solar PV programme in Eastern Indonesia, and a micro-grid-based electrification programme undertaken by the MEMR. There is also a 1,000 islands PV development programme, which has identified 39 locations in Sulut, and has potential power capacity of 30.9 MWp[100].	1.0
		FINAL SCORE	**3.0**

Final Score: 3 out of 5. Source: Own elaboration

3.2.3.7 Financial Feasibility

3.2.3.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to determine the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**: includes one component:

Table 89: Use of PV panels on buildings - Financial Feasibility parameters

Parameter	SEZ Bitung
(1) Cost of PV installations ($1 per Wp installed)	$2,082,650
Overall capital investment = (1)	$2,082,650

Source: Own elaboration

- **Cost of O&M**: includes the regular operation and maintenance activities and has been estimated up to $11.821 (10,000 euro) per MW installed.
- **Assumed investment lifetime**: 10 years.
- **Benefits**:
  - Electricity generated with FiT: for solar PV generation the FiT is $0.3 per kWh fed into the grid[101].
  - Grid electricity not consumed: the electricity price for consumer has been estimated as up to $0.172 per kWh[102].

3.2.3.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M. Calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

3.2.3.7.3 Result & Scoring:

The quantitative assessment shows that the CBA ratiofor this LCM has a value slightly above one, indicating a financially feasible investment over an investment lifetime of 10 years.

See the main financial results from the quantitative assessment in the table below:

[100] Source: Centralised photovoltaic development policy in Indonesia (PT PLN, 2015).
[101] Source: MEMR Regulation No 17, (2013).
[102] Source: *Perusahaan Listrik Negara* (PLN), National Electricity Tariffs, http://www.pln.co.id/wp-content/uploads/2015/05/Tariff-Adjusment-Juni-2015.pdf (with option on 40% tariff escalation up to 2017, following economic trend in the last few years).

Table 90: Use of PV panels on buildings - Financial Feasibility results

Parameter for a 10 year investment lifetime	
Costs	
(1) Capital investment	$2,082,650
(2) O&M	$185,647
Overall Net Cost discounted	$928,487
Benefits	
(1) Electricity generated with FiT	$3,948,775
Overall Net Benefit discounted	$1,055,255
NPV	$422,563
IRR	28 %
CBA ratio	1.14

Source: Own elaboration

For the final score, the CBA ratio from this LCM has been compared to the individual CBAs of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest CBA ratio (41.8), and has consequently been given the maximum score of 5. The Urban Forestry & Urban Greening LCM represents the lowest CBA ratio (0.00), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relative to the highest and lowest scores.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(1.8 - 0.00)}) * (1.14 - 0.00]$$

Final Score - Quantitative assessment: 3.5 out of 5

The qualitative assessment shows that the implementation of the use of PV panels on buildings faces mid-high capital investment costs and requires improvements in the financial framework to allow for its successful implementation.

Table 91: Scoring Summary: Use of PV panels on buildings - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	YES, PARTIALLY	0.5
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES, PARTIALLY	0.5
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES, PARTIALLY	0.5
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES	1.0
5	Has the LCM already been successfully financed by international financial partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES, PARTIALLY	0.5
		FINAL SCORE	**3.0**

Final Score - Qualitative assessment: 3 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with a 80% quantitative and 20% qualitative ratio, as the quantitative parameters are regarded as being fairly complete and accurate.

$$\text{Final Score Calculation} = (3.5 * 0.8) + (3 * 0.2)$$

Final Score: 3.4 out of 5

3.2.3.8 Sustainable Development Benefits

The use of PV panels on buildings will lead to environmental, growth & development, and economic SD impacts.

In terms of environmental impact, a reduction in air pollution will be achieved, as PM 10 and 2.5[103], as well as nitrous oxides (NO_x) (which are caused by conventional diesel consumption from generators and electricity generation processes for grid power supply), will be avoided.

Access to electricity generated using PV technologies will lead to more people having access to clean and sustainable energy and will therefore contribute to the sustainable growth and development path of the SEZ Bitung. In addition, any surplus electricity generated can be sold to the PLN and/or electricity costs can be reduced, allowing businesses and individuals to benefit economically from solar based power generation.

Table 92: Scoring Summary: Use of PV panels on buildings - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Environment	Reduction in air pollution	PM10 and PM2.5, NO_x	+	3	4
Growth and Development	Access to clean and sustainable energy	Share of people with access to sustainable electricity	+	1	5
Economic	Income generation / expenditure reduction	Income generated / expenditure reduced	+	2	3

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact with their respective score. The resulting total score has then been divided by the sum of its relevance scores, providing one final weighted score of all the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 3 * 4 + 1 * 5 + 2 * 3}{\sum 3 + 1 + 2}$$

Final Score: 3.8 out of 5

[103] The numbers are referred to micrometres.

3.2.3.9 Summary

The table below summarises the MCA for the use of PV panels on buildings:

Table 93: Scoring Summary of Use of PV panels on buildings

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Use of PV panels on buildings	4.5	1.3	1.1	2.5	3.0	3.4	3.8	**2.7**

Source: Own elaboration

3.2.4 Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater

3.2.4.1 SEZ-specific Context

The methane capture and AD system for solid waste and wastewater under the energy sector is composed of two components: (1) the implementation of a sanitary landfill; and (2) the implementation of a Mechanical Biological Treatment (MBT) with AD system.

A sanitary landfill would collect Municipal Solid Waste (MSW) from the SEZ Bitung (but also from Bitung city). According to the review of the SEZ Bitung planning, no such facility is expected to be implemented during its development. The sanitary landfill would help to avoid the open dumping and open burning of waste. The new facility will have a treatment capacity of 150 tonnes of MSW per day.

The MBT with AD system would complement the sanitary landfill, by recovering and capturing the methane (also called biogas) produced through anaerobic biological processes (from the MSW and wastewater) and use it to produce RE to feed into the grid.

Consequently, the installation of these facilities will achieve potential GHG ER by replacing fossil-based fuels with the generation of electricity from biogas using the AD system. The implementation of this LCM will also lead to relevant SD benefits including improved air quality, increased energy security and better local health conditions.

The financial analysis for the MBT with AD system has been addressed as a total project investment (instead of assigning financial costs and revenues proportionally to Bitung SEZ demand). This is necessary as it provides a generated electricity off-take guarantee for power plant developers, securing project revenues to cover returns on total investment.

The construction of the landfill and the MBT with AD system is expected to be completed in Phase 1 (2017) and will be operational until the end of the SEZ Bitung development (2031), and beyond.

Please note that construction of the other Low Carbon Measure, LCM-10 (Integrated Solid Waste Management and 3R Strategy, or compost production facility) is to be developed based on the same facility built on this LCM-3 (Methane Capture and AD System). Up to 20% of waste, expected to be organic part to be composted, would be pre-sorted during waste collection procedure, prior to waste delivery to the sanitary landfill. Therefore, the MBT system would receive the remaining amount of waste, after pre-sorting of incoming waste. It is expected that 50% of the remaining waste can be treated in the MBT system (containing organic waste remains) to produce biogas and generate electricity. The other 50% of the remaining waste is expected to have low organic content, with the option of utilisation as fuel to be installed add-on to the LCM-10 activity.

3.2.4.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- National level policies:
  - National Action Plan for GHG ER (*RAN-GRK*);
  - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*);
  - National Energy Policies (*Kebijakan Energi Nasional, KEN; Energi Baru Terbarukan, EBT;*).
- Provincial level policies:
  - North Sulawesi Province Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Provinsi Sulawesi Utara*);
  - North Sulawesi Province Spatial Planning (*Rencana Tata Ruang Wilayah Provinsi, RTRWP*);
  - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
  - Bitung City Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung*);
  - Bitung Detailed City Planning (*Rencana Detail Tata Ruang, Bitung*).

- SEZ level policies:
  - o SEZ Masterplan 2008 (Wastewater Treatment).

The result of the analysis is presented in the table below:

Table 94: Scoring Summary: Methane capture and AD system for Solid Waste and Wastewater - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES: policies that explicitly promote the LCM are in place. Specifically, at the national level (*RAN-GRK*) and the provincial level (*RAD-GRK*), where the use of landfill gas and urban integrated waste water management are highlighted.	1.0
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions from the waste sector by up to 0.048 $GtCO_2e$ (+0.030 $GtCO_2e$ with international support) and from the energy and transport sector by up to 0.038 $GtCO_2e$ (+0.018 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES: policies that include a SD target are in place. Specifically, at the national level, the National Energy Policy (*KEN, RIKEN*) provides a set of indicators, baseline and targets in relation to the share of RE in the total energy consumption mix (up to 23% by 2025 and 31% by 2050 of total primary energy resources utilisation) and the electrification ratio (100% by 2020), among others.	1.0
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES: the LCM would directly contribute to achieving the SD target of the policy.	1.0
		FINAL SCORE	**5.0**

Final Score: 5 out of 5. Source: Own elaboration

3.2.4.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.4.3.1 Assumptions:

- **Methane generation**: the ratio of methane generation in the landfill has been calculated according to the 1966 IPCC Guidelines, with a value of 0,078 tCH_4/t MSW.
- **Waste composition**: the MSW composition in North Sulawesi has been assumed as follows: 66% food, gardens and similar organic waste; 13% paper, cardboard and paper products; 11% plastics; 6% other types of waste; 2% ferrous metals; 1% fabrics; 1% glass[104].
- **GWP from methane**: 25 tCO_2e per tCH_4 (IPCC, 2006).
- **Methane recovery target**: a progressive target from 5% in 2017 and 2018, to 10% in 2019, to 15% in 2020, to 20% in 2021, to 25% in 2022, to 30% from 2023 until 2031, has been assumed.

[104] Source: Dokumen Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca (RAD-GRK) SULUT 2012.

3.2.4.3.2 Calculation Methodology:

GHG ER have been calculated against the BAU scenario for the SEZ Bitung following the IPCC Guidelines (Vol. 5 Waste).

The envisioned sanitary landfill will be used by both Bitung City and the SEZ Bitung. In order to determine the amount of waste produced only by the SEZ, a proportional value has been applied, reflecting its expected population and economic growth. The proportional ratio from the SEZ Bitung to Bitung City increases from 1.4% in 2017 to 15.5% in 2031.

In addition, the impacts of methane capture and recovery have been estimated progressively, starting from 0% in 2017 and rising to 30% in 2031.

3.2.4.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER achieved through the replacement of fossil-based fuels due to the generation of electricity from biogas the AD system and through the prevention of methane entering the atmosphere has been calculated as follows:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**92,824 tCO_2e**

For the final score, the cumulative absolute GHG ER resulting from the implementation of the methane capture and AD system for solid waste and wastewater has been compared with the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest GHG ER potential (256,753 tCO_2e), and has consequently been given the maximum score of 5. The NMT and TOD LCM represents the lowest GHG ER potential (1,293 tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relative to the highest and lowest score.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(256{,}753\ tCO2e - 1{,}293\ tCO2e)}) * (92{,}824\ tCO2e - 1{,}293\ tCO2e)]$$

Final Score: 2.5 out of 5

3.2.4.4 Cost Effectiveness

3.2.4.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV's discount rate. The discount rate has been estimated at 11.75%[105].

3.2.4.4.2 Calculation Methodology:

The LCM CE represents the cost of reducing one additional unit of pollution (i.e. one tonne of CO_2e). The NPV calculated during the financial feasibility assessment of this LCM has been used as the financial cost parameter. However, in order to be able to compare the unbiased CE of individual LCMs, any kind of national or sectoral incentive scheme (e.g. FiT), has been excluded from the NPV applied here.

In order to calculate the overall CE of the LCM, the achieved GHG ER have been calculated proportionally to the assumed investment lifetime. This allows for an accurate comparison between the costs occurred in reducing GHG emissions with the actual ER achieved through implementation of the LCM.

---

[105] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)

The cumulative GHG ER achieved over the duration of the investment for a methane capture and AD system for solid waste and wastewater are shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: 20 years)[106]: **1,122,748 tCO_2e**

The calculation of the CE has been carried out taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -(\frac{-487{,}185\ USD}{1{,}122{,}748\ tCO2e})$$

3.2.4.4.3 Result & Scoring:

The abatement cost for mitigating one tonne of CO_2e from the methane capture and AD system for solid waste and wastewater within the SEZ Bitung has been calculated as up to **$0.43/$tCO_2e$**.

For the final score, the CE from a methane capture and AD system for solid waste and wastewater has been compared with the CE results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), other LCMs potentially have better CE. The LCM "Comprehensive EE programme for Industrial Buildings, Appliances and Processes" represents the LCM with the best CE (-$28/$tCO_2e$), and has consequently been given the maximum score of 5. The LCM "NMT & TOD" represents the lowest CE ($52/$tCO_2e$), consequently being given the minimum score of 1.

In order to assign a relative score of between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relatively to the lowest and highest mitigation abatement costs achieved by all LCMs analysed.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(52\ USD\ per\ tCO2e - (-28\ \ USD\ per\ tCO2e)}) * (52\ USD\ per\ tCO2e - 0.43\ USD\ per\ tCO2e)]$$

Final Score: 3.5 out of 5

3.2.4.5 Technical Feasibility

The implementation of MBT technologies faces high technical requirements. There are complex processes that should be followed which aim at capturing, cleaning and feeding the biogas into a gas engine for the generation of electricity delivered to the grid. In broad terms, the steps to follow are: (i) selection of the project site; (ii) assessment of the landfill feedstock and composition; (iii) selection of the gas engine technology; and (iv) assessment of the methane gas estimation.

On a general level, the methane capture and AD system for solid waste and wastewater is available in the region, but is not commonly used. Therefore, associated technical capacity is scarce and the MRV is considered as being partially feasible.

The results of the MCA are presented in the table below:

Table 95: Scoring Summary: Methane capture and AD system for Solid Waste and Wastewater - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: the LCM technology is available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES, PARTIALLY: the LCM technology is being used in the sector but not as an established practice. There are currently at least 26 landfills with direct use of landfill gas, whereas just two landfills are producing	0.5

[106] This figure represents the GHG ER achieved over the duration of the investment lifetime.

Nº	Questions	Answers	Scoring
		electricity from landfill gas (Suwung in Bali and Bantargebang in Jakarta)[107].	
3	Is the necessary capacity to apply and use the LCM technology available in the country?	YES, PARTIALLY: the know-how is there in a very few academic centres but is not well-spread across technology users.	0.5
4	Are technology-related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES, PARTIALLY: the MRV is feasible but will need changes (institutional, regulatory) to adapt the national system to MRV requirements.	1.0
		FINAL SCORE	**3.0**

Final Score: 3 out of 5. Source: Own elaboration

3.2.4.6 Legal/Regulatory/Institutional/Political/Social Feasibility

The policy, regulatory and institutional framework for implementing waste to energy (W2E) projects in Indonesia is diverse, with different stakeholders involved at the national (e.g. MERM, Ministry of Environment and Forestry, Ministry of Public Works and Housing) and local governmental levels. Synchronisation between these institutions is key to successfully developing these sorts of projects.

Overall, the implementation of this LCM has been considered partially feasible with regards to the existing regulatory environment, institutional framework and political landscape.

The result of the analysis is presented in the table below:

Table 96: Scoring Summary: Methane capture and AD system for Solid Waste and Wastewater - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory framework, but several changes will be required to ensure its success. Currently, the local government has the right to issue a license or permit to contract the services of a waste service provider regarding the MSW of non-commercial areas setting a waste tariff policy. This waste will be transported to a landfill on-site treatment facility. However, the commercial sector has to develop a Business to Business (B2B) agreement with the waste service provider; there is therefore a need for local regulations to cover this gap[108].	1.0
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing institutional framework, but several changes will be required to ensure its success. The institutions involved in waste management projects are the: National Development Planning Agency (PPP regulation); Ministry of Energy and Mineral Resources (MERM); Ministry of Environment and Forestry; Ministry of Public Works and Housing (sectoral regulation); and the Municipal Government (local regulation). The main issue is moving from a grant scheme of procurement to commercially driven investment for MSW infrastructures.	1.0
3	Is the LCM suited to the existing political landscape?	YES, PARTIALLY: the LCM is suited to the existing political landscape, but minor changes will be required to ensure its success. Political will from the local government should be driven by the need to manage a key issue - waste generation - and its associated costs, rather than focussing on the revenues that can be generated for the local administration from the energy sales from W2E projects.	0.5
		FINAL SCORE	**2.5**

Final Score: 2.5 out of 5. Source: Own elaboration

[107] Source: Waste to energy in Indonesia, Challenges and Opportunities, Indonesia Solid Waste Association (InSWA, 2015).
[108] Source: Waste to energy in Indonesia, Challenges and Opportunities, Indonesia Solid Waste Association (InSWA, 2015).

3.2.4.7 Financial Feasibility

3.2.4.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**: includes two parameters as shown in the table below:

Table 97: Methane capture and AD system for Solid Waste and Wastewater - Financial Feasibility parameters

Parameter	Amount
(1) Cost of the sanitary landfill construction (treatment capacity of 450 m^3 MSW per day, which means around 150 t MSW per day)	$1,328,372
(2) Construction of MBT with AD system	$4,599,000
Overall capital investment = (1) + (2)	$5,927,372

Source: Own elaboration

- **Cost of O&M**:
  - <u>O&M from the sanitary landfill</u>: includes the regular operation and maintenance activities and has been estimated as being up to $1.1 per tonne MSW treated.
  - <u>O&M from the MBT with AD system:</u> includes the regular operation and maintenance activities and has been estimated as being up to $8.47 per tonne MSW treated[109].
- **Assumed investment lifetime:** 20 years.
- **Benefits**:
  - <u>Electricity generated with FiT</u>: for landfill and biogas generation the FiT is $82.1 per MWh fed into the grid[110].

3.2.4.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessments include the NPV, CBA ratio, the investment cost and the O&M. Calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

Additionally, in order to calculate the capital investment, the amount of MSW and wastewater generation estimated in the SEZ Bitung has been compared with the overall treatment capacity of the facilities (sized for the Bitung city). This proportion has been applied to the calculations to prevent overestimation of the figures and to ensure that they are proportional to the SEZ Bitung context.

3.2.4.7.3 Result & Scoring:

The quantitative assessment shows that the CBA ratio is slightly below 1 for this LCM, indicating that certain incentive schemes are required to make this LCM a financially feasible investment opportunity. See the main figures in the table below:

[109] Source: Aleksandar Dedinec et al., *Economic and environmental evaluation of climate change mitigation measures in the waste sector of developing countries*, 2014.
[110] Source: MEMR Regulation No 4, (2012).

Table 98: Methane capture and AD system for Solid Waste and Wastewater - Financial Feasibility results

Parameter for a 20 year investment lifetime	
Costs	
(1) Capital investment	$5,927,372
(2) O&M	$3,196,865
Overall Net Cost discounted	$7,410,728
Benefits	
(1) Electricity generated with FiT from MSW & Wastewater	$21,771,366
Overall Net Benefit discounted	$7,084,639
NPV	$436,617
IRR	11%
CBA ratio	0.96

Source: Own elaboration

For the final score, the CBA ratio from this LCM has been compared with the individual CBAs of the other 9 selected LCMs. As can be seen in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest CBA ratio (4.09 tCO_2e), and has consequently been given the maximum score of 5. The Urban Forestry & Urban Greening LCM represents the CBA ratio (0.00), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relatively to the highest and lowest score.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(1.8 - 0.00\,)}) * (0.96\ - 0.00\,)]$$

Final Score - Quantitative assessment: 3.1 out of 5

The qualitative assessment demonstrates that the implementation of the methane capture and AD system for solid waste and wastewater is complex and that an improvement of the financial framework is needed.

Table 99: Scoring Summary: Methane capture and AD system for Solid Waste and Wastewater - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	YES	0.0
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES, PARTIALLY	0.5
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES, PARTIALLY	0.5
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES, PARTIALLY	0.5
5	Has the LCM already been successfully financed by international financial partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES, PARTIALLY	0.5
		FINAL SCORE	**2.0**

Final Score - Quantitative assessment: 2 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with an 80% quantitative and 20% qualitative ratio, as the quantitative parameter are regarded fairly complete and accurate.

$$\text{Final Score Calculation} = (3.1 * 0.8) + (2 * 0.2)$$

Final Score: 2.9 out of 5

3.2.4.8 Sustainable Development Benefits

Implementing a methane capture and AD system for solid waste and wastewater will lead to environmental, social and growth & development SD impacts.

From an environmental perspective, proper sanitary landfill management including methane avoidance through methane capturing systems will reduce not only odour from the open dumping of waste, but also prevents suspended particular matter (SPM) from solid waste and wastewater entering soil, freshwater reservoirs (groundwater) and water streams (e.g. rivers). This in turn decreases the spread of diseases (caused by air pollutants in the low atmospheric layer and SPM that accumulates in freshwater) and improves the overall standard of health in the SEZ Bitung.

Through the use of captured methane for RE power generations, energy can be generated locally and independently from fossil fuel resources, therefore contributing to local and national energy security.

Table 100: Scoring Summary: Methane capture and AD system for Solid Waste and Wastewater - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Environment	Reduction in air and water pollution	Odour, SPM (Suspended Particulate Matter)	+	3	4
Social	Health	Decrease in disease prevalence	+	2	3
Growth and Development	Energy security	Share of imported oil (attributed to sector), share of total energy supply from RE	+	2	3

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact with their respective score. The resulting total score has then been divided by the sum of the relevance scores, providing one final weighted score of all of the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 3 * 4 + 2 * 3 + 2 * 3}{\sum 3 + 2 + 2}$$

Final Score: 3.4 out of 5

3.2.4.9 Summary

The table below shows the summary of the MCA for the implementation of the Methane capture and AD system for solid waste and wastewater:

Table 101: Scoring Summary of Methane capture and AD system for Solid Waste and Wastewater

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Methane capture and AD system for solid waste and wastewater	5.0	2.5	3.5	3.0	2.5	2.9	3.4	**3.3**

Source: Own elaboration

3.2.5 Thermal energy generation from agricultural waste

3.2.5.1 SEZ-specific Context

The main objective of using thermal energy generation from agricultural waste is the replacement of fossil-based fuels (coal and fuel oil) used in industrial boilers. Conventional boilers would be replaced by biomass boilers powered with coconut shells, the main major agricultural resource.

According to the SEZ Bitung planning, several coconut industries will be operational in the SEZ, potentially generating a considerable amount of organic waste which could be recovered and reutilised in order to produce thermal energy (heating and steam). In addition, several coconut plantations are located in the region, providing additional sources for biomass feedstock.

The combustion of this biomass will lead to the replacement of conventional thermal boilers powered by coal and fuel oil in the industry sector, and will therefore also lead to a high amount of GHG ER. In turn, this LCM will lead to SD benefits such as the reduction of air pollution and energy costs, as well as an increase in energy security.

Installation of biomass boilers is expected to take place from Phase 1 until Phase 5 (2017-2031). Installations will be carried out every year, depending on thermal energy consumption in the industrial sector, throughout the whole SEZ Bitung development period.

A further option to enhance the scope of this LCM is the installation of a Combined Heat and Power (CHP) system at individual biomass boilers. Such system can use excessive heat to generate additional electricity.

3.2.5.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- National level policies:
  - National Action Plan for GHG ER (*RAN-GRK*);
  - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*);
  - National Energy Policies (*Kebijakan Energi Nasional, KEN; Energi Baru Terbarukan, EBT*).
- Provincial level policies:
  - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
  - Bitung City Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung*);
  - Bitung Detailed City Planning (*Rencana Detail Tata Ruang, Bitung*).
- SEZ level policies:
  - SEZ Masterplan 2008.

The results of the MCA are presented in the table below:

Table 102: Scoring Summary: Thermal energy generation from agricultural waste - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES, PARTIALLY: no policies that explicitly promote thermal energy generation from agricultural waste for the SEZ Bitung are in place. However, the RAN-GRK at the national level stresses the need to develop new RE supplies and types of management, shifting the primary energy mix away from fossil fuel-based sources towards more diversified RE sources.	0.5
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions from the energy and transportation sectors by up to 0.038 $GtCO_2e$ (+0.018 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES: policies that include a SD target are in place. Specifically, at the national level, the National Energy Policy (*KEN, RIKEN*) provides a set of indicators, baseline and targets in relation with the share of RE in the total energy consumption (up to 23% by 2025 and 31% by 2050 of total primary energy resources utilisation) and the electrification ratio (100% by 2020), among others.	1.0
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES: the LCM would directly contribute to achieving the SD target of the policy.	1.0
		FINAL SCORE	**4.5**

Final Score: 5 out of 5. Source: Own elaboration

3.2.5.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.5.3.1 Assumptions:

- **Agricultural waste availability**: the estimated quantity of available coconut shells as a resource for biomass heating production is up to 30 tonnes/day in 2031 (maximum potential).
- **Net Calorific Value (NCV):** coconut shells (19.15 MJ/kg); coal (28.20 MJ/kg); fuel oil (43.00 MJ/kg) (IPCC, 2006).
- **Efficiency ratios:** efficiency ratios for biomass boiler performance is up to 76.75%[111]; cogeneration is up to 75%[112]; and diesel generators is up to 35%[113].
- **Fuel consumption in biomass boiler:** an estimated 2.5 tonnes of coconut shell per day are used.
- **Power installed per unit:** an average of 380kW per biomass boiler.
- **Number of biomass boilers:** according to the assumptions developed previously, the installation of five biomass boilers is estimated by 2031.
- **Emission factors:** biomass (0.11 tCO_2e/TJ); coal (95.07 tCO_2e/TJ); fuel oil (74.35 tCO_2e/TJ) (IPCC, 2006).

[111] Desk-based review of performance and installation practices of biomass boilers (DECC UK, 2014)
[112] http://www.epa.gov/chp/basic/methods.html
[113] http://www.esru.strath.ac.uk/EandE/Web_sites/05-06/constr_village/supply_side_at_xscape_site.htm

3.2.5.3.2 Calculation Methodology:

The GHG ER potential has been calculated by estimating the replacement of the coal and fuel oil used for heating and steam process in the industrial sector by coconut shells as the main energy source.

The efficiencies from biomass boilers, cogeneration and diesel generators have been used to calculate the primary energy required to cover the heating and steam process energy needs.

The coal and fuel oil saved have been multiplied by their respective emission factors. In addition, the GHG emissions from the coconut shells used have also been accounted for. The GHG ER are therefore the result of the difference between fossil fuel GHG emissions saved and coconut shell GHG emissions produced.

3.2.5.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER achieved through the replacement of coal and fuel oil used for heating and steam processes in the industrial sector by biomass (i.e. coconut shells) has been calculated as follows:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**49,230 tCO_2e**

For the final score, the cumulative absolute GHG ER resulting from thermal energy generation from agricultural waste has been compared with the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM “Utilisation of Geothermal Energy” represents the LCM with the highest GHG ER potential (256,753 tCO_2e), and has consequently been given the maximum score of 5. The NMT and TOD LCM has the lowest GHG ER potential (1,293 tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relative to the highest and lowest scores.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(256{,}753\ tCO2e - 1{,}293\ tCO2e)}) * (49{,}230\ tCO2e - 1{,}293\ tCO2e)]$$

Final Score: 1.8 out of 5

3.2.5.4 Cost Effectiveness

3.2.5.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV’s discount rate. The discount rate has been estimated at 11.75%[114].

3.2.5.4.2 Calculation Methodology:

The LCM CE represents the cost of reducing one additional unit of pollution, i.e. one tonne of CO_{2e}.

In order to calculate the overall CE of the LCM, the achieved GHG ER have been calculated proportional to the assumed investment lifetime. This allows for an accurate comparison between the costs incurred in reducing GHG emissions and the actual emission reduction achieved through the LCM.

The cumulative GHG ER achieved over the duration of the investment for thermal energy generation from agricultural waste are shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: 30 years)[115]: **108,066 tCO_2e**

[114] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)

[115] This figure represents the GHG ER achieved over the duration of the investment lifetime.

The calculation of the CE has been carried out taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -\left(\frac{621{,}096\ \text{USD}}{108{,}066\ tCO2e}\right)$$

3.2.5.4.3 Result & Scoring:

As a result, the abatement cost for mitigating one tonne of CO_2e from thermal energy generation from agricultural waste within the SEZ Bitung has been calculated as being up to **\$-5.8/tCO_2e.**

For the final score, the CE from thermal energy generation from agricultural waste has been compared with the CE results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), other LCMs potentially lead to better CE. The LCM "Comprehensive EE programme for Industrial Buildings, Appliances and Processes" represents the LCM with the best CE (-\$28/tCO_2e), and has consequently been given the maximum score of 5. The LCM "NMT & TOD" represents the lowest CE (\$52/tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relatively to the lowest and highest mitigation abatement costs achieved by all LCMs analysed.

$$\text{Final Score Calculation} = 1 + \left[\left(\frac{4}{(52\ USD\ per\ tCO2e - (-28\ \ USD\ per\ tCO2e)}\right) * (52\ USD\ per\ tCO2e - (-5.8\ USD\ per\ tCO2e)\right]$$

Final Score: 3.8 out of 5

3.2.5.5 Technical Feasibility

The coconut shell is an agricultural waste product from coconut plantations, which is mainly subjected to open burning in Indonesia. The coconut shell is often converted to charcoal with varying levels of quality.

The coconut shell has a high net calorific value (19 MJ/kg) and is used in a wide variety of energy-related services including: steam production, energy-rich gases, bio-oil, biochar, etc. Due to its composition, the coconut shell is well suited to being used in the pyrolysis process, as its ash content is lower, contains high volatile matter and is available at low cost. In addition, the solid residue can be used as activated carbon in wastewater treatment[116].

The technology required for full-scale biomass pyrolysis is not widely available in the region, although the resource potential is high. The use of biomass boilers which use coconut shells is not a common practice in the industrial sector and there is a definite need for capacity building in this field. MRV is not considered feasible in terms of time and cost in the short term.

The results of the MCA are presented in the table below:

[116] Source: http://www.bioenergyconsult.com/coconut-biomass/

Table 103: Scoring Summary: Thermal energy generation from agricultural waste - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES, PARTIALLY: the LCM technology is available in the country, but not in the region.	0.5
2	Are the current technology measures already being used in the sector?	NO: the LCM technology is not being used in the sector. Only one feasibility analysis has been carried out in the region[117].	0.0
3	Is the necessary capacity to apply and use the LCM technology available in the country?	NO: the know-how is not available.	0.0
4	Are technology-related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	NO: the MRV is too expensive or too lengthy to make sense for this LCM.	0.0
		FINAL SCORE	**0.5**

Final Score: 0.5 out of 5. Source: Own elaboration

3.2.5.6 Legal/Regulatory/Institutional/Political/Social Feasibility

In this assessment no specific regulatory or institutional framework has been identified in relation to thermal energy generation from agricultural waste. Conversely, governmental institutions are paying more attention to reinforcing biofuels policy for the transport sector.

The implementation of this LCM is not considered feasible in terms of the existing regulatory environment and institutional framework, and partially feasible regarding the political landscape.

The result of the analysis is presented in the table below:

Table 104: Scoring Summary: Thermal energy generation from agricultural waste - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	NO: the LCM is not suited, because the regulatory environment is related to biofuels (biodiesel and bioethanol), but does not include other solid biomass such as agricultural waste for heating purposes, in this case coconut shells.	0.0
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	NO: the LCM is not suited, because the institutional framework is related to biofuels (biodiesel and bioethanol), but does not include other solid biomass such as agricultural waste for heating purposes, in this case coconut shells.	0.0
3	Is the LCM suited to the existing political landscape?	YES, PARTIALLY: the LCM is suited to the existing political landscape, but several changes will be required to ensure its success. There is strong political will to reinforce the use of biofuels in the transportation sector but it seems apparent that this is not the case for heating purposes in the industrial sector.	0.5
		FINAL SCORE	**0.5**

Source: Own elaboration

[117] CDM-SSC-PDD: Amurang Biomass Cogeneration Project (2005).

3.2.5.7 Financial Feasibility

3.2.5.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**[118]: includes one parameter:

Table 105: Thermal energy generation from agricultural waste - Financial Feasibility parameters

Parameter	SEZ Bitung
(1) Cost of the biomass boilers installation	$3,000,000
Overall capital investment = (1)	$3,000,000

Source: Own elaboration

- **Cost of O&M**: includes the regular operation and maintenance activities and has been estimated as being up to 5% of the capital investment[119].
- **Assumed investment lifetime:** 15 years.
- **Benefits**:
  - Coal consumption saved: the price of coal is estimated as being up to $70 per tonne.
  - Fuel oil consumption saved: the price of fuel oil is estimated as being up to $510 per tonne[120].

3.2.5.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M. The calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

3.2.5.7.3 Result & Scoring:

The quantitative assessment shows that the CBA ratio has a slightly negative value for this LCM, indicating that certain incentive schemes are required to make this LCM a financially feasible investment opportunity. See the main figures in the table below:

Table 106: Thermal energy generation from agricultural waste - Financial Feasibility results

Parameter for a 30 year investment lifetime	
Costs	
(1) Capital investment	$3,000,000
(2) O&M	$1,110,000
Overall Net Cost discounted	$2,259,601
Benefits	
(1) Coal and fuel oil consumption saved	$21,771,366
Overall Net Benefit discounted	$1,763,686
NPV	$621,096
IRR	16%
CBA ratio	0.78

Source: Own elaboration

[118] Further options on Combined Heat and Power (CHP) installation on the biomass boiler system might increase required capital investment, up to USD 2,000 / kW capacity, while thermal output (steam production) would be reduced, specific attention is required to put capacity balance in the overall thermal system design
[119] ESTAP (IRENA, 2015).
[120] Retrieved and adapted from: http://www.pln.co.id/dataweb/STAT/STAT2013IND.pdf

For the final score, the CBA ratio from this LCM has been compared to the individual CBAs of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM “Utilisation of Geothermal Energy” represents the LCM with the highest CBA ratio (1.8 tCO_2e), and has consequently been given the maximum score of 5. The Urban Forestry & Urban Greening LCM represents the CBA ratio (0.00), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relatively to the highest and lowest score.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(1.8 - 0.00)}) * (0.78 - 0.00)]$$

Final Score - Quantitative assessment: 2.7 out of 5

The qualitative assessment demonstrates that the implementation of thermal energy generation from agricultural waste (specifically coconut shells) with a full-scale biomass pyrolysis faces high capital investment costs and there is a high need for a strong financial framework due to lack of experience in the field.

Table 107: Scoring Summary: Thermal energy generation from agricultural waste - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	YES	0.0
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES	0.0
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES	0.0
4	Has the LCM already been successfully financed by domestic finance partners (such as domestic development banks, the government, or similar)?	YES, PARTIALLY	0.5
5	Has the LCM already been successfully financed by international finance partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES, PARTIALLY	0.5
		FINAL SCORE	**1.0**

Final Score - Qualitative assessment: 1 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with an 80% quantitative and 20% qualitative ratio, as the quantitative parameters are regarded fairly complete and accurate.

$$\text{Final Score Calculation} = (2.7 * 0.8) + (1 * 0.2)$$

Final Score: 2.4 out of 5

3.2.5.8 Sustainable Development Benefits

The generation of thermal energy from agricultural waste will lead to SD benefits in three SD impact domains.
The environment will be positively impacted since air pollutants such as NO_x and SO_x, which are produced in conventional fossil-based fuel thermal boilers (coal and heavy diesel), will be reduced and will be replaced by biomass.

This LCM also contributes to local and national energy security by decreasing the amount of imported fossil-based fuels in the SEZ Bitung industrial facilities and, consequently, increasing the share of RE in the total energy supply.

A positive economic impact for related industries can also be obtained as the economic cost per unit of thermal energy can be reduced (biomass can usually be bought cheaper than coal or heavy fuel).

Table 108: Scoring Summary: Thermal energy generation from agricultural waste - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Environment	Reduction of air pollution	NO_x, SO_x (Sulphur oxide)	+	2	3
Growth and Development	Energy security	Share of imported oil (attributed to sector), share of total energy supply from RE	+	1	3
Economic	Income generation / expenditure reduction	Income generated / expenditure reduced	+	2	4

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact with their respective score. The resulting total score has then been divided by the sum of the relevance scores, providing one final weighted score of all the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 2*3+1*3+2*4}{\sum 2+1+2}$$

Final Score: 3.4 out of 5

3.2.5.9 Summary

The table below shows the summary of the MCA for the implementation of the thermal energy generation from agricultural waste:

Table 109: Scoring Summary of Thermal energy generation from agricultural waste

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Thermal energy generation from agricultural waste	4.5	1.8	3.8	0.5	0.5	2.4	3.4	**2.6**

Source: Own elaboration

3.2.6 Comprehensive EE Programme for Industrial Buildings, Appliances and Processes

3.2.6.1 SEZ-specific Context

The comprehensive EE programme for industrial buildings, appliances and processes under the energy sector is composed of three components: (1) industrial equipment and appliances; (2) industrial processes; and (3) industrial building design.

With regards to the setting of scope and boundaries, it should be noted that different types of industries are expected in the Bitung SEZ (according to the SEZ Masterplan), including: fisheries, agricultural processing (coconut) and logistics. However, the specific type of industries and the anticipated scale of their operations is not currently known and cannot be confirmed at this stage. As a consequence, the proposed LCMs in the industrial sector are based on the assumed industries mentioned above, without more specific information regarding the magnitude of their operation, or estimations of the expected production volumes or productivity ratios. However, potential EE measures have been estimated for each component against energy consumption assessed in the BAU scenario.

Regarding industrial equipment and appliances, EE measures in energy end-uses such as lighting, cooling, motor systems and other uses (e.g. electronic devices) have been assessed. The replacement of fluorescent lamps T12 - 40W by T8 LED - 18W has been considered. Additionally, the replacement of regular Heating, Ventilating and Air Conditioning (HVAC) systems with high efficiency systems (with EE improvements of up to 10%) and the replacement of regular motor systems with high efficiency systems (with EE improvements of up to 10%) have also been considered.

Regarding industrial processes, EE measures in energy end-uses such as heating processes and motor systems have not been assessed as they are beyond the scope of this LCM assessment having been assessed under the LCM "Thermal energy generation from agricultural waste". In addition, the use of alternative refrigerants has been assessed qualitatively. A wide range of appliances contain F-gas refrigerants, including: heat pump boilers, water heaters, room air conditioners, commercial refrigeration (display cabinets, cold vending machines), domestic refrigeration, laundry dryers (heat pump dryers), local room heaters, hot air central heating systems, commercial refrigerating equipment, air conditioning and ventilation, etc. As these appliances mostly run on F-gas refrigerants, they cause harm to the climate and ozone layer through leakages from devices. The introduction of recovery practices at the end of the product or equipment's life is expected, so the F-gas refrigerants can be either recycled or destroyed.

Regarding building design, EE measures involved in energy end-uses such as cooling have been assessed. Improvement in the envelope and insulation of the walls and rooftops of buildings (with energy savings of up to 5% as a result of cooling) have been considered.

The implementation of EE measures across different types of equipment, appliances, processes, and building design will achieve a large amount of GHG ER from energy savings (mainly electricity consumption). The replacement of conventional refrigerants (e.g. HFC) with natural refrigerants (propane, CO_2, etc.) which have low GWP, and the implementation of recovery practices will lead to only minor GHG ER. Moreover, in terms of SD benefits, the implementation of EE measures in the industrial sector will lead to improved energy security, capacity enhancement and a reduction in energy costs.

The implementation of a comprehensive EE programme is expected to take place from Phase 1 through to Phase 5 (2017-2031). The installation of the equipment and appliances required will be carried out every year depending on the electricity demand in the industrial sector throughout the whole period.

3.2.6.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- National level policies:
    - National Action Plan for GHG ER (*RAN-GRK*);

  - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*);
  - Masterplan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI);
  - National Energy Conservation Development Plan *(Rencana Induk Konservasi Energi Nasional, RIKEN*).
- Provincial level policies:
  - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
  - N/A
- SEZ level policies:
  - SEZ Masterplan 2008.

The result of the analysis is presented in the table below:

Table 110: Scoring Summary: Comprehensive EE Programme for Industrial Buildings, Appliances and Processes - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES: policies that explicitly promote the LCM are in place. Specifically, at the national level (*RAN-GRK*), the need for energy management for energy intensive users, energy conservation and energy audits for different industry sectors (i.e. food and fertilisers) are stressed. The elimination of Ozone Depleting Substances (ODS) in refrigerants, chillers, and fire extinguishers are also mentioned. Additionally, at the national level (*RIKEN),* the importance of tapping the potential energy saving through EE and conversation measures to avoid wasteful energy use practices (e.g. 15-30% industry) are highlighted.	1.0
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions in the industrial sector by up to 0.001 $GtCO_2e$ (+0.004 $GtCO_2e$ with international support) and from the energy and transportation sectors by up to 0.038 $GtCO_2e$ (+0.018 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES, PARTIALLY: policies that include a numeric GHG ER target are in place but it is not clear how much the policy should contribute to its achievement. Specifically, at the national level, the National Energy Conservation Development Plan (*RIKEN*) provides a tentative set of targets in relation to potential energy savings in the industrial sector.	0.5
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES, PARTIALLY: the LCM would indirectly contribute to achieving the SD target of the policy.	0.5
		FINAL SCORE	**4.0**

Final Score: 4 out of 5. Source: Own elaboration

3.2.6.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.6.3.1 Assumptions:

- **Energy end-use**: steam (20%) and process heating (25%) account for almost half of the energy consumed (45%) in the industrial sector. It is assumed that these energy needs are fulfilled by coal and fuel oil energy sources[121]. In turn, process cooling (25%), motor systems (20%), lighting (5%) and other end uses (5%) are supplied by electricity sources[122].
- **Energy consumption**:
  - Lighting: replacement of fluorescent lamps T12 (40W) to T8 (18W), with an estimated 1,460 hours of operation (estimated replacement period of T12 is 16 years and for T8 is 34 years).
  - Process cooling: replacement of regular HVAC (570,000 kWh/year) to efficient HVAC (513,000 kWh/year) (lifetime 30 years).
  - Motor systems: due to the complexity and variety of these sorts of machines, energy consumption has been assumed as being equal to that of process cooling.
- **EE potential per energy end-use**:
  - Lighting: 45%
  - Process cooling: 15%[123]
  - Motor systems: 10%[124]
  - Other end-uses: 10%
- **Grid emission factor**: 0.746 tCO_2e per MWh

3.2.6.3.2 Calculation Methodology:

The GHG ER have been calculated against the BAU scenario for the SEZ Bitung in relation to electricity consumption in the industrial sector.

Overall energy consumption has been divided amongst each energy type of end-use. The assessment has taken into account lighting, process cooling, motor systems and other end-uses. The number of regular appliances/machinery needed per energy end-use has been estimated according to their expected energy consumption on a yearly basis. As a result, the number of units to be replaced is known each year.

The individual EE potential per energy end-use defined in the assumptions above has been applied to each energy end-use assessed to obtain the GHG ER.

3.2.6.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER results are the following:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**140,602 tCO_2e**

For the final score, the cumulative calculated absolute GHG ER from the implementation of a comprehensive EE programme for the industrial buildings, appliances and processes has been compared with the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM “Utilisation of Geothermal Energy” represents the LCM with the highest GHG ER potential (256,753 tCO_2e), and has consequently been given the maximum score of 5. The “NMT and TOD” LCM represents the lowest GHG ER potential (1,293 tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relative to the highest and lowest score.

[121] To avoid double counting with the LCM "Thermal energy generation from agricultural waste", this amount of energy has not affected by EE measures.
[122] Retrieved and Adapted from: Energy End-Use: Industry, Indian Institute of Technology-Bombay.
[123] Retrieved from: http://www.nrcan.gc.ca/energy/publications/efficiency/6037
[124] Retrieved and Adapted from: Energy End-Use: Industry, Indian Institute of Technology-Bombay.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(256{,}753\ tCO2e - 1{,}293\ tCO2e)}) * (140{,}602\ tCO2e - 1{,}293\ tCO2e)]$$

Final Score: 3.2 out of 5

3.2.6.4 Cost Effectiveness

3.2.6.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV's discount rate. The discount rate has been estimated at 11.75%[125].

3.2.6.4.2 Calculation Methodology:

The LCM CE demonstrates the cost for reducing one additional unit of pollution, i.e. one tonne of CO_{2e}.

In order to calculate the overall CE of the LCM, the achieved GHG ER have been calculated proportional to the assumed investment lifetime. This allows for an accurate comparison between the costs incurred in reducing GHG emissions and the actual ER achieved through the LCM.

The cumulative GHG ER achieved over the duration of the investment for a comprehensive EE programme for industrial buildings, appliances and processes is shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: 8 years)[126]: **68,845 tCO_2e**

The calculation of the CE has been carried out by taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -(\frac{1{,}041{,}195\ \text{USD}}{68{,}845\ \ tCO2e})$$

3.2.6.4.3 Result & Scoring:

As a result, the abatement cost for mitigating one tonne of CO_2e from a comprehensive EE programme the industrial buildings, appliances and processes within the SEZ Bitung has been calculated up to **\$ -15.1/tCO_2e.**

For the final score, the CE from a comprehensive EE programme for industrial buildings, appliances and processes has been compared with the CE results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), other LCMs potentially lead to a better CE. The LCM "Comprehensive EE programme for Industrial Buildings, Appliances and Processes" represents the LCM with the best CE (-\$28/tCO_2e), and has consequently been given the maximum score of 5. The LCM "NMT & TOD" represents the lowest CE (\$52/tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, assigning it a score relative to the lowest and highest mitigation abatement costs achieved by all LCMs analysed.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(52\ USD\ per\ tCO2e - (-28\ \ USD\ per\ tCO2e)}) * (52\ USD\ per\ tCO2e - (-15.1\ USD\ per\ tCO2e))]$$

Final Score: 4.3 out of 5

---

125 Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)
126 This figure represents the GHG ER achieved over the duration of the investment lifetime.

3.2.6.5 Technical Feasibility

There are different types of energy end-uses depending on the type of sector and the size of the company analysed, which can be classified as follows: motor systems, steam and process heating systems, facilities, process cooling, etc. In general, the focus on EE measures is centred on unit components rather than systems, which have a larger energy saving potential but require alternative approaches.

The technical requirements for implementing EE measures in the industrial sector are very diverse due to the different components and systems in place. For instance, in terms of motor systems, performance improvements can only be achieved through the use of high efficiency compressors and regulators (e.g. variable speed drives) that lower heat losses and the input power needed. In terms of steam and process heating systems, one of the best options is the CHP (combined heat power) system. For facilities, environmental comfort can be improved through the use of an HVAC, and conventional lighting can be replaced by high-efficiency LEDs.

In addition, currently applied technologies for refrigerants and foam blowing agents are based on HFCs with high GWP. The replacement of these by eco-friendly technologies (e.g. R290 (propane), carbon dioxide (R744) or ammonia (R717)) faces specific technical considerations and skills including: safety and environmental requirements of refrigeration systems and heat pumps, refrigerant circuit pipe joining and installation methods, identification of leaks, application of natural refrigerants, etc.

In general, as mentioned above, the use of EE components does not guarantee the efficiency of the overall industrial system. In each case, it will be important to determine the best configurations available.

The EE programme for the industrial sector therefore has the required technology available in the region and builds on established practices, although this is not the case for refrigerants or foam blowing agents. However, there is a need for technical capacity building, which should be covered by international donors. Finally, MRV is foreseen to be feasible.

The result of the analysis is presented in the table below:

Table 111: Scoring Summary: Comprehensive EE Programme for Industrial Buildings, Appliances and Processes - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: the LCM technology is available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES: the LCM technology is being used in the sector and is an established practice. Since the endorsement of Government Regulation No. 70/2009 on energy conservation energy and the following regulations, an energy conservation programme is up and running which includes: energy audits, energy management and auditor certification, EE standards and labelling, etc.	1.0
3	Is the necessary capacity to apply and use the LCM technology available in the country?	YES, PARTIALLY: the know-how is there in very few academic centres but is not well-spread across technology users. For instance, the Centre for Training and Education from MERM is carrying out training on EE and energy conservation practices. Besides this, there is comprehensive international cooperation from donors aimed at improving EE in the industrial sector in Indonesia (e.g. DANIDA-Denmark supports EE in large buildings; NL Agency-Netherlands supports EE improvement in the industrial sector through implementation of Energy Potential Scan (EPS); NEDO-Japan supports the implementation of smart grids in industrial parks). In	0.5

Nº	Questions	Answers	Scoring
		addition, the recently launched "Green-Chillers Indonesia" initiative[127] is now in place, aiming to build capacity to reduce the impacts of F-gas.	
4	Are technology related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES: the MRV is feasible in terms of time and cost at the national level in the short-term.	2.0
		FINAL SCORE	**4.5**

Final Score: 4.5 out of 5. Source: Own elaboration

3.2.6.6 Legal/Regulatory/Institutional/Political/Social Feasibility

Indonesia is aware that EE measures must be prioritised in order to achieve sustainable energy development in a wide-economical regard. Indonesia has therefore changed its approach from supply-side management to demand-side management, and has implemented various EE and conservation programmes in order to achieve its target of reducing energy intensity by 1% per year, and energy elasticity to less than 1% by 2025. This demonstrates the firm commitment to EE and conservation practices across all sectors at the national level.

The implementation of this LCM has been considered partially feasible in terms of the existing regulatory environment and institutional framework, and feasible with regards to the political landscape.

The result of the analysis is presented in the table below:

Table 112: Scoring Summary: Comprehensive EE Programme for Industrial Buildings, Appliances and Processes - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory framework, but minor changes will be required to ensure its success. The New Energy Act (2007) aims to decouple energy use and industrial output. In this regard, the Government of Indonesia, through the Presidential Regulation nº5/2006, aims to achieve an energy elasticity of less than 1 (which would confirm the decoupling) and a reduction in energy intensity of 1% per year for the whole economy by 2025. However, a quantitative decoupling target for the industrial sector has not been set, neither have specific tax incentives or rebates for achieving EE measures. Energy conservation measures should be considered under the five-year National Energy Conservation Master Plan. From the demand side management perspective, high energy consumers (more than 6,000 TOE[128]/year) should: designate an energy manager, carry out energy audits and energy conservation programmes etc.	1.0
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory framework, but minor changes will be required to ensure its success. The existing institutional frameworks for EE in the industrial sector include: the MEMR; the MoF; the NREEC; the BAPPENAS; and the DEN. The main issue is that there is a lack of coordination between governmental institutions regarding the implementation of programmes, varying procedures and the financing sources.	1.0
3	Is the LCM suited to the existing	YES: the LCM is suited to the existing political landscape. There has been an established state-owned energy service company	1.0

[127] http://www.greenchillers-indonesia.org/
[128] Toe: Ton of oil equivalent.

Nº	Questions	Answers	Scoring
	political landscape?	(ESCO) since 1986 with a leading role in energy conservation in the industrial sector. Additionally, there is a Public-Private Partnership (PPP) Programme on Energy Conservation funded by the Government of Indonesia, targeting industries which have to implement energy audits.	
		FINAL SCORE	**3.0**

Final Score: 3 out of 5. Source: Own elaboration

3.2.6.7 Financial Feasibility

3.2.6.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**: includes three main components as presented in the table below:

Table 113: Comprehensive EE Programme for Industrial Buildings, Appliances and Processes - Financial Feasibility parameters

Parameter	SEZ Bitung
(1) Overall costs of lighting: - Cost of fluorescent T12 - 40W: $2 per unit - Cost of fluorescent T8 LED - 18W: $14 per unit	$1,336,908
(2) Overall costs of process cooling: - Cost of regular HVAC: $45,000 - Cost of high efficiency HVAC: $75,000	$1,740,000
(3) Overall costs of motor systems: - Cost of regular motor system: $22,500 - Cost of high efficiency motor system: $44,000	$805,000
Overall capital investment = (1)+(2)+(3)	$3,881,908

Source: Own elaboration

- **Cost of O&M**: includes the regular operation and maintenance activities and has been estimated as being up to 2% of the capital investment.
- **Assumed investment lifetime**: 8 years.
- **Benefits**:
  Electricity savings: the price of electricity for the industrial sector has been estimated as being up to $0.09 per kWh.

3.2.6.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M. The calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

3.2.6.7.3 Result & Scoring:

The quantitative assessment shows that both the NPV as well as the CBA ratio have a positive value for this LCM, indicating a financially feasible investment. See the main investment parameters in the table below:

Table 114: Comprehensive EE Programme for the Industry Buildings, Appliances and Processes - Financial Feasibility results

Parameter for a 8 year investment lifetime	
Costs	
(1) Capital investment	$3,881,908
(2) O&M	$621,105
Overall Net Cost discounted	$3,102,818
Benefits	
(1) Electricity savings	$8,416,633
Overall Net Benefit discounted	$4,144,013
NPV	$1,041,195
IRR	25%
CBA ratio	1.34

Source: Own elaboration

For the final score, the CBA ratio from this LCM has been compared to the individual CBAs of the other 9 selected LCMs. As can be seen in the final evaluation summary table (section 2.3), the LCM “Utilisation of Geothermal Energy” represents the LCM with the highest CBA ratio (1.8 tCO_2e), and has consequently been given the maximum score of 5. The Urban Forestry & Urban Greening LCM represents the CBA ratio (0.00), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, assigning it a score relative to the highest and lowest scores.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(1.8 - 0.00)}) * (1.34 - 0.00)]$$

Final Score - Quantitative assessment: 4 out of 5

The qualitative assessment demonstrates that the implementation of a comprehensive EE programme for the industrial buildings, appliances and processes faces mid-high capital investment costs, but that there is a good financial framework supported by several Demand-Side Management (DSM) programmes led by national and international institutions.

Table 115: Scoring Summary: Comprehensive EE Programme for Industrial Buildings, Appliances and Processes - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	YES, PARTIALLY	0.5
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES, PARTIALLY	0.5
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES, PARTIALLY	0.5
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES	1.0
5	Has the LCM already been successfully financed by international financial partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES	1.0
FINAL SCORE		**3.5**	

Final Score - Qualitative assessment: 3.5 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with an 80% quantitative and 20% qualitative ratio, as the quantitative parameters are regarded fairly complete and accurate.

$$\text{Final Score Calculation} = (4 * 0.8) + (3.5 * 0.2)$$

Final Score: 3.9 out of 5

3.2.6.8 Sustainable Development Benefits

EE measures in the industrial sector will lead to major SD benefits in terms of growth and development, and economic impacts for industries located within the SEZ Bitung as well as at the local and national level.

Local and national growth and development will be reinforced through increased energy security (as overall electricity consumption will be reduced) and capacity enhancement for the entire industry in terms of knowledge and awareness raising on energy consumption and energy saving activities, as well as availability and application of EE technology.

The most relevant and strongest impact of EE measures in the industrial sector is its economic impact, where substantial energy cost reductions can be achieved, enhancing industry's competitiveness and improving its positioning in national and international markets.

Table 116: Scoring Summary: Comprehensive EE Program for Industrial Buildings, Appliances and Processes - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Growth and Development	Energy security	Reduction of fossil fuels used for electricity generation	+	1	4
	Capacity enhancement	Knowledge before and after implementation of EE strategies, number and kind of EE technology applied	+	2	3
Economic	Expenditure reduction	Expenditure reduced	+	3	5

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact by their respective score. The resulting total score has then been divided by the sum of the relevance scores, providing one final weighted score of all the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 1 * 4 + 2 * 3 + 3 * 5}{\sum 1 + 2 + 3}$$

Final Score: 4.2 out of 5

3.2.6.9 Summary

The table below shows the summary of the MCA for the implementation of a comprehensive EE programme for industrial buildings, appliances and processes:

Table 117: Scoring Summary of Comprehensive EE Programme for Industrial Buildings, Appliances and Processes

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Comprehensive EE Programme for Industrial Buildings, Appliances and Processes	4.0	3.2	4.3	4.5	3.0	3.9	4.2	**3.9**

Source: Own elaboration

3.2.7 Comprehensive Energy Efficiency (EE) Programme for Residential and Commercial Buildings and Appliances

3.2.7.1 SEZ-specific Context

A comprehensive EE programme for residential and commercial buildings and appliances under the energy sector consists of two components: (1) residential buildings and appliances; and (2) commercial buildings and appliances.

In terms of residential buildings and appliances, EE measures in energy end-uses such as lighting, refrigeration, cooking, room conditioning and other uses (e.g. electronic appliances) have been assessed. In this regard, the replacement of CFL - 20W by LED - 7W has been considered. Additionally, the replacement of regular devices by high efficiency ones has also been considered, including: refrigerators (up to 10% energy savings), cook stoves (up to 15% energy savings), air conditioning (AC) split (up to 10% energy savings) and other uses (up to 5% energy savings). Low carbon building design has also been considered, increasing energy savings from room conditioning energy use by up to an additional 5%.

With regards to commercial buildings and appliances, EE measures in energy end-uses such as lighting, cooling, refrigeration and other uses (e.g. electronic appliances) have been assessed. In this regard, the replacement of T12 - 40W by T5 LED - 14W has been considered. Additionally, the replacement of regular devices by high efficiency ones has also been considered, including: HVAC (up to 10% energy savings), refrigerators (up to 10% energy savings) and other uses (up to 5% energy savings). Low carbon building design has also been considered, increasing energy savings from cooling energy use by up to an additional 5%.

The use of energy efficient lighting in public areas such as streets, parks and other public places are also included in the EE programme.

Consequently, implementation of a comprehensive EE programme for residential and commercial buildings and appliances will achieve a significant amount of GHG ER from energy savings resulting from reduced energy consumption (electricity and fuels) due to the EE improvements. In turn, the EE measures will lead to SD benefits including energy security, capacity enhancement and reduction of energy costs.

The implementation of the comprehensive EE programme is expected to take place from Phase 1 until Phase 5 (2017-2031). The installation of equipment and appliances required will be carried out every year, depending on the energy demand in the residential and commercial sector, throughout the whole period.

3.2.7.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- National level policies:
    - National Action Plan for GHG ER (*RAN-GRK*);
    - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*);
    - Masterplan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI);
    - National Energy Conservation Development Plan *(Rencana Induk Konservasi Energi Nasional, RIKEN*).
- Provincial level policies:
    - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
    - N/A
- SEZ level policies:
    - SEZ Masterplan 2008.

The results of the MCA are presented in the table below:

Table 118: Scoring Summary: Comprehensive EE Programme for the Residential and Commercial Buildings and Appliances - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES: policies that explicitly promote the LCM are in place. Specifically, the need to implement energy conservation partnership programmes and increase the EE of household appliances is stressed at the national level (*RAN-GRK*). Also highlighted at the national level (*RIKEN)* is the importance of tapping potential energy saving through EE and conversation measures to avoid wasteful energy use practices (e.g. 25% in commercial buildings for electricity, and 10-30% in the household sector).	1.0
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place but it is not clear how much the policy should contribute to their achievement. At the national level the *RAN-GRK* aims to reduce GHG emissions from the energy and transportation sectors by up to 0.038 $GtCO_2e$ (+0.018 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES, PARTIALLY: policies that include a SD target are in place. Specifically, at the national level, the National Energy Conservation Development Plan (*RIKEN*) provides a tentative set of targets in relation to potential energy savings in the residential and commercial sectors.	0.5
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES, PARTIALLY: the LCM would indirectly contribute to achieving the SD target of the policy.	0.5
		FINAL SCORE	**4.0**

Final Score: 4 out of 5. Source: Own elaboration

3.2.7.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.7.3.1 Assumptions:

- **Energy end-use**:
  - Residential sector: cooking accounts for 52% of energy end-use supplied by fossil fuels (LPG and kerosene) and biomass (firewood). The remaining electricity consumption is divided as follows: lighting (25%), cooling (6%), refrigeration (2%) and other uses (15%)[129].
  - Commercial sector: cooling accounts for 56% followed by lighting (21%), refrigeration (8%) and other uses (15%). These are electricity related energy services[130].

[129] Own estimation based on "End-use Model for Indonesia Low Carbon Development Pathways in Energy sector" (Centre for Research on Energy Policy, 2015).
[130] Own estimation based on Energy Technology Centre, 2009.

- **Energy consumption**:
  - Residential sector:
    - Lighting: replacement of CFL lamps (20W) with LED (7W) with an estimated 1,460 hours of operation (estimated replacement period of CFL is eight years and LED is 30 years).
    - Cooling: replacement of regular AC (706 kWh/year) with efficient AC (635 kWh/year) (lifetime 10 years).
    - Refrigeration: replacement of regular refrigerators (407 kWh/year) with efficient refrigerators (366 kWh/year) (lifetime eight years).
    - Cooking stoves: replacement of regular cook stove (0.034 TJ/year) with efficient cook stove (0.029 kWh/year) (lifetime six years).
  - Commercial sector:
    - Lighting: replacement of T12 (40W) with T5 (14W), with an estimated 1,460 hours of operation (estimated replacement period of the T12 is 16 years and for T5 is 10 years).
    - Cooling: replacement of regular HVAC (3,527 kWh/year) with efficient AC (3,175 kWh/year) (lifetime 30 years).
    - Refrigeration: replacement of regular refrigerators (2,033 kWh/year) with efficient refrigerator (1,830 kWh/year) (lifetime eight years).
- **EE potential per energy end-use**:
  - Lighting: 65%
  - Cooling: 15%
  - Refrigeration: 10%
  - Cooking stoves: 15%
  - Other end-uses: 5%
- **Grid emission factor**: 0.746 tCO_2e per MWh.

3.2.7.3.2 Calculation Methodology:

The GHG ER have been calculated against the BAU scenario for the SEZ Bitung in relation to energy consumption in the residential and commercial sector.

Overall energy consumption has been divided according to each type of energy end-use. The assessment has taken into account lighting, process cooling, motor systems and other end-uses. The quanitity of regular equipment and appliances needed per energy end-use has been estimated according to their expected energy consumption in a yearly basis. As a result, the number of units to be replaced is known each year.

The EE potential for each energy end-use defined in the assumptions above has been applied for each energy end-use assessed to obtain the GHG ER.

3.2.7.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER results are the following:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**44,045 tCO_2e**

For the final score, the cumulative absolute GHG ER that can be achieved through a comprehensive EE programme for residential and commercial buildings and appliances has been compared to the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest GHG ER potential (256,753 tCO_2e), and has consequently been given the maximum score of 5. The NMT and TOD LCM represents the lowest GHG ER potential (1,293 tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, assigning it a score relative to the highest and lowest scores.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(256{,}753\ tCO2e - 1{,}293\ tCO2e)}) * (44{,}045\ tCO2e - 1{,}293\ tCO2e)]$$

Final Score: 1.7 out of 5

3.2.7.4 Cost Effectiveness

3.2.7.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV's discount rate. The discount rate has been estimated at 11.75%[131].

3.2.7.4.2 Calculation Methodology:

The LCM CE represents the cost of reducing one additional unit of pollution, i.e. one tonne of CO_{2e}.

In order to calculate the overall CE of the LCM, the achieved GHG ER have been calculated proportional to the assumed investment lifetime. This allows for an accurate comparison between the costs occurred to reduce GHG emissions and the actual ER achieved through the LCM.

The cumulative GHG ER achieved over the duration of the investment for a comprehensive EE programme for residential and commercial buildings and appliances are shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: eight years)[132]: **21,425 tCO_2e**

The calculation of CE has been carried out by taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -(\frac{591{,}872\ USD}{21{,}425\ tCO2e})$$

3.2.7.4.3 Result & Scoring:

The abatement cost for mitigating one tonne of CO_2e from a comprehensive EE programme for residential and commercial buildings and appliances within the SEZ Bitung has been calculated as being up to **$ -28/tCO_2e**.

For the final score, the CE from the implementation of a comprehensive EE programme for residential and commercial buildings and appliances has been compared to the CE results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), this LCM has the best CE (-$-28/$tCO_2e$) of all assessed LCMs, consequently being given the maximum score of 5.

Final Score: 5 out of 5

3.2.7.5 Technical Feasibility

The technical requirements for the implementation of a comprehensive EE programme for the residential and commercial sectors are focussed more on the demand side than the supply side. A wide range of options to improve EE in buildings and appliances are available, but it can be the case that there is not enough information for consumers to decide which option is best. In the case of the residential sector, for instance in the air conditioning sector, AC split systems with inverter technology are more efficient than conventional systems; this therefore needs to be reflected on an energy label. The situation is similar in the case of refrigerators, cooking stoves, TVs and other appliances. Moreover, in the commercial sector, professional services from a specialised firm need to be contracted (e.g. ESCO, energy audits, etc.) so that the EE potential of each activity can be understood.

---

[131] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)
[132] This figure represents the GHG ER achieved over the duration of the investment lifetime.

Overall, EE technology is available in the region and is an established practice. However, there is still a need for capacity building for households and managers in the commercial sector to help them understand the benefits of EE measures. MRV is foreseen to be feasible, but must be adapted to the requirements of the national system.

The result of the analysis is presented in the table below:

Table 119: Scoring Summary: Comprehensive EE Programme for Residential and Commercial Buildings and Appliances - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: the LCM technology is available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES: the LCM technology is being used in the sector and it is an established practice. After the endorsement of Government Regulation No. 70/2009 on energy conservation energy and related regulations, an energy conservation programme has been implemented which: creates incentives for EE appliances, improves EE labelling of appliances, implements Minimum Energy Performance Standards (MEPS) for electric motors and air conditioning, etc.	1.0
3	Is the necessary capacity to apply and use the LCM technology available in the country?	YES, PARTIALLY: the know-how is there in very few academic centres but is not well-spread across technology users. More EE public awareness targeting the commercial and residential sector is needed.	0.5
4	Are technology related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES, PARTIALLY: the MRV is feasible but will need changes (institutional, regulatory) to adapt the national system to MRV requirements.	1.0
		FINAL SCORE	**3.5**

Final Score: 3.5 out of 5. Source: Own elaboration

3.2.7.6 Legal/Regulatory/Institutional/Political/Social Feasibility

As mentioned in the LCM "Comprehensive EE programme for industrial buildings, appliances and processes", Indonesia is committed to EE and implementing conservation programmes. Specifically, in the residential and commercial sector, DSM practices focussed on replacing inefficient light bulbs (incandescent bulbs) with high efficient compact fluorescent lamps (CFL) and free energy audit services are common practices. In general, DSM programmes are undertaken by the MEMR and PLN.

The implementation of this LCM has been considered partially feasible in terms of the existing regulatory environment and institutional framework, and feasible regarding the political landscape. The results of the MCA are presented in the table below:

Table 120: Scoring Summary: Comprehensive EE Programme for Residential and Commercial Buildings and Appliances - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory framework, but several changes will be required to ensure its success. EE standards and labelling for domestic and commercial appliances are voluntary and don't cover all electronic devices. The central government issues building regulations and codes and the local government decides voluntarily whether or not to adopt them. Most of the municipal building codes are focussed on financial information (fees), rather than on energy and environmental aspects. There is no mandatory green building standard in Indonesia.	1.0
2	Is the LCM suited	YES, PARTIALLY: the LCM is suited to the existing institutional	1.0

Nº	Questions	Answers	Scoring
	to the existing institutional framework? (2 Point Question)	framework, but minor changes will be required to ensure its success. The existing institutional frameworks for EE in the residential and commercial sectors include: the MEMR; the MoF; the NREEC; the BAPPENAS; and the DEN. The main issue is a lack of coordination between governmental institutions in terms of implementation of programmes, and varying procedures and financing sources.	
3	Is the LCM suited to the existing political landscape?	YES: the LCM is suited to the existing political landscape. For instance, there exist different DSM programmes including an EE lighting programme in the residential sector. Information on energy conservation measures is available and is disseminated to civil society.	1.0
		FINAL SCORE	**3.0**

Final Score: 3 out of 5. Source: Own elaboration

3.2.7.7 Financial Feasibility

3.2.7.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**: includes several components:

Table 121: Comprehensive EE Programme for Residential and Commercial Buildings and Appliances - Financial Feasibility parameters

Parameter
RESIDENTAL SECTOR:
(1) Overall costs of lighting: - Cost of fluorescent CFL - 20W: $6 per unit - Cost of fluorescent LED - 7W: $13 per unit
(2) Overall costs of room conditioning: - Cost of regular AC: $333 per unit - Cost of high efficiency AC: $500 per unit
(3) Overall costs of refrigeration: - Cost of regular refrigerator: $556 per unit - Cost of high efficiency refrigerator: $835 per unit
(4) Overall costs of cook stoves: - Cost of regular cook stove: $48 per unit - Cost of high efficiency cook stove: $72 per unit
COMMERCIAL SECTOR
(5) Overall costs of lighting: - Cost of fluorescent T12 - 40W: $6 per unit - Cost of fluorescent T5 LED - 14W: $13 per unit
(6) Overall costs of room conditioning: - Cost of regular HVAC: $1,000 per unit - Cost of high efficiency HVAC: $1,500 per unit
(7) Overall costs of refrigeration: - Cost of regular refrigerator: $1,670 per unit - Cost of high efficiency refrigerator: $2,505 per unit

Source: Own elaboration

- **Cost of O&M**: includes regular operation and maintenance activities and has been estimated as being up to 2% of the capital investment.
- **Assumed investment lifetime**: eight years.
- **Benefits**:

Electricity savings: the electricity price for the residential and the commercial sector has been estimated as being up to $0.12 per kWh[133].

3.2.7.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M. The calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

3.2.7.7.3 Result & Scoring:

The quantitative assessment shows that both the NPV as well as the CBA ratio have a positive value for this LCM, indicating a financially feasible investment. The main investment parameters in the table are presented below:

Table 122: Comprehensive EE Programme for Residential and Commercial Buildings and Appliances - Financial Feasibility results

Parameter for an eight year investment lifetime	
Costs	
(1) Capital investment	$1,941,383
(2) O&M	$324,459
Overall Net Cost discounted	$1,427,154
Benefits	
Overall Net Benefit discounted	$2,019,026
NPV	$591,872
IRR	36%
CBA ratio	1.41

Source: Own elaboration

For the final score, the CBA ratio from this LCM has been compared to the individual CBAs of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest CBA ratio (1.8 tCO_2e), consequently being given the maximum score of 5. The "Urban Forestry & Urban Greening" LCM represents the CBA ratio (0.00), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, assigning a score relative to the highest and lowest scores.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(1.8 - 0.00)}) * (1.41 \ - 0.00)]$$

Final Score - Quantitative assessment: 4.1 out of 5

The qualitative assessment demonstrates that the implementation of a comprehensive EE programme for residential and commercial buildings and appliances faces mid-high capital investment costs. However, a good financial framework supported by several DSM programmes led by national and international institutions is in place.

[133] Source: *Perusahaan Listrik Negara* (PLN), National Electricity Tariffs, http://obengplus.com/articles/4518/1/Daftar-kenaikan-tarif-dasar-listrik-PLN-2015.html (Accessed 10 July 2015).

Table 123: Scoring Summary: Comprehensive EE Programme for Residential and Commercial Buildings and Appliances - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	YES, PARTIALLY	0.5
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES, PARTIALLY	0.5
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES, PARTIALLY	0.5
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES	1.0
5	Has the LCM already been successfully financed by international financial partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES	1.0
		FINAL SCORE	**3.5**

Final Score - Qualitative assessment: 3.5 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with an 80% quantitative and 20% qualitative ratio, as the quantitative parameters are regarded fairly complete and accurate.

$$\text{Final Score Calculation} = (4.1 * 0.8) + (3.5 * 0.2)$$

Final Score: 4 out of 5

3.2.7.8 Sustainable Development Benefits

EE measures for residential and commercial buildings and appliances are very similar to EE measures in the industrial sector with regards to the associated SD benefits. Only the magnitude and scoring for certain impact domains differ slightly.

Local and national growth and development will equally be reinforced through increased energy security (as overall electricity consumption will be reduced). The impact of capacity enhancement in terms of knowledge and awareness raising regarding energy consumption and energy saving activities as well as availability and application of EE technology is considered higher in the residential and commercial sector due to the higher number of people and individual businesses involved in EE investment strategies and usually lower cash flow and financial capitalisation (leading to more stringent cost management).

Energy cost reduction is still the most relevant and strongest economic impact of EE measures in the residential and commercial sector, but due to the sector consuming less energy overall, potential energy savings are considered slightly lower than in the industrial sector.

Table 124: Scoring Summary: Comprehensive EE Programme for Residential and Commercial Buildings and Appliances - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Growth and Development	Energy security	Reduction of fossil fuel used for electricity generation	+	1	3
	Capacity enhancement	Knowledge before and after implementation of EE strategies, number and kind of EE technology applied	+	2	4
Economic	Expenditure reduction	Expenditure reduced	+	3	4

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact with their respective score. The resulting total score has then been divided by the sum of the relevance scores, providing one final weighted score of all the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 1 * 3 + 2 * 4 + 3 * 4}{\sum 1 + 2 + 3}$$

Final Score: 3.8 out of 5

3.2.7.9 Summary

The table below shows the summary of the MCA for the implementation of the comprehensive EE programme for residential and commercial buildings and appliances:

Table 125: Scoring Summary of Comprehensive EE Programme for the Residential and Commercial Buildings and Appliances

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Comprehensive EE Programme for Residential and Commercial Buildings and Appliances	4.0	1.7	5.0	3.5	3.0	4	3.8	**3.5**

Source: Own elaboration

3.2.8 Bus Rapid Transit (BRT)

3.2.8.1 SEZ-specific Context

BRT has been identified under the transportation sector and mainly focuses on the development of a BRT system for the SEZ Bitung.

In terms of scope and boundaries and according to the BAU scenario, the demand for a BRT system from the SEZ's population (including inhabitants, workers, etc.) amounts to less than 2,000 passengers per hour per direction. The type of BRT solution required would therefore consist of a simple bus priority, without physical segregation and possibly with a part-time bus lane[134]. The replacement of regular buses with articulated buses which have double occupancy levels, although more expensive, is expected.

The main goal of the implementation of a BRT system is to enable a shift from travel in private vehicles (e.g. passenger cars) to the use of articulated buses. A 10% target shifting ratio has been estimated, to be achieved by2031. This target is assumed to be progressive, increasing from 0% in 2017 to 10% in 2031[135].

As a result of the introduction of a BRT system, potential GHG ER will be achieved through energy savings (e.g. diesel) from the articulated buses (due to the higher occupancy ratio and less distance travelled compared to regular buses) and the fuel savings (e.g. diesel and gasoline) of the 10% shifting from passenger cars to the BRT. Moreover, the development of the BRT system will lead to SD benefits including a reduction in air pollution and noise, as well as time saving.

The BRT system is expected to be implemented from Phase 1 through Phase 5 (2017-2031), with the addition of more articulated buses on a yearly basis, depending on the estimated demand of users throughout the whole period.

3.2.8.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- National level policies:
  - National Action Plan for GHG ER (*RAN-GRK*);
  - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*);
  - National Energy Policies (National Energy Conservation Development Plan, *RIKEN*).
- Provincial level policies:
  - North Sulawesi Province Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Provinsi Sulawesi Utara*);
  - North Sulawesi Province Spatial Planning (*Rencana Tata Ruang Wilayah Provinsi, RTRWP*);
  - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
  - Bitung City Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung*);
  - Bitung Detailed City Planning (*Rencana Detail Tata Ruang, Bitung*).
- SEZ level policies:
  - SEZ Masterplan 2008.

The results of the MCA are presented in the table below:

[134] Bus Rapid Transit, Planning Guide (ITDP, 2007).
[135] The target has been implemented through a regression line approach.

Table 126: Scoring Summary: BRT - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES: policies that explicitly promote the LCM are in place. Specifically, reformation of the BRT systems is emphasised at the national level (*RAN-GRK*).	1.0
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions from the energy and transportation sector by up to 0.038 $GtCO_2e$ (+0.018 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES, PARTIALLY: policies that include a SD target are in place, but it is not clear how much the policy should contribute to its achievement at the sectoral level. Specifically, the National Energy Policy (*RIKEN*) provides a set of indicators, baseline and targets in relation to energy saving overall, but not the contribution from the transport sector.	0.5
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES, PARTIALLY: the LCM would indirectly contribute to achieving the SD target of the policy.	0.5
		FINAL SCORE	**4.0**

Source: Own elaboration

3.2.8.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.8.3.1 Assumptions:

- **Type of transport occupation ratio**: the ratio of occupancy in regular buses has been estimated as 35 people, whereas with articulated buses it occupancy is up to 75 people. In the case of passenger cars, occupancy has been estimated as being up to 2 people.
- **Vehicles performance**: the ratio for regular buses is 1.50 km per litre of fuel; for articulated buses it is 1.80 km per litre of fuel. Vehicle performance is estimated as being up to 7.80 km per litre of fuel for passenger cars.
- **Number of buses**: demand for 4 regular buses in 2017 and 60 buses in 2031 has been estimated. Demand for articulated buses has been estimated as being up to 2 buses in 2017 and 35 buses in 2031.
- **Distance travelled by buses**: it is assumed that regular buses would travel a distance of 118,172 km in 2017 and 1,646,760 km in 2031. In the case of the articulated buses, it is assumed that they will travel 59,086 km distance in 2017 and 970,489 km in 2031.
- **Fuel consumption saved (buses)**: diesel consumption from regular buses has been estimated as being up to 78,781 litres in 2017 and 1,097,840 litres in 2031 (BAU scenario). In the case of articulated buses, it is assumed that they will consume 32,826 litres of diesel in 2017 and 539,160 litres of diesel in 2031. As a result, fuel consumption saved accounts for 45,956 litres and 558,679 litres of diesel in 2017 and 2031 respectively.
- **Shift from passenger cars to BRT target:** a progressive target from 0% in 2017 to 10% in 2031 has been assumed.

- **Passenger cars taken off the road**: according to the target mentioned above, the number of passenger cars avoided has been estimated as being up to 2 in 2017 and 188 in 2031.
- **Fuel consumption saved (passenger cars)**: according to the target mentioned above, fuel consumption saved from passenger cars avoided has been estimated as being up to 183 litres of diesel and 910 litres of gasoline in 2017 and 17,804 litres of diesel and 88,739 litres of gasoline in 2031.
- **Emission factor**: diesel 2.62 kg CO_2e per litre and gasoline 2.33 kg CO_2e per litre.

3.2.8.3.2 Calculation Methodology:

The GHG ER have been calculated against the BAU scenario for the SEZ Bitung. The calculation methodology has focused on two main aspects:

1. The GHG ER derived from fuel savings from the replacement of regular buses with articulated buses (due to their higher occupancy ratio and less distance travelled).
2. The GHG ER derived from fuel savings from a shift from passenger cars to BRT of 10%.

3.2.8.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER results are the following:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**7,940 tCO_2e**

For the final score, the cumulative absolute GHG ER achieved through a BRT system has been compared to the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM “Utilisation of Geothermal Energy” represents the LCM with the highest GHG ER potential (256,753 tCO_2e), and has consequently been given the maximum score of 5. The “NMT and TOD” LCM represents the lowest GHG ER potential (1,293 tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, assigning a score relative to the highest and lowest scores.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(256{,}753\ tCO2e - 1{,}293\ tCO2e)}) * (7{,}940\ tCO2e - 1{,}293\ tCO2e)]$$

Final Score: 1.1 out of 5

3.2.8.4 Cost Effectiveness

3.2.8.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV’s discount rate. The discount rate has been estimated at 11.75%[136].

3.2.8.4.2 Calculation Methodology:

The LCM CE expresses the cost of reducing one additional unit of pollution (i.e. one ton of CO_2e). The NPV calculated during the financial feasibility assessment of this LCM has been used as the financial cost parameter. However, in order to be able to compare the unbiased CE of individual LCMs, all kinds of national or sectoral incentive scheme (e.g. infrastructure construction financing) have been excluded from the NPV applied here.

In order to calculate the overall CE of the LCM, the GHG ER that can be achieved have been calculated proportional to the assumed investment lifetime. This allows for an accurate comparison between the costs incurred in reducing GHG emissions and the actual ER achieved through the LCM.

[136] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)

The cumulative GHG ER achieved over the duration of the investment for a BRT system are shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: 8 years)[137]: **4,726 tCO_2e**

The calculation of the CE has been carried out by taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -(\frac{-155{,}924\ \text{USD}}{4{,}726\ tCO2e})$$

3.2.8.4.3 Result & Scoring:

The abatement cost for mitigating one tonne of CO_2e from a BRT system within the SEZ Bitung has been calculated as being up to **$33/$tCO_2e$.**

For the final score, the CE from the BRT system has been compared with the CE results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), other LCMs potentially lead to a better CE. The LCM “Comprehensive EE programme for Industrial Buildings, Appliances and Processes” represents the LCM with the best CE (-$28/$tCO_2e$), and has consequently been given the maximum score of 5. The LCM “NMT & TOD” represents the lowest CE ($52/$tCO_2e$), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, assigning a score relative to the lowest and highest mitigation abatement costs achieved by all LCMs analysed.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(52\ USD\ per\ tCO2e - (-28\ \ USD\ per\ tCO2e)}) * (52\ USD\ per\ tCO2e - 33\ USD\ per\ tCO2e)]$$

Final Score: 1.9 out of 5

3.2.8.5 Technical Feasibility

BRT systems are complex and require a combination of a wide range of technically skilled experts covering the following areas: governance, finance, engineering, urban design and planning, marketing and communication.

The main stages in achieving successful implementation of a BRT system are: (i) project preparation: includes demand analysis (defining the user profile), corridor selection and communications (key stakeholders consultation); (ii) operational design: includes the network and service design (closed or open system), assessment of system capacity and speed, definition of intersections and signal control and design of customer service; (iii) physical design: includes infrastructure (i.e. bus stations, terminals, traffic control signals, etc.) and technology (in terms of vehicles and intelligent transport systems (ITS)); (iv) integration: includes modal integration (e.g. bicycle, taxis, etc.), transportation demand management (e.g. congestion charges, vehicle ownership fees, etc.) and land-use policies integrated with the BRT; (v) business plan; and (vi) evaluation and implementation[138].

BRT systems exist in Indonesia in larger cities which means that know-how is available; however, additional capacity building is needed for the implementation of this LCM in the context of the SEZ Bitung due to the low number of transit passengers expected. MRV is not foreseen to be feasible if it is not done with the technical and financial support of a policy instrument such as a NAMA and combined with other sustainable urban transport measures.

[137] This figure represents the GHG ER achieved over the duration of the investment lifetime.
[138] Source: Bus Rapid Transit, Planning Guide (ITDP, 2007).

The results of the MCA are presented in the table below:

Table 127: Scoring Summary: BRT - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: the BRT system related technologies are available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES: there are at least two best practices in BRT implementation in the Indonesian cities of Jakarta and Pekanbaru[139].	1.0
3	Is the necessary capacity to apply and use the LCM technology available in the country?	YES, PARTIALLY: the technical know-how is in the region resulting from previous experiences, although the cities were at least four times larger than Bitung.	0.5
4	Are technology related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES, PARTIALLY: MRV is feasible but will need changes to adapt to the national system for MRV requirements. The lack of and the poor quality of data is a major constraint in the accurate measurement of the mitigation potential and co-benefits of the LCM. However, if combined with other sustainable urban transport measures it could be feasible.	1.0
		FINAL SCORE	**3.5**

Final Score: 3.5 out of 5. Source: Own elaboration

3.2.8.6 Legal/Regulatory/Institutional/Political/Social Feasibility

In broad terms, the transport policy framework is developed and enforced by the national government in Indonesia led by the Ministry of Transportation (Department of Transportation, *DISHUB*), which promotes the National Urban Transport Programme which has significant potential for transformational change in the sector. *DISHUB* is responsible for developing and implementing local transport strategies and infrastructure. It has the mandate of providing urban transport services (public bus transportation) and infrastructure (bus stops, local roads and pedestrian facilities)[140].

For instance, the institutional framework for the BRT in Jakarta involves the provincial government which has the responsibility for the development and implementation of transport strategy for the whole city, while actual implementation and operation are the city's responsibility. Transport strategy development, including the implementation of the Transportation Master Plan, is the responsibility of the Department of Transportation of the local government (in this case the Government Unit for Transport in Bitung), which reports directly to the governor of DKI Jakarta.

The implementation of this LCM has therefore been considered partially feasible in terms of the existing regulatory environment, institutional framework and political landscape. The results of the MCA are presented in the table below:

Table 128: Scoring Summary: BRT - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory framework, but several changes will be required to ensure its success. There are regulatory instruments that should be taken into account to improve the implementation of BRT systems including: regulation of entrance of private vehicles to the SEZ Bitung to encourage use of the BRT instead of privately-own vehicles; strict enforcement of traffic regulations; stricter qualifications for approval of driver's licenses; strict implementation of fuel efficiency protocols and standards for the buses.	1.0

[139] Retrieved from: https://www.itdp.org/where-we-work/indonesia/pekanbaru/ (Access in August 2015).
[140] MoT, GIZ (2014). Supported NAMA. Sustainable Urban Transport Programme Indonesia. Pilot Phase. www.transport-namas.org

Nº	Questions	Answers	Scoring
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing institutional framework, but several changes will be required to ensure its success. A suitable institutional arrangement should allow the local government to approve new local regulations to give some privileges to the BRT including: using special lanes on the roads, special stops, a ticketing system and additional features. Coordination between different local Governmental Units (i.e. Transport, Spatial Planning, City Development Planning Agency, Public Works, etc.) is therefore key.	1.0
3	Is the LCM suited to the existing political landscape?	YES, PARTIALLY: the LCM is suited to the existing political landscape, but minor changes will be required to ensure its success. The local government should guarantee the operation of the BRT system, which will attract private investment as well promoting a competitive and well-managed public service. The most successful BRT systems have been initiated by public officials with strong political leadership.	0.5
		FINAL SCORE	**2.5**

Final Score: 2.5 out of 5. Source: Own elaboration

3.2.8.7 Financial Feasibility

3.2.8.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**: includes two components:

Table 129: BRT - Financial Feasibility parameters

Parameter	SEZ Bitung
(1) Cost of the BRT infrastructure (10 km per $250,000 per km)	$2,500,000
(2) Overall cost articulated buses: - Regular bus unit cost: $400,000 - Articulated bus unit cost: $700,000	$533,333
Overall capital investment = (1)+(2)	$3,033,333

Source: Own elaboration

- **Cost of O&M**: includes the regular operation and maintenance activities and has been estimated as being up to $0.26 per km travelled for articulated buses[141].
- **Assumed investment lifetime:** eight years.
- **Investor for infrastructure:** Indonesian Government.
- **Benefits**:
  - O&M savings: the reduction in the number of articulated buses operating when compared with regular buses (due to higher occupancy ratio) results in less distance travelled, and therefore a reduced cost of O&M.
  - Bus drivers' salary savings: the reduction in the number of articulated buses operating when compared with regular buses (due to a higher occupancy ratio) leads to fewer bus drivers working, and therefore la reduction in cost.
  - Ticket price: the price of BRT tickets has been estimated as being up to $0.30[142].
  - Diesel consumption saved: the fewer number and reduced distance travelled of articulated buses compared with regular buses and reduced number of passenger cars on the roads.

[141] Source: World Bank, 2009.
[142] Global BRT data: http://brtdata.org/indicators/systems/capital_cost_per_kilometer_us_million_per_km

- o <u>Gasoline consumption saved</u>: from the reduced number of passenger cars on the roads.

3.2.8.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M. The calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

3.2.8.7.3 Result & Scoring:

The quantitative assessment shows that both the NPV as well as the CBA ratio have a positive value for this LCM, indicating a financially feasible investment for the private sector if the local government contributes to infrastructure development. The main investment parameters are shown in the table below:

Table 130: BRT - Financial Feasibility results

Parameter for an eight year investment lifetime	
Costs	
(1) Capital investment	$3,033,000
(2) O&M	$3,236,688
Overall Net Cost discounted	$1,597,124
Benefits	
Overall Net Benefit discounted	$2,661,319
NPV	$1,064,195
IRR	31 %
CBA ratio	1.67

Source: Own elaboration

For the final score, the CBA ratio from this LCM has been compared to the individual CBAs of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM “Utilisation of Geothermal Energy” represents the LCM with the highest CBA ratio (1.8 tCO_2e), and has consequently been given the maximum score of 5. The Urban Forestry & Urban Greening LCM represents the CBA ratio (0.00), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relative to the highest and lowest score.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(1.8 - 0.00\,)}) * (1.67\; - 0.00)]$$

Final Score - Quantitative assessment: 4.7 out of 5

The financial qualitative assessment demonstrates that the implementation of a BRT is very challenging and requires both high capital investment and strong financial support from national and international donors.

Table 131: Scoring Summary: BRT - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	YES	0.0
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES	0.0
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES	0.0
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES, PARTIALLY	0.5
5	Has the LCM already been successfully financed by international financial partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES, PARTIALLY	0.5
		FINAL SCORE	**1.0**

Final Score - Qualitative assessment: 1 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with an 80% quantitative and 20% qualitative ratio, as the quantitative parameters are regarded fairly complete and accurate.

$$\text{Final Score Calculation} = (4.7 * 0.8) + (1 * 0.2)$$

Final Score: 4 out of 5

3.2.8.8 Sustainable Development Benefits

The BRT LCM will also result in environmental and social SD benefit impacts.

Through the reduction of emissions due to a shift in travel from cars and motorcycles to an efficient public bus system, PM 10 and 2.5 as well as NO_x levels in the air will be reduced, improving the air quality within the SEZ Bitung. Additionally, dust and noise resulting from individual vehicles will bereduced, improving air quality further and making outdoor activities more enjoyable.

From a social standpoint, a well-functioning BRT system can reduce travelling time significantly (due to special allocated bus lanes and traffic management), improving people's overall livelihoods as less time has to be spend for travelling within the SEZ Bitung.

Table 132: Scoring Summary: BRT - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Environment	Reduction of air pollution	PM10 and PM2.5, NO_x	+	2	3
	Noise reduction	Reduction of motorized vehicles used, reduction in noise level	+	2	4
Social	Time savings	Average travel time saved	+	2	4

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact with their respective score. The resulting total score has then been divided by the sum of the relevance scores, providing one final weighted score of all the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 2 * 3 + 2 * 4 + 2 * 4}{\sum 2 + 2 + 2}$$

Final Score: 3.7 out of 5

3.2.8.9 Summary

The table below shows the summary of the MCA for the implementation of the BRT system:

Table 133: Scoring Summary of BRT

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Bus Rapid Transit (BRT)	4.0	1.1	1.9	3.5	2.5	4	3.7	**2.8**

Source: Own elaboration

3.2.9 Non-Motorised Transport (NMT) and Transit-Oriented-Development (TOD)

3.2.9.1 SEZ-specific Context

This LCM has been considered under the transport sector and consists of two different components: (1) implementation of NMT measures; and (2) promotion of TOD measures.

Regarding the NMT measures, it is divided in two specific actions: (i) purchasing of bicycles and infrastructure related development; and (ii) promoting environmental awareness campaigns.

In terms of the purchasing of bicycles and infrastructure related development, the goal is to provide to the inhabitants of SEZ Bitung with free environmentally friendly private transport. The development of supporting infrastructure to achieve the shift towards NMT usage is therefore necessary. For instance, this includes: sidewalks, crosswalks, paths, bicycle lanes, pedestrian oriented land use and building design, increased road and path connectivity with special non-motorised shortcuts, bicycle parking, bicycle integration in transit systems (e.g. racks on bus), traffic calming through traffic speed reductions, vehicle restrictions and road space reallocation. It is important to note that the option of introducing a bike sharing system has been rejected due to space limitations. According to international standards[143], planning guides strongly recommend a minimum system coverage area of 10 km^2 to develop this type of NMT system; the overall surface of the SEZ Bitung is only 5.34 km^2. This is therefore the main reason why a bike-sharing system has not been considered for the SEZ Bitung.

In terms of promoting environmental awareness campaigns, it is expected to enhance the population living and working in SEZ Bitung to shift from fossil-fuel based means of transport (e.g. passenger cars and motorbikes) to NMT options such as walking or biking. A target of 5% shifting ratio has been estimated to be achieved in 2031. This target is assumed to be progressively implemented from 0% in 2017 to 5% in 2031[144].

The TOD measures are divided in two specific actions: (i) promoting the development of infrastructure, and (ii) promoting environmental awareness campaigns.

In terms of promoting the development of infrastructure, the focus is on the integration of transit and land use in urban areas. the aim is development of a smart infrastructure concept in which residential and commercial facilities are located in short distance to each other and close to public transportation hubs.

In terms of promoting environmental awareness campaigns, similarly to the NMT measures, the target of a 5% shifting ratio has been estimated to be achieved in 2031. This is assumed to be a progressive target, being implemented from 0% in 2017 to 5% in 2031.

Consequently, the implementation of NMT and TOD will achieve a certain amount of GHG ER, although these will be limited and mainly focussed on energy savings achieved by the shift from fossil-fuel based modes of transport to more environmental friendly ones, enhancing walkability, connections and transit. The NTM and TOD measures will lead to SD benefits such as an improvement in air quality, less congestion, noise reduction, and health benefits.

The schedule for implementation of NMT and TOD measures can be divided in three components:

- Construction of infrastructure aimed at improving pedestrian and cyclist safety, as well as shifting between means of transport: in phase 1 (2017) and operation from 2018 until (and beyond) 2031.
- Purchasing of bicycles for inhabitants and workers: at the beginning of each phase (2017, 2020, 2022, 2024, 2026, 2029).
- Environmental awareness campaigns: at least one at the beginning of each phase (2017, 2020, 2022, 2024, 2026, 2029).

[143] The Bike-share planning guide (ITDP, 2013).
[144] The target has been implemented through a regression line approach.

3.2.9.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- National level policies:
  - National Action Plan for GHG ER (*RAN-GRK*);
  - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*);
  - National Energy Policies (National Energy Conservation Development Plan, *RIKEN*).
- Provincial level policies:
  - North Sulawesi Province Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Provinsi Sulawesi Utara*);
  - North Sulawesi Province Spatial Planning (*Rencana Tata Ruang Wilayah Provinsi, RTRWP*);
  - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
  - Bitung City Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung*);
  - Bitung Detailed City Planning (*Rencana Detail Tata Ruang, Bitung*).
- SEZ level policies:
  - SEZ Masterplan 2008.

The results of the MCA are presented in the table below:

Table 134: Scoring Summary: NMT and TOD - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES: policies that explicitly promote the LCM are in place. Specifically, the following are stressed at the national level (*RAN-GRK*): development intelligent transport system (ITS), implementation of schemes focussed on congestion charging and road pricing, enhancing eco-driving and developing NMT.	1
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions from the energy and transport sector by up to 0.038 $GtCO_2e$ (+0.018 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES, PARTIALLY: policies that include a SD target are in place, but it is not clear how much the policy should contribute to its achievement at the sectoral level. Specifically, the National Energy Policy (*RIKEN*) provides a set of indicators, baseline and targets in relation to overall energy saving, but not the contribution from the transport sector.	0.5
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES, PARTIALLY: the LCM would indirectly contribute to achieving the SD target of the policy.	0.5
		FINAL SCORE	**4.0**

Final Score: 4 out of 5. Source: Own elaboration

3.2.9.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.9.3.1 Assumptions:

- **Shift from passenger cars to NMT and TOD target:** a progressive target from 0% in 2017 to 10% in 2031 has been assumed.
- **Number of passenger cars**: according to the target mentioned above, the reduction in the number of passenger cars has been estimated as being up to 2 in 2017 and 188 in 2031.
- **Distance travelled avoided by reduction in passenger cars**: the assumption is that the reduction in passenger cars will avoid up to 4,380 km distance travelled in 2017 and 411,720 km distance travelled in 2030.
- **Fuel consumption saved (passenger cars)**: according to the target mentioned above, fuel consumption saved from the reduction in passenger cars has been estimated as being up to 94 litres of diesel and 468 litres of gasoline in 2017 and 8,821 litres of diesel and 43,964 litres of gasoline in 2031.
- **Emission factor**: diesel 2.62 kg CO_2e per litre and gasoline 2.33 kg CO_2e per litre.

3.2.9.3.2 Calculation Methodology:

The GHG ER have been calculated against the BAU scenario for the SEZ Bitung. The calculation methodology has focussed on the GHG ER derived from fuel savings of a 10% shift from passenger cars to NMT and TOD measures.

3.2.9.3.3 Result & Scoring:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**1,293 tCO_2e**

For the final score, the cumulative calculated absolute GHG ER from the implementation of NMT and TOD has been compared to the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), this LCM has the lowest GHG ER potential (1,293 tCO_2e) of all assessed LCMs, consequently being given the minimum score of 1.

Final Score: 1 out of 5

3.2.9.4 Cost Effectiveness

3.2.9.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV's discount rate. The discount rate has been estimated at 11.75%[145]

3.2.9.4.2 Calculation Methodology:

The CE of this LCM shows the cost of reducing one additional unit of pollution, i.e. one tonne CO_{2e}.

In order to calculate the overall CE of the LCM, the GHG ER that can be achieved have been calculated proportional to the assumed investment lifetime. This allows for an accurate comparison between the costs incurred in reducing GHG emissions and the actual ER achieved through the LCM.

[145] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)

The cumulative GHG ER achieved over the duration of the investment for NMT and TOD are shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: 15 years)[146]: **1,292 tCO_2e**

The calculation of the CE has been carried out by taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -\left(\frac{-67{,}049\ USD}{1{,}293\ tCO2e}\right)$$

3.2.9.4.3 Result & Scoring:

The abatement cost for mitigating one tonne of CO_2e from NMT and TOD within the SEZ Bitung has been calculated as **\$52/tCO_2e.**

For the final score, the CE from NMT and TOD has been compared with the CE results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), this LCM represents the lowest CE (\$52/tCO_2e) of all assessed LCMs, consequently being given the minimum score of 1.

Final Score: 1 out of 5

3.2.9.5 Technical Feasibility

Firstly, the implementation of NMT measures in a context like the SEZ Bitung involves the following several steps: (i) regulate the location of non-motorised vehicle (NMV) use; (ii) regulate the design of NMT facilities; (iii) plan for NMT; (iv) collect data for and monitor NMT improvement; (v) identify the NMT network; and, (vi) design the appropriate NMT facilities, local streets and mixed use.

Secondly, the TOD measures are focussed on the integration of transit and land use in urban areas. Due to its wide scope of principles (walk, cycle, connect, transit, shift, mix), TOD implementation is complex and requires specific expertise to achieve a reduction in distance travelled by users through: (i) mixed-use development; (ii) high densities of housing and employment; (iii) pedestrian/bicycle-friendly network; (iv) zoning of station area; (v) park and ride design, among others.

Overall, there are a few NMT and TOD experiences promoted by local governments in Indonesia on which to draw; however, whilst the technology is available, know-how is not comprehensive. MRV is not foreseen to be feasible if it is not with the technical and financial support of a policy instrument such as a NAMA and combined with other sustainable urban transport measures.

The results of the MCA are presented in the table below:

Table 135: Scoring Summary: NMT and TOD - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: NMT and TOD related technologies are available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES, PARTIALLY: there are existing experiences in NMT and TOD facility implementation in big cities like Jakarta (improvement of pedestrian cycling infrastructure as a means of BRT feeder system) and Yogyakarta (enhancing the safety of the pedestrian facilities and improving the walkability of the city).[147]	0.5
3	Is the necessary capacity to apply and use the LCM technology available in the country?	YES, PARTIALLY: know-how is scarce and local governments in Indonesia lack the close coordination and technical expertise needed to implement the LCM.	0.5

[146] This figure represents the GHG ER achieved over the duration of the investment lifetime.
[147] Retrieved from: http://walkabilityasia.org/2012/06/29/enhancing-walkability-in-the-city-of-yogyakarta-indonesia/ (Access in August 2015).

Nº	Questions	Answers	Scoring
4	Are technology related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES, PARTIALLY: the MRV is feasible but will need changes to adapt the national system to MRV requirements. The lack of and poor quality of data is a major constraint in the accurate measurement of the mitigation potential and co-benefits of the LCM. However, if combined with other sustainable urban transport measures it could be feasible.	1.0
		FINAL SCORE	**3.0**

Final Score: 3 out of 5. Source: Own elaboration

3.2.9.6 Legal/Regulatory/Institutional/Political/Social Feasibility

In accordance with the regulatory environment, institutional framework and political landscape of the transport sector detailed in the BRT measure, and taking into account the scope of this NMT and TOD actions, the implementation of this LCM is considered partially feasible in terms of existing regulatory environment, institutional framework and political landscape. The results of the MCA are presented in the table below:

Table 136: Scoring Summary: NMT and TOD - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory framework, but several changes will be required to ensure its success. This gap should be bridged with policy advice on policy enforcement and better technical assistance on project planning and management. Besides, the local governments in Indonesia have limited fiscal capacity to finance transport infrastructure, undermining their capacity to leverage the required investment.	1.0
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing institutional framework, but several changes will be required to ensure its success. The local agencies (Government Unit for Transport) in charge of the operation of the transport-related projects and the regional planning authorities lack consistent coordination and technical expertise in sustainable transport measures such as NMT and TOD. The lack of stakeholder engagement in this process can also lead to missed opportunities to identify high-quality project proposals in terms of transport at the local level.	1.0
3	Is the LCM suited to the existing political landscape?	YES, PARTIALLY: the LCM is suited to the existing regulatory framework, but several changes will be required to ensure its success. This gap should be bridged with policy advice on policy enforcement and better technical assistance on project planning and management. Additionally, local governments in Indonesia have limited fiscal capacity to finance transport infrastructure, undermining their capacity to leverage the required investment.	0.5
		FINAL SCORE	**2.5**

Final Score: 2.5 out of 5. Source: Own elaboration

3.2.9.7 Financial Feasibility

3.2.9.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**: includes three components:

Table 137: NMT and TOD - Financial Feasibility parameters

Parameter	SEZ Bitung
(1) Cost of the infrastructure	$370,000
(2) Cost of the purchase of bikes (300 overall from 2016-2030)	$35,000
(3) Environmental awareness campaigns	$35,000
Overall capital investment = (1)+(2)+(3)	$440,000

Source: Own elaboration

- **Cost of O&M**: includes the regular operation and maintenance activities and has been estimated as being up to 2% of the capital investment.
- **Assumed investment lifetime:** 15 years.

3.2.9.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M. The calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

3.2.9.7.3 Result & Scoring:

The quantitative assessment shows that the CBA ratio has a slightly positive value for this LCM, indicating that certain incentive schemes are required to make this LCM a financially feasible investment opportunity. See the main figures in the table below:

Table 138: NMT and TOD - Financial Feasibility results

Parameter for a 15 years investment lifetime	
Costs	
(1) Capital investment	$440,000
(2) O&M	$103,600
Overall Net Cost discounted	$455,115
Benefits	
(1) Diesel consumption saved	$47,527
(2) Gasoline consumption saved	$273,326
Overall Net Benefit discounted	$388,065
NPV	-$67,049
IRR	10%
CBA ratio	0.85

Source: Own elaboration

For the final score, the CBA ratio from this LCM has been compared with the individual CBAs of the other 9 selected LCMs. As can be seen in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest CBA ratio (1.8 tCO_2e), and has consequently been given the maximum score of 5. The Urban Forestry & Urban Greening LCM represents the CBA ratio (0.00), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, scoring it relative to the highest and lowest score.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(1.8 - 0.00)}) * (0.85 - 0.00)]$$

Final Score - Quantitative assessment: 2.9 out of 5

The qualitative assessment demonstrates that the implementation of NMT and TOD measures requires low-mid capital investment, and that there is a need for developing a clear and effective financial framework to support these sorts of initiatives.

Table 139: Scoring Summary: NMT and TOD - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	YES, PARTIALLY	0.5
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES, PARTIALLY	0.5
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES, PARTIALLY	0.5
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES, PARTIALLY	0.5
5	Has the LCM already been successfully financed by international financial partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES, PARTIALLY	0.5
		FINAL SCORE	**2.5**

Final Score - Qualitative assessment: 2.5 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with an 80% quantitative and 20% qualitative ratio, as the quantitative parameter are regarded complete and accurate.

$$\text{Final Score Calculation} = (2.9 * 0.8) + (2.5 * 0.2)$$

Final Score: 2.8 out of 5

3.2.9.8 Sustainable Development Benefits

Similar to the BRT LCM, NMT and TOD activities will lead to environmental and social SD benefit impacts.

Due to the shift from cars and motorcycles to non-motorised means of transport, emissions (PM 10 and 2.5, NO_x) dust, and motor noises will be reduced, improving the air quality and people's overall livelihood within the SEZ Bitung.

In addition, physical activities such as walking and bicycling, combined with the improved air quality, will lead to improvements in the health of local residents.

Table 140: Scoring Summary: NMT and TOD - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Environment	Reduction in air pollution	PM10 and PM2.5, NO_x	+	2	4
	Noise reduction	Reduction of motorised vehicles used, reduction in noise level	+	3	3
Social	Health	Number and magnitude of health problems, reduction of health damaging air pollutants	+	2	4

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact with their respective score. The resulting total score has then been divided by the sum of the relevance scores, providing one final weighted score of all the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 2 * 4 + 3 * 3 + 2 * 4}{\sum 2 + 3 + 2}$$

Final Score: 3.6 out of 5

3.2.9.9 Summary

The table below shows the summary of the MCA for the implementation of NMT and TOD measures:

Table 141: Scoring Summary of NMT and TOD

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Non-Motorised Transport (NMT) and Transport-Oriented-Development (TOD)	4.0	1.0	1.0	3.0	2.5	2.9	3.6	**2.8**

Source: Own elaboration

3.2.10 Urban Forestry and Urban Greening

3.2.10.1 SEZ-specific Context

This LCM comes under the AFOLU sector and is focussed on two main activities: (1) land use management and (2) urban greening.

In terms of land use management, the main objective is to afforest specific areas within green urban spaces[148] already planned in the SEZ Bitung by planting tropical tree species.

The urban greening measure aims to take advantage of mixed-use urban areas[149], turning them into recreational areas for the local residents.

According to the SEZ Bitung Masterplan, it is expected that the green urban areas will cover an area of at least 102 ha (19% of total) in 2031. Moreover, the mixed-use urban areas will cover an amount of almost 26 ha (5% of total) once the SEZ has been completely developed. It is assumed that part of this land use can be recovered, with the aim of enhancing reforestation and afforestation activities. The afforestation or re-greening (*penghijauan*) activities will be focussed on community areas outside of state forests.

The reason for selecting native tree species for planting is centred on technical feasibility, availability and carbon sink capacity; the aim is to increase carbon removal in the SEZ Bitung.

The tree species have been classified depending on two parameters:

1) How fast they grow: slow growing species: *Ficus benjamina*, *Dysoxylum excelsum* and *Canangium odoratum;* medium growing species: *Swietenia macrophylla* and *Swietenia mahagoni.*

2) How much CO_2 they can absorb: moderate level: *Swietenia macrophylla;* high level: *Swietenia mahagoni;* very high level: *Ficus benjamina*, *Dysoxylum excelsum* and *Canangium odoratum.*

Through the planting of trees, this LCM will achieve GHG emission removals rather than GHG ER due to its carbon sink capacity. Moreover, this LCM will also lead to SD benefits such as reduction of air pollution, improvement of health and job creation.

The implementation of the urban forestry and urban greening measures is expected to take place from Phase 1 through to Phase 5 (2017-2031), with trees being planted on a yearly basis throughout the whole period.

3.2.10.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

- <u>National level policies:</u>
  - National Action Plan for GHG ER (*RAN-GRK*);
  - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*).
- <u>Provincial level policies:</u>
  - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- <u>SEZ level policies:</u>
  - SEZ Masterplan 2008.

The results of the MCA are presented in the table below:

[148] Defined in the SEZ Bitung Masterplan as "Green Open Space".
[149] Defined in the SEZ Bitung Masterplan as "Green Open Space".

Table 142: Scoring Summary: Urban Forestry and Urban Greening - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES: policies that explicitly promote the LCM are in place. Specifically, at the national level (*RAN-GRK*), provincial level (*RAD-GRK*) and SEZ level (SEZ Masterplan 2008), they promote socially beneficial forestry development and the development of environmental services.	1.0
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions from forestry and peatland by up to 0.672 $GtCO_2e$ (+0.367 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES, PARTIALLY: policies that include a SD target are in place, but they are not numeric. More specifically, at the national level the *RPJPN & RPJMN* aims to avoid unsustainable economic growth and rapid depletion of the natural resources.	0.5
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES, PARTIALLY: the LCM would indirectly contribute to achieving the SD target of the policy.	0.5
		FINAL SCORE	**4.0**

Final Score: 4 out of 5. Source: Own elaboration

3.2.10.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.10.3.1 Assumptions:

- **Living biomass**: carbon stock and changes in carbon stock resulting from living biomass from the trees planted is considered to remain stable over the lifecycle of the SEZ Bitung development.
- **Carbon sink capacity per tree species**: *Swietenia macrophylla* (114,03 $kgCO_2$), *Swietenia mahagoni* (295,73 $kgCO_2$), *Ficus benjamina* (535,90 $kgCO_2$), *Dysoxylum excelsum* (720,49 $kgCO_2$) and *Canangium odoratum* (756,59 $kgCO_2$).
- **Average density of tree species**: taking into account the average space occupied by a tree of 5x5 meters, the average density for a forest with the tree species mentioned above is 400 trees per hectare.
- **Percentage of trees planted in urban green areas**: 1.0% of the overall urban green areas have been considered; this represents an average of more than 30 trees planted every year from 2017 to 2031.
- **Distribution of the selected tree species planted**: the distribution has been considered equal for every tree species, resulting in a proportion of 20% each.

3.2.10.3.2 Calculation Methodology:

Firstly, the number of tree species to be planted every year has been calculated by multiplying the AFOLU land use in the SEZ Bitung by the average density of tree species, the percentage of trees planted in urban green areas and the distribution of the selected tree species planted.

Secondly, the amount of trees planted per species each year has been multiplied by its carbon sink capacity. As a result, the ex-ante estimation of carbon removals has been achieved for the period comprised of 2017 to 2031.

3.2.10.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER results are the following:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**1,707 tCO_2e**

For the final score, the cumulative absolute GHG ER that can be achieved through urban forestry and urban greening has been compared to the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest GHG ER potential (256,753 tCO_2e), and has consequently been given the maximum score of 5. The "NMT and TOD" LCM represents the lowest GHG ER potential (1,293 tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, scoring it relative to the highest and lowest score.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(256{,}753\ tCO2e - 1{,}293\ tCO2e)}) * (1{,}707\ tCO2e - 1{,}293\ tCO2e)]$$

Final Score: 1.0 out of 5

3.2.10.4 Cost Effectiveness

3.2.10.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV's discount rate. The discount rate has been estimated at 11.75%[150].

3.2.10.4.2 Calculation Methodology:

The LCM CE expresses the cost of reducing one additional unit of pollution, i.e. one tonne of CO_{2e}.

In order to calculate the overall CE of the LCM, the achieved GHG ER have been calculated proportional to the assumed investment lifetime. This allows for an accurate comparison of the costs incurred in reducing GHG emissions and the actual ER achieved through the LCM.

The cumulative GHG ER achieved over the duration of the investment for forestry and urban greening measures are shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: 15 years)[151]: **1,707 tCO_2e**

The calculation of the CE has been carried out by taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -(\frac{-\ 83{,}263\ USD}{1{,}707\ tCO2e})$$

[150] Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)
[151] This figure represents the GHG ER achieved over the duration of the investment lifetime.

3.2.10.4.3 Result & Scoring:

As a result, the abatement cost for mitigating one tonne of CO_2e from forestry and urban greening measures within the SEZ Bitung has been calculated as being up to **$48.8/t$CO_2$e**.

For the final score, the CE from forestry and urban greening measures has been compared to the CE results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), other LCMs potentially lead to a better CE. The LCM "Comprehensive EE programme for Industrial Buildings, Appliances and Processes" represents the LCM with the best CE (-$28/t$CO_2$e), and has consequently been given the maximum score of 5. The LCM "NMT & TOD" represents the lowest CE ($52/t$CO_2$e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, scoring it relative to the lowest and highest mitigation abatement costs achieved by all LCMs analysed.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(52\ USD\ per\ tCO2e - (-28\ \ USD\ per\ tCO2e)}) * (52\ USD\ per\ tCO2e - 48.8\ USD\ per\ tCO2e)]$$

Final Score: 1.1 out of 5

3.2.10.5 Technical Feasibility

The technical requirements for urban forestry and greenery activities are mainly based on the following features: site plan, tree protection provisions, tree density calculations, planting plan (including O&M), tree replacement plan and tree inventory. Specific technical aspects are related to land preparation, planting seeds and nursing.

Due to the high rate of deforestation in Indonesia in the late 1990s and during the first decade of the 21st century (mainly in Java and Sumatra), the country has developed technical skills and capacity to face the threat of deforestation through the successful implementation of different mitigation initiatives such as: at least 2 Reduced Emissions from Deforestation and Degradation projects (REDD+)[152] and 5 community Afforestation and Forestation (A/F) projects (max. 500 ha).

the country has the technical knowledge and capacity to implement the LCM. However, it is foreseen that the application of an MRV scheme will be partially feasible. The results of the MCA are presented in the table below:

Table 143: Scoring Summary: Urban Forestry and Urban Greening - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: the urban forestry and urban greening related technologies and techniques are available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES: the reforestation and afforestation practices have been in place for decades in the region.	1.0
3	Is the necessary capacity to apply and use the LCM technology available in the country?	YES: the technical know-how is there.	1.0
4	Are technology related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES, PARTIALLY: the MRV is feasible but it will be necessary to build capacity of the local authorities on calculation & MRV for GHG ER from urban forestry and urban greening measures.	1.0
		FINAL SCORE	**4.0**

Final Score: 4 out of 5. Source: Own elaboration

[152] http://www.redd-indonesia.org/

3.2.10.6 Legal/Regulatory/Institutional/Political/Social Feasibility

The Ministry of Forestry ofthe Government of Indonesia is still the main institution responsible for the enactment of regulations regarding forestry management in the country. However, a process of decentralisation since 1999 has allowed the approval of new policies and regulations, leading to a change in the institutional landscape in central and local governments.

Currently, there are several programs in place that attempt to boost afforestation and reforestation activities in Indonesia in the form of Community Forestry Programs (*Hutan Kemasyarakatan, Hutan Rakyat, Hutan Tanaman Rakyat* and *Hutan Desa*). However, other factors such as palm oil and timber plantations detract from efforts to enhance these forestry related activities. There is therefore the political intention to promote afforestation and reforestation within the country, but such actions are not yet fully supported by a strong legal and regulatory framework.

Overall, the implementation of this LCM has been considered partially feasible in terms of the existing regulatory environment, institutional framework and political landscape. The results of the MCA are presented in the table below:

Table 144: Scoring Summary: Urban Forestry and Urban Greening - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory environment, but small changes will be required to ensure its success.	1.0
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing institutional framework, but small changes will be required to ensure its success.	1.0
3	Is the LCM suited to the existing political landscape?	YES, PARTIALLY: the LCM is suited to the existing political landscape, but small changes will be required to ensure its success.	0.5
		FINAL SCORE	**2.5**

Final Score: 2.5 out of 5. Source: Own elaboration

3.2.10.7 Financial Feasibility

3.2.10.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**: infrastructure development, cost of material and utilities
- **Capital investment**: includes two components:

Table 145: Urban Forestry and Urban Greening - Financial Feasibility parameters

Parameter	SEZ Bitung
(1) Cost of infrastructure development (2) Cost of utilities	$40,000 $20,000
Overall capital investment = (1)	$60,000

Source: Own elaboration

- **Cost of O&M**: it includes the regular operation and maintenance activities including cost for utilities and salaries for workers
- **Assumed investment lifetime:** 15 years.
- **Land use area**: includes AFOLU land use (102 ha) plus half of the mixed-use land use (12.95 ha), which amounts to an overall area of 115 ha.

3.2.10.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M. The calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

3.2.10.7.3 Result & Scoring:

The financial feasibility includes both a quantitative and a qualitative assessment.

The quantitative assessment shows that the NPV for this LCM is negative. This indicates that urban forestry and greening measures are not attractive from a financial investment point of view as it does not generate a return on investment. The main financial parameters are shown in the table below:

Table 146: Urban Forestry and Urban Greening - Financial Feasibility results

Parameter for a 30 year investment lifetime	
Costs	
(1) Capital investment	$60,000
(2) O&M	$45,000
Overall Net Cost discounted	$83,263
N/A	-
Overall Net Benefit discounted	-
Net present Value (NPV)	-$83,263
Internal Rate Return (IRR)	-
Cost-benefit (CB) ratio	0.00

Source: Own elaboration

For the final score, the CBA ratio from this LCM has been compared to the individual CBAs of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), this is the LCM with the lowest CBA ratio (0.00) of all assessed LCMs, consequently being given the minimum score of 1.

Final Score - Quantitative assessment: 1 out of 5

The qualitative assessment reveals that no high upfront costs are required for this LCM and that a wide range of actors are already implementing urban greening activities in Indonesia (Government, State/Private companies, NGO, local communities). However, no strong incentive systems exist, nor are international finance partners involved.

Table 147: Scoring Summary: Urban Forestry and Urban Greening - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	NO	1.0
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES	0.0
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES	0.0
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES	1.0
5	Has the LCMalready been successfully financed by international finance partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	NO	0.0
		FINAL SCORE	**2.0**

Final Score - Qualitative assessment: 2 out of 5. Source: Own elaboration

The MCA for the financial feasibility of this LCM is based on a weightage scoring which has been defined as 80% quantitative and 20% qualitative. The main reason in applying this weightage is due to the simplicity and accuracy of this financial assessment.

$$\text{Final Score Calculation} = (1 * 0.8) + (2.* 0.2)$$

Final Score: 1.2 out of 5

3.2.10.8 Sustainable Development Benefits

Afforestation and forestation measures will lead to SD benefits in terms of environment, social, and economic impacts within the SEZ Bitung.

Trees and plants absorb CO2 and act as a natural filter for air pollutants, hence improving the quality of the surrounding air. Trees and plants also reduce soil erosion, enhancing natural means of flood control and regulating groundwater recharge.

In terms of a positive social impact, this LCM contributes considerably to the health and wellbeing of local residents through the reduction of damaging air pollutants as well as stress-relief, community cohesion, and space for recreation and outdoor activities provided by the green areas within the city.

Urban forestry and urban greening also creates long-term local job opportunities, as constant tree planting, nursery and maintenance will be required.

Table 148: Scoring Summary: Urban Forestry and Urban Greening - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Environment	Reduction of air pollution and improvement of soil quality	PM10 and PM2.5, NO_x	+	3	3
Social	Livelihood	Number of green recreation areas, number of green outdoor activity offerings	+	3	5
Economic	Job creation	Number of jobs created	+	2	3

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact with their respective score. The resulting total score has then been divided by the sum of the relevance scores, providing one final weighted score of all the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 3 * 3 + 3 * 5 + 2 * 3}{\sum 3 + 3 + 2}$$

Final Score: 3.8 out of 5

3.2.10.9 Summary

The table below shows the summary of the MCA for the Urban Forestry and Urban Greening measure:

Table 149: Scoring Summary of Urban Forestry and Urban Greening

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Urban Forestry and Urban Greening	4.0	1.0	1.1	4.0	2.5	1.2	3.8	**2.5**

Source: Own elaboration

3.2.11 Integrated Solid Waste Management System and 3R strategies

3.2.11.1 SEZ-specific Context

This LCM is formed by two main components: (1) the implementation of an integrated MSW management system, including the development of an organic waste composting facility and a biomass gasification[153] power plant unit; and (2) the promotion of environmental awareness campaigns to implement 3R strategies.

The integrated MSW management system aims at enhancing the potential for recycling of MSW in the SEZ Bitung (and also in Bitung City). Due to its technical characteristics and magnitude, a suggested sanitary landfill facility has been estimated at the municipality level with a treatment capacity of up to 450 m^3 MSW per day, which represents 150 t MSW per day[154]. The main goal of the integrated MSW management system is twofold: (i) to reduce the amount of MSW transported to the sanitary landfill; and (ii) to convert the organic waste into high quality compost to be reutilised as manure (e.g. for the green urban areas) and other refuse-derived-fuel (RDF) for biomass gasification at the local level, promoting a cradle to grave or circular economy approach.

Conceptually, waste is separated into ‘wet waste’ and ‘dry waste’ based on its size. Smaller materials contain a high proportion of organic waste and are considered ‘wet waste’ (for composting process). The larger material with only a low proportion of organic waste is considered ‘dry waste’ (this includes mainly garden waste, paper, packaging materials, wood waste). The separation is carried out using a combination of two rotary screens and manual sorting for coarser materials.

The main objective of the 3R strategies is to increase the recycling ratio in relation to the MSW produced in the SEZ Bitung (and also in Bitung city). A target to achieve a 20% wet waste recycling ratio to be achieved in 2031 has been estimated. This target is assumed to be progressively implemented from 0% in 2017 to 20% in 2031[155]. In order to achieve this ambitious target, several environmental awareness campaigns will be promoted among the different sectors (e.g. residential, commercial and industry) of the SEZ Bitung.

The implementation of this LCM will achieve a certain amount of GHG ER, limited to the methane generation avoided by the MSW transported to the sanitary landfill. In turn, this LCM will also lead to relevant SD benefits such as the reduction of air pollutants, environmental education for citizens and businesses and an overall improvement in people’s livelihood.

The schedule of implementation for this LCM can be divided in two components:

- Implementation of the integrated waste management centre: (i) construction in phase 1 (2017) and (ii) operation from 2018 until (and beyond) 2031.
- Environmental awareness campaigns: at least one at the beginning of each phase (2017, 2020, 2022, 2024, 2026, 2029).

Please note that construction of this LCM-10 is to be developed based on the same facility built on this LCM-3 (Methane Capture and AD System). Up to 20% of waste, expected to be organic part to be composted, would be pre-sorted during waste collection procedure, prior to waste delivery to the sanitary landfill. Some 50% of the remaining waste is expected to have low organic content, with the option of utilisation as fuel to be installed add-on to the LCM-10 activity.

3.2.11.2 Alignment and Coherence with Domestic Policy Framework

To assess how this LCM is aligned with the domestic policy framework, the following relevant LCM policies have been reviewed:

---

[153] Pyrolysis Gasification is a combination of pyrolysis and gasification processes. The pyrolysis process converts dry waste into low molecular weight hydrocarbon gases or ‘pyrogas’. Energy from the pyrogas and the water-gas is recovered through isothermal combustion process in the high temperature oxidation unit. Ensuring complete combustion and therefore minimize generation of pollutant gas, all gases and any small particulate matter is maintained at constant temperature of 1,250^{O}C for a minimum of 2 seconds. The heat from the combustion process is used to produce steam in the 2 MWe boiler-turbine generator (Waste-to-Energy system). Electricity is delivered to a local / regional PLN interconnected grid system, and subsequently generating project revenue through PLN Feed-in-Tariff scheme.

[154] The density of the MSW has been estimated in 350 kg/m3 (Source: http://es.scribd.com/doc/256050249/Lecture-MSW-and-BMW-Management#scribd)

[155] The target has been implemented through a regression line approach.

- National level policies:
    - National Action Plan for GHG ER (*RAN-GRK*);
    - Indonesia's National Development Strategy (*RPJPN* & *RPJMN*).
- Provincial level policies:
    - North Sulawesi Province Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Provinsi Sulawesi Utara*);
    - North Sulawesi Province Spatial Planning (*Rencana Tata Ruang Wilayah Provinsi, RTRWP*);
    - North Sulawesi Province Action Plan for GHG Emissions Reduction (*RAD-GRK*).
- City level policies:
    - Bitung City Development Strategy (*Rencana Pembangunan Jangka Menengah Daerah, RPJMD Kota Bitung*);
    - Bitung Detailed City Planning (*Rencana Detail Tata Ruang, Bitung*).
- SEZ level policies:
    - SEZ Masterplan 2008.

The results of the MCA are presented in the table below:

Table 150: Scoring Summary: Integrated Solid Waste Management System and 3R strategies - Alignment and Coherence with Domestic Policy Framework

Nº	Questions	Answers	Scoring
1	Do policies in place have the same objective or explicitly promote the LCM?	YES: policies that explicitly promote the LCM are in place. Specifically, at the national level (*RAN-GRK*) and provincial level (*RAD-GRK*) they highlight the improvement of waste management and the 3R strategies.	1.0
2	Do these policies have a numeric GHG ER target?	YES: policies that include a numeric GHG ER target are in place. At the national level the *RAN-GRK* aims to reduce GHG emissions from the waste sector by up to 0.048 $GtCO_2e$ (+0.030 $GtCO_2e$ with international support).	1.0
3	Do these policies have a numeric SD benefits target?	YES, PARTIALLY: policies that include a SD target are in place, but they are not numeric. More specifically, at the national level the *RPJPN & RPJMN* aims to avoid unsustainable economic growth and rapid depletion of natural resources.	0.5
4	Does the LCM contribute directly to the numeric GHG ER target of the country/sector?	YES: the LCM would directly contribute to achieving the GHG ER target of the policy.	1.0
5	Does the LCM contribute directly to numeric sustainable development targets of the country/sector?	YES, PARTIALLY: the LCM would indirectly contribute to achieving the SD target of the policy.	0.5
		FINAL SCORE	**4.0**

Final Score: 4 out of 5. Source: Own elaboration

3.2.11.3 GHG ER Calculation

The data used for the calculation of GHG ER comes from a number of sources (see references in assumptions) and builds on the best technical knowledge, taking into account the specific characteristics of the Indonesian context.

3.2.11.3.1 Assumptions:

- **Methane generation**: the ratio of methane generation in the landfill has been calculated according to the 1996 IPCC Guidelines. The value is 0,078 tCH_4/t MSW.

- **Waste composition**: it has been assumed that MSW composition in North Sulawesi is: 66% food, gardens and similar organic waste; 13% paper, cardboard and paper products; 11% plastics; 6% other sort of waste; 2% ferrous metals; 1% fabrics; 1% glass[156].
- **GWP from methane**: 25 tCO_2e per tCH_4 (IPCC, 2006).
- **Recycling target**: a progressive recycling target from 0% in 2017 to 20% in 2031 has been assumed.
- **Compost generated from organic waste**: the ratio of compost generated per biodegradable waste is 0.44 tonnes compost per tonnes organic waste. In this sense, the maximum potential for compost generation has been assumed[157].
- **Installed power capacity**: the capacity installed is expected to reach 2 MW.
- **Electricity generation**: according to the installed power capacity and the number of operation hours estimated (7,446 hours)[158], generation of electricity of up to 14,892 MWh (which represents a capacity factor of 0.85) has been assumed.
- **Grid emission factor**: 0.746 tCO_2e per MWh.

3.2.11.3.2 Calculation Methodology:

GHG ER have been calculated against the BAU scenario for the SEZ Bitung following the IPCC Guidelines (Vol. 5 Waste).

In order to determine the amount of waste transported from the SEZ to the sanitary landfill, a proportional value of the waste coming from Bitung City has been applied. The proportional waste amount ratio from SEZ Bitung to Bitung City increases from 1.4% in 2017 to 15.5% in 2031, reflecting the expected population and economic growth of the the SEZ Bitung.

The recycling target has been applied progressively, starting from 0% in 2017 to 20% in 2031.

3.2.11.3.3 Result & Scoring:

Based on the assumptions and calculation methodology described above, the GHG ER results are the following:

Cumulative GHG ER achieved over the entire SEZ Bitung development (2017-2031)	**43,055 tCO_2e**

For the final score, the cumulative absolute GHG ER achieved through integrated solid waste management and 3R for the SEZ Bitung system has been compared to the individual cumulative GHG ER results of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM "Utilisation of Geothermal Energy" represents the LCM with the highest GHG ER potential (256,753 tCO_2e), and has consequently been given the maximum score of 5. The NMT and TOD LCM represents the lowest GHG ER potential (1,293 tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relative to the highest and lowest score.

$$\text{Final Score Calculation} = 1 + [(\frac{4}{(256{,}753\ tCO2e - 1{,}293\ tCO2e)}) * (43{,}055\ tCO2e - 1{,}293\ tCO2e)]$$

Final Score: 1.7 out of 5

[156] Source: Dokumen Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca (RAD-GRK) SULUT 2012.
[157] Aleksandar Dedinec, et al, *Economic and environmental evaluation of climate change mitigation measures in the waste sector of developing countries*, 2014.
[158] Source: *Scaling-up renewable geothermal energy in Indonesia* (ESMAP, 2013).

3.2.11.4 Cost Effectiveness

3.2.11.4.1 Assumptions:

- **Discount rate:** The NPV calculated during the financial feasibility assessment of this LCM is one major factor used to determine its CE. A prime lending rate of 10.25% and 1.5% spread has been applied to determine the NPV's discount rate. The discount rate has been estimated at 11.75%[159].

3.2.11.4.2 Calculation Methodology:

The LCM CE expresses the cost of reducing one additional unit of pollution (i.e. one tonne of CO_2e). The NPV calculated during the financial feasibility assessment of this LCM has been used as the financial cost parameter. However, in order to be able to compare the unbiased CE of individual LCMs, any kind of national or sectoral incentive scheme (e.g. FiT) has been excluded from the NPV applied here.

In order to calculate the overall CE of the LCM, the achieved GHG ER have been calculated proportional to the assumed investment lifetime. This allows for an accurate comparison between the costs incurred in reducing GHG emissions and the actual ER achieved through the LCM.

The cumulative GHG ER achieved over the duration of the investment for an Integrated Solid Waste Management and 3R system are shown below:

- Cumulative GHG ER achieved over the duration of the investment lifetime (for this LCM: 30 years)[160]: **405,777 tCO_2e**

The calculation of the CE has been carried out by taking the NPV of the LCM and dividing it by the cumulative GHG emissions achieved over the LCM investment lifetime. The following formula has been applied:

$$\text{Cost} - \text{effectiveness} = -\left(\frac{-2{,}499{,}697\ \text{USD}}{405{,}777\ tCO2e}\right)$$

3.2.11.4.3 Result & Scoring:

As a result, the abatement cost for mitigating one tonne of CO_2e from an Integrated Solid Waste Management and 3R system within the SEZ Bitung has been calculated up to **\$6.2/tCO_2e**.

For the final score, the CE from this LCM has been compared to the CE results of the other 9 selected LCMs. As can be seen in the final evaluation summary table (section 2.3), other LCMs potentially lead to a better CE. The LCM "Comprehensive EE programme for Industrial Buildings, Appliances and Processes" represents the LCM with the best CE (-\$28/tCO_2e), and has consequently been given the maximum score of 5. The LCM "NMT & TOD" represents the lowest CE (\$52/tCO_2e), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCMs, a "rule of 3" has been applied, scoring it relative to the lowest and highest mitigation abatement costs achieved by all LCMs analysed.

$$\text{Final Score Calculation} = 1 + \left[\left(\frac{4}{(52\ USD\ per\ tCO2e - (-28\ \ USD\ per\ tCO2e)}\right) * (52\ USD\ per\ tCO2e - 6.2\ USD\ per\ tCO2e)\right]$$

Final Score: 3.2 out of 5

159 Official Indonesian Lending Rate: http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Default.aspx (http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls)

160 This figure represents the GHG ER achieved over the duration of the investment lifetime.

3.2.11.5 Technical Feasibility

The technical knowledge required for implementing an integrated solid waste management system and 3R strategies are the following: waste sorting at source (differentiation of waste streams: organic, plastic, cardboard, glass, etc.); waste collection on-site and transportation to segregation facility; waste storage facility; waste processing and treatment facility; resource recovery facility; and waste recycling facility (including composting).

At the national level, the country has the technical know-how and capacity to implement this LCM, but there are still some gaps to be covered at local level to effectively use the technology proposed. In terms of the MRV, currently there is a lack of bottom-up GHG accounting in the waste sector from the local to the national level.

The results of the MCA are presented in the table below:

Table 151: Scoring Summary: Integrated Solid Waste Management System and 3R strategies - Technical Feasibility

Nº	Questions	Answers	Scoring
1	Is the related LCM technology available in the country and region?	YES: Integrated SWM and 3R strategies related technologies are available in the region.	1.0
2	Are the current technology measures already being used in the sector?	YES: there exist several prior experiences in terms of Integrated SWM and 3R strategies in different Indonesian cities, for example, in the city of Balikpapan[161].	1.0
3	Is the necessary capacity to apply and use the LCM technology available in the country?	YES, PARTIALLY: the technical know-how does exist in the region but is not comprehensibly available at the local level. Currently, the following initiatives that aim at building capacity to local governments in this LCM are being implemented: PAKLIM (GIZ), Waste management V-NAMA in Indonesia (GIZ)[162], Urban LEDS (ICLEI)[163] and Emission Reduction in Cities (KfW), among others.	0.5
4	Are technology related MRV activities feasible in terms of time and cost of the envisaged LCM? (2 points question)	YES, PARTIALLY: Some municipalities that undertake waste mitigation actions don't have an effective MRV system which allows the inclusion of the GHG ER in national GHG accounting.	1.0
		FINAL SCORE	**3.5**

Final Score: 3.5 out of 5. Source: Own elaboration

3.2.11.6 Legal/Regulatory/Institutional/Political/Social Feasibility

Waste management is one of the sectors where local governments have relevant competences and can play a key role in Indonesia. The Government Unit for Environment (Environmental Office) is currently disseminating waste management information to the community in Bitung City. In addition, the waste sector has been identified at the national level as being one of the five priority areas for mitigating the effects of climate change (RAN-GRK).

However, there are still several institutional, political and even social barriers that need to be overcome in order to implement a successful integrated waste management facility which will cover the SEZ Bitung (and Bitung city). As a result, the implementation of this LCM has been considered partially feasible in terms of existing regulatory environment, institutional framework and political landscape.

[161] http://www.uncrd.or.jp/content/documents/25996-3R_City-Report_Balikpapan.pdf
[162] http://www.solutions-gateway.org/images/vnamas/1/v-nama_-_case_study_indonesia_2014(2).pdf
[163] http://seas.iclei.org/logos/indonesian-cities-low-emissions-development.html

Table 152: Scoring Summary: Integrated Solid Waste Management System and 3R strategies - Legal/Regulatory/Institutional/Political/Social Feasibility

Nº	Questions	Answers	Scoring
1	Is the LCM suited to the existing regulatory environment? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing regulatory environment, but several changes will be required to ensure its success. The main existing regulatory barriers should be overcome: low enforcement of existing laws, due to lack of punitive measures; and low priority of MSW in local governments' budget allocation.	1.0
2	Is the LCM suited to the existing institutional framework? (2 Point Question)	YES, PARTIALLY: the LCM is suited to the existing institutional framework, but several changes will be required to ensure its success. The main existing institutional barriers should be overcome: lack of horizontal and vertical coordination between different line ministries, departments and governance entities (national level); lack of institutional capacity to face climate change related issues connected with waste management; inadequate technical and administrative capacity at the local level; ineffective MRV-system to track GHG emissions reduced at local level to be included in the national GHG accounting; municipalities are not prepare to operate infrastructure in accordance with national laws and regulations; among others.	1.0
3	Is the LCM suited to the existing political landscape?	YES, PARTIALLY: the LCM is adequate to the existing political landscape, but several changes will be required to ensure its success. The main political barriers are related to the lack of political will to introduce regulation and tipping fees for the waste generation and disposal. Social perceptions of waste management facilities are also a sensitive issue for the community[164].	0.5
		FINAL SCORE	**2.5**

Final Score: 2.5 out of 5. Source: Own elaboration

3.2.11.7 Financial Feasibility

3.2.11.7.1 Assumptions:

- **Discount rate:** a prime lending rate of 10.25% and 1.5% spread has been applied to select the discount rate needed for the calculation of the NPV of the LCM. The discount rate has been estimated at 11.75%.
- **Capital investment**: includes three components:

Table 153: Integrated Solid Waste Management System and 3R strategies - Financial Feasibility parameters

Parameter	Amount
(1) Cost of the integrated waste management centre[165] (treatment capacity of 450 m^3 MSW per day, which means around 150 t MSW per day)	$ 900,000
(2) Purchase of equipment and vehicles fleet	$ 300,000
(3) Environmental awareness campaigns (3Rs)	$ 40,000
(4) Cost of the biomass waste gasification-pyrolysis installation (at USD 3,250,000 per MW installed)	$ 6,500,000
Overall capital investment = (1)+(2)+(3)+(4)	$ 7,740,000

Source: Own elaboration

[164] Source: Waste Management V-NAMA in Indonesia (GIZ, 2014).

[165] It should be pointed out that the landfill construction is not included here which is accounted in the Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater LCM measure in order to avoid double counting.

- **Cost of O&M**: includes the regular operation and maintenance activities and has been estimated for compost processing as being up to $8.47 per tonnes of MSW treated[166], and for biomass power plants as being up to $12.5 per MWh produced.
- **Assumed investment lifetime:** 15 years.
- **Benefits**:
  - o Compost revenues: the generation and selling of compost has been assumed at $16.17 per tonne[167].
  - o Electricity generated with FiT: for biomass waste power generation, the FiT is $82.11 per MWh fed into the PLN Suluttenggo grid[168], and distributed by PLN-P3B to Bitung SEZ consumers (industrial, commercial, residential).

3.2.11.7.2 Calculation Methodology:

The overall financial feasibility evaluation includes both a quantitative and a qualitative assessment.

The financial parameters taken into account for the quantitative assessment include the NPV, CBA ratio, the investment cost and the O&M. The calculations are based on the standard economic methodologies for these indicators.

For the qualitative assessment, financial evaluation questions have been applied (see 2.1.6 for the qualitative methodology explanation).

3.2.11.7.3 Result & Scoring:

The quantitative assessment shows that both the NPV as well as the CBA ratio have a positive value for this LCM, indicating a financially feasible investment. The main investment parameters are shown in the table below:

Table 154: Integrated Solid Waste Management System and 3R strategies - Financial Feasibility results

Parameter for a 15 year investment lifetime	
Costs	
(1)) Integrated waste – composting process capital investment	$900,000
(2)) Integrated waste – composting process O&M	$5,790,225
(3) Environmental awareness campaigns (3Rs)	$40'000.00
(4) Biomass gasification power plant capital investment	$6,500'000.00
(5) Biomass gasification power plant O&M	$2,792,250
Overall Net Cost discounted	$11,540,199
Benefits	
(1) Compost revenues	$380,791
(2) Electricity sales revenues	$26,072,793
Overall Net Benefit discounted	$11,998,208
NPV	$458,109
IRR	13%
CBA ratio	1.04

Source: Own elaboration

For the final score, the CBA ratio from this LCM has been compared to the individual CBAs of the other 9 selected LCMs. As is shown in the final evaluation summary table (section 2.3), the LCM “Utilisation of Geothermal Energy” represents the LCM with the highest CBA ratio (1.8 tCO_2e), and has consequently been given the maximum score of 5. The Urban Forestry & Urban Greening LCM represents the CBA ratio (0.00), consequently being given the minimum score of 1.

In order to assign a relative score between 1 and 5 to this LCM, a "rule of 3" has been applied, scoring it relative to the highest and lowest score.

[166] Source: Aleksandar Dedinec et al., *Economic and environmental evaluation of climate change mitigation measures in the waste sector of developing countries*, 2014.
[167] Idem above.
[168] Source: MEMR Regulation No.4 (2012).

$$\text{Final Score Calculation} = 1 + \left[\left(\frac{4}{(1.8 - 0.00\,)}\right) * (1.04\ - 0.00)\right]$$

Final Score - Quantitative assessment: 3.3 out of 5

The qualitative assessment demonstrates that the implementation of an integrated waste management in SEZ Bitung is a complex undertaking with high upfront costs, very limited financial incentive systems in place and only few potential financing partners.

Table 155: Scoring Summary: Integrated Solid Waste Management System and 3R strategies - Financial Feasibility

Nº	Questions	Answers	Scoring
1	Has the LCM faced high upfront costs problems?	YES	0.0
2	Has the LCM faced lack of adequate/sufficient financial incentives?	YES, PARTIALLY	0.5
3	Has the LCM faced lack of enabling finance/guarantee mechanisms?	YES, PARTIALLY	0.5
4	Has the LCM already been successfully financed by domestic financial partners (such as domestic development banks, the government, or similar)?	YES, PARTIALLY	0.5
5	Has the LCM already been successfully financed by international financial partners or mechanisms (such as international development banks, public or private funds, donor governments, or similar)?	YES, PARTIALLY	0.5
		FINAL SCORE	**2.0**

Final Score - Qualitative assessment: 2 out of 5. Source: Own elaboration

The final score resulting from the quantitative and qualitative assessment has been weighted with an 80% quantitative and 20% qualitative ratio, as the quantitative parameters are regarded complete and accurate.

$$\text{Final Score Calculation} = (3.3 * 0.8) + (2 * 0.2)$$

Final Score: 3 out of 5

3.2.11.8 Sustainable Development Benefits

Integrated Solid Waste Management System and 3R strategy implementation will lead to positive environmental, social, and growth & development SD impacts within the SEZ Bitung.

By applying 3R strategies and by utilising organic waste for compost and manure nutrients that can be applied to urban forestry and urban greening measures, methane resulting from anaerobic digestion processes can be avoided, leading to a reduction in odour and air pollutants.

Furthermore, this LCM will reduce the common practice of open dumping of residential, commercial and industrial waste to random open and public spaces within the SEZ Bitung, resulting in a cleaner and more enjoyable environment for everyone.

The promotion of environmental campaigns will inform people about waste management 3R principles and hence increase the environmental awareness of civil society and local business, contributing to the long-term sustainable growth and development target of the SEZ Bitung.

Table 156: Scoring Summary: Integrated Solid Waste Management System and 3R strategies - SD Benefit Impacts

Impact Domain	Specific Impacts	Indicator	Impact (+/-)	Relevance (1-3)	Score (1-5)
Environment	Reduction of air pollution	Production and use of compost, Manure nutrient	+	2	4
Social	Improved Livelihood	Amount of waste reduced, recycled and reused	+	2	3
Growth & Development	Education	Knowledge about waste management and 3R principles before and after environmental promotion campaigns	+	2	3

Source: Own elaboration

The following final score has been calculated by multiplying the relevance of each individual specific impact with their respective score. The resulting sum of the total score has then been divided by the sum of the relevance, providing one final weighted score of all the above listed SD impacts.

$$\text{Final Score Calculation} = \frac{\sum 2*4+2*3+2*3}{\sum 2+2+2}$$

Final Score: 3.4 out of 5

3.2.11.9 Summary

The table below shows the summary of the MCA for the Integrated Solid Waste Management System and 3R strategies:

Table 157: Scoring Summary of Integrated Solid Waste Management System and 3R strategies

Evaluation Criteria / Mitigation Options	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Weight	15%	20%	15%	10%	10%	10%	20%	**100%**
Integrated Solid Waste Management System and 3R strategies	4.0	1.7	3.2	3.5	2.5	3.0	3.4	**3.0**

Source: Own elaboration

3.3 Summary of the LCM Impact and Cost Assessment

The table below shows the summary of the assessment of all individual LCMS through the MCA. The table is arranged descending from LCMs with the highest weighted average score at the top to the lowest score at the bottom:

Table 158: Summary of LCM Impact and Cost Assessment

	Evaluation Criteria	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Mitigation Options									
1	Utilisation of Clean Energy - Geothermal Energy	4.5	5.0	2.7	5.0	3.0	4.5	3.5	**4.0**
2	Comprehensive EE Programme for Industrial Buildings, Appliances and Processes	4.0	3.2	4.3	4.5	3.0	3.9	4.2	**3.9**
3	Comprehensive EE Programme for Residential and Commercial Buildings and Appliances	4.0	1.7	5.0	3.5	3.0	4.0	3.8	**3.5**
4	Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater	5.0	2.5	3.5	3.0	2.5	2.9	3.4	**3.3**
5	Integrated Solid Waste Management System and 3R strategies	4.0	1.7	3.2	3.5	2.5	3.0	3.4	**3.0**

	Evaluation Criteria	Alignment and Coherence with Domestic Policy Framework	GHG Emission Reduction Potential	Cost-effectiveness (economic effectiveness)	Technical Feasibility	Legal / Regulatory / Institutional / Political / Social Feasibility	Financial Feasibility	Sustainable Development Benefits	**Weighted Average Score**
Mitigation Options									
6	Bus Rapid Transit (BRT)	4.0	1.1	1.9	3.5	2.5	4.0	3.7	**2.8**
7	Use of Photo Voltaic (PV) panels on buildings	4.5	1.3	1.0	2.5	3.0	3.4	3.8	**2.7**
8	Urban Forestry and Urban Greening	4.0	1.0	1.1	4.0	2.5	1.2	3.8	**2.5**
9	Thermal energy generation from agricultural waste	4.5	1.8	3.8	0.5	0.5	2.4	3.4	**2.5**
10	Non-Motorised Transport (NMT) and Transit-Oriented-Development (TOD)	4.0	1.0	1.0	3.0	2.5	2.8	3.6	**2.5**
Weightage		15%	20%	15%	10%	10%	10%	20%	100%

Source: Own elaboration

3.4 Conclusions

This section summarizes the key findings of the detailed impact and cost assessment of all the LCMs that have been selected for final consideration and inclusion in the APEC LCMT initiative.

Through this comprehensive and detailed MCA exercise, a prioritised list of LCMs to be implemented within the SEZ Bitung during the expected development period (2017 to 2031) have been developed. The list provides a range of mitigation options – classified according to their different levels of feasibility - that could be carried out and implemented through an integrated and holistic Low Carbon Development Strategy (LCDS) for the SEZ Bitung.

According to the scores resulting from the impact and cost assessment of the selected LCMs, the sectors that should be prioritised by order of importance are the following: 1) Energy, 2) Waste, 3) Transportation, and 4) AFOLU.

Two distinct groups of LCMs can be identified.

Firstly, the top five LCMs with the highest overall rating in regard to their impact and associated costs for the SEZ LCMT development are:

1. **Utilisation of Clean Energy - Geothermal Energy;**
2. **Comprehensive EE Programme for Industrial Buildings, Appliances and Processes;**
3. **Comprehensive EE Programme for Residential and Commercial Buildings and Appliances;**
4. **Methane Capture and Anaerobic Digestion (AD) System for Solid Waste and Wastewater;**
5. **Integrated Solid Waste Management System and 3R Strategies;**

These LCMs represent the mitigation actions that should be the highest priority during development of the SEZ Bitung.

Secondly, the bottom five LCMs, with a lower yet still reasonable overall rating are:

6. **Bus Rapid Transit System (BRT);**
7. **Use of on and off solar PV panels on buildings;**
8. **Urban Forestry and Urban Greening;**
9. **Thermal energy generation from agricultural waste;**
10. **Non-Motorised Transport (NMT) and Transit-Oriented-Development (TOD);**

These LCMs complete the list of mitigation actions that should be carried out during development of the SEZ Bitung.

The assessment of the feasibility of the LCMs across each of the evaluation criterion is summarised below:

Regarding **alignment and coherence with the domestic policy framework**, all LCMs contribute positively to at least one of the following national climate and/or SD targets:

(i) reducing energy intensity by 1% per year by 2025;
(ii) achieving an energy elasticity of less than 1;
(iii) reducing GHG emissions by 26/29% (with domestic resources) up to 41% (with international support) by 2020/2030 (RAN-GRK / INDC);
(iv) reducing dependency on imported fossil fuels;
(v) improving energy access;
(vi) improving the electrification ratio to 100% by 2020; and,
(vii) increasing the share of renewable energy in total energy mix to 23% in 2025.

In terms of **GHG ER**, energy-related LCMs provide the highest mitigation potential. The highest potential resides with RE generation through geothermal energy, followed by the industrial EE programme. A methane capture and anaerobic digestion (AD) system for solid waste and wastewater, thermal energy generation from agricultural waste and the EE programme in the residential and commercial sector also provide good GHG ER potential. LCMs in the transportation and AFOLU sectors, on the other hand, have relatively lower ER potentials.

As is often the case, the LCMs with the best **cost-effectiveness (CE)**[169] by a substantial margin are the EE-related measures (industrial, residential and commercial EE programmes). A second group of LCMs with good CE ratios include the thermal energy generation from agricultural waste, integrated solid waste management and system and methane capture and AD system for solid waste and wastewater. The other LCMs assessed have medium or low CE.

The vast majority of the LCMs assessed are generally **technically feasible**. Geothermal energy in particular is a common practice in Indonesia (particularly in North Sulawesi); and multiple EE and energy conservation programmes have been developed and already contributed to significant energy savings. Other LCMs, such as urban forestry, BRT systems and integrated solid waste management, have a relatively good level of technical feasibility, although additional support and capacity building will be required. Special attention should be paid to biogas, solar PV, biomass generation and NMT/TOD, which will require skills and capabilities that are not currently available (a comprehensive, specific and determined capacity building effort will therefore be needed).

In terms of the **regulatory, institutional and political framework feasibility**, local-level support is quite limited. The main reason is that national-level institutions are usually responsible for policy and planning in key sectors such as energy, transport, waste and forestry. Although provincial and local governmental institutions are also involved, a lack of coordination hinders smooth and effective implementation of the proposed mitigation actions.

Regarding **financial feasibility**, the majority of LCMs present positive cash-flow returns and overall investment feasibility. This is particularly the case for geothermal energy utilisation and EE measures. A second group of LCMs which presents mid-level financial feasibility are: the use of PV panels, a methane capture and AD system for solid waste and wastewater and integrated solid waste management system and 3R strategies. Lastly, a third group of LCMs will need financial support and incentives systems in place at national, regional and local levels in order to be feasible. This group includes: thermal energy generation from agricultural waste; a BRT system; NMT and TOD and urban forestry and urban greening.

Last but not least, implementation of the selected LCMs will lead to a wide range of **Sustainable Development (SD) benefits** across the different domains of sustainable development: environment, social, growth & development, and economic. These SD benefits can be summarised as follows: (i) reduction in air pollution, (ii) improvement of overall livelihood conditions (iii) access to clean and sustainable energy, (iv) increase in energy security, (v) improvement of health conditions of local inhabitants/workers as a result of reduced air pollutants, (vi) increased RE share of total energy supply, (vii) reduction in energy expenditures (viii) additional income opportunities for the local community, (ix) creation of local green jobs, and (x) improved overall awareness of sustainability and GHG mitigation reduction activities.

All high potential mitigation actions for the SEZ Bitung LCMT development have now been prioritised according to their individual impact potential and related costs.

The next part will provide the implementation roadmap for successful implementation of the LCDS, including the most coherent and synergetic phasing and combination of the measures mentioned above, as well as considerations on institutional, regulatory, financial and technical aspects.

[169] The more negative the cost-effectiveness ratio is, the better the score. Negative marginal abatement costs mean in effect that implementing the measure will result in absolute savings (i.e., not costs but negative costs).

4 Implementation Roadmap

The implementation roadmap is presented as the third and last activity under this LCMT Feasibility Study for the SEZ Bitung. It builds on the results of the LCMT Low Carbon Development Strategy (LCDS) in section 2 and the detailed impact and cost analysis presented in section 3. In addition, key governmental stakeholders had the chance to comment, refine and endorse the elements of the roadmap so they could be included in this final version.

The first section of the implementation roadmap presents the approach used and shows the four main methodological steps for an implementation roadmap.

The second section entails the actual implementation strategy for the LCMT Bitung, covering in detail the following key implementation aspects:

(i) Institutional and Regulatory Framework;
(ii) Integrated MRV & M&E system;
(iii) Required enabling activities for implementation readiness;
(iv) Comprehensive overview of all 10 selected LCMs;
(v) Financial consideration including a financial architecture, financial instruments and available financing sources;

The third and last section concludes with an overview of the overall LCMT impact in regard to its contribution to achieving the national policy objectives, overall GHG ER and SD impacts. In addition, the overview provides an estimation of the investment needed to implement the LCDS and its related LCMs that aims at making the SEZ Bitung an example of how a well-designed LCMT initiative can contribute to the global efforts towards a clean, sustainable and low carbon future.

4.1 Approach and Methodology

This section presents the approach and methodology for the SEZ Bitung's implementation roadmap, which is built along the following four main steps:

1. Identifying individual implementation activities and establishing specific activity profiles for each selected LCM under consideration of the official SEZ Bitung development plan
2. Defining the potential institutional and regulatory framework for each LCM in consideration of the local and LCM context
3. Defining the overall Financial Architecture including potential financing sources and instruments
4. Determining the investment requirements for each LCM and for the overall LCMT implementation

This implementation roadmap follows the SEZ Bitung development plan issued by the Ministry of Industry (MoI, 2008[170]), but has been adapted to respond to the comments and suggestions received during several stakeholder consultations at the national, provincial and city level. Please see SEZ Masterplan 2008 for the detailed description of all SEZ development phases.

4.2 Implementation Roadmap

The following section details the implementation roadmap for the LCDS of the SEZ Bitung considering the elements described above.

4.2.1 Institutional and Regulatory Framework

The successful implementation of the proposed LCDS for the SEZ Bitung will require the coordination and cooperation of different institutions and actors, each of which with specific tasks and responsibilities. The relevant institutions and their respective roles for each of the selected LCMs are

[170] The SEZ Masterplan 2008 is currently under revision, however no updated version was available during the time of writing this report.

included in the LCM Overview. The following two institutions will be essential to ensuring the successful implementation of the LCDS and will be involved in all of the proposed LCMs:

SEZ Management Council (SMC): The SMC has oversight of the SEZ Bitung's overall development. The SMC is currently headed by the Governor of North Sulawesi and managed by a high level administrator (currently the head of the provincial government office for industry). It is suggested that the SMC's authority be expanded to include oversight of implementation of the LCDS, given the envisioned scope of the strategy and the fact that the LCDS will need to build and be mainstreamed into the SEZ Masterplan. SMC's current structure would need to be adapted so that it could effectively carry out its new envisioned role. Preliminary guidance on the tasks and responsibilities of the SMC has been provided but will need to be refined as part of the enabling and readiness activities (see in the following section). The following guidelines are based on the implementation of similar urban low carbon initiatives and international best practices around the World. These guidelines include the following tasks and responsibilities for the SMC:

- Monitoring of overall LCDS and specific LCMs implementation progress as carried out by the SEZ Management Agency (SMA) (see description of SMA below);
- Definition of LCDS and LCM requirements, responsibilities and duties for SMA through the definition of detailed Terms of References (TORs) for the SMA tendering process;
- Definition of the organisational set up of the SMA, including specific profiles for the SMA staff positions (Director, Sectoral Managers, Financial Manager, Admin Staff etc.);
- Development of monitoring guidelines and reporting procedures for the LCDS of the SEZ Bitung;
- Development of the SEZ's M&E guidelines and reporting procedures for overall LCMT implementation results (GHG ER, SD, Implementation Progress, Continuous Improvement Processes – CIP); and
- Development of sectoral low carbon regulations for the SEZ Bitung.

SEZ Management Agency (SMA): The SMA will be the on-the-ground coordinator and main implementation manager of the SEZ Bitung. The SMA is still being selected and is expected to begin operations in 2017. It will be crucial to mainstream the LCDS's implementation strategy into the SEZ Masterplan, so the SMA will have to be the one-stop service provider and the main counterpart for both the facilities and actors within the SEZ, as well as for the SMC. The following initial set of suggested tasks for the SMA has been developed, based on the implementation of similar urban low carbon initiatives and international best practices around the World:

- Assignment of sectoral managers for each of the sectors identified under this study: energy, transport, waste and AFOLU, sufficiently capable and formed in sectoral low carbon strategies and LCMs;
- Monitoring of GHG ER, SD, Implementation Progress, and CIP of the respective sectoral LCM and reporting results to SMC by each of the sectoral managers;
- Reporting GHG ER and sectoral indicators to the respective provincial government office (BLH, Dinas Energy, Dinas Transport, Dinas PU etc.) by each of the sectoral managers;
- Reporting overall LCDS implementation results to SMC by the SMA Director;
- Smooth, transparent and integer operation of the SMA, overseen by the SMA Director (who will be held accountable by the SMC);
- Enforcement by the SMA of the low carbon regulation developed by the SMC for the SEZ Bitung, with compliance also being reported to SMC.

The final process of aligning and setting up both the SMC and SMA should be led by the provincial and city government in order to build on the existing monitoring and reporting structures and to avoid the establishment of inefficient and overlapping bodies. The inclusion of key stakeholders including those from the private sector, academia, Civil Society Organisations (CSO) and local communities are of key importance to ensuring local ownership, hear the voice of the local communities and achieving the sustainable long term vision of the SEZ Bitung. One potential concept for the SEZ Bitung set-up to ensure stakeholder involvement would be the establishment of a committee in which all stakeholders are given the chance to contribute to decision making processes.

4.2.2 Integrated MRV + M&E system

The integrated MRV + M&E system for the LCDS will measure, report and verify (MRV): (i) the GHG emission reduction impact; (ii) the SD impacts (environmental, economic and social); and (iii) the efficiency of the investment/support (MRV of finance). The LCDS will also have to incorporate an M&E system to track and evaluate: (i) the effectiveness of implementation and the impact of the proposed mitigation actions and enabling activities; and (ii) the CIP indicators; to be in line with the most advanced international best practices.

Setting up a credible, accurate and comprehensive MRV + M&E system is one of the key design elements for achieving an effective LCDS and implementation roadmap. The MRV + M&E system is critical for the following reasons:

- It enables the effectiveness of the LCDS as a whole and of every specific LCM to be tracked, which in turn allows for the fine-tuning their design by addressing gaps at implementation stage.
- It provides a third party, reliable, transparent and independent means of verification of impacts (GHG emissions reduction and SD benefits) that can be trusted by partners and donors.
- It ensures alignment of the LCDS and its individual LCM with the country GHG emissions reduction, SD and policy targets, and allows for an estimation of how much it is contributing to them.

The objective of the MRV + M&E system is to define a set of targets, key performance indicators (KPIs), and describe the related MRV plus M&E procedures for tracking the progress against them. KPIs will have to follow the SMART principles as much as is possible and be[171]:

- **S**pecific – define clearly what to measure,
- **M**easurable – measure the actual value and compare it to the set targets,
- **A**chievable – motivate to reach the targets that are possible to reach,
- **R**elevant – contribute to the assessment of the overall performance,
- **T**ime phased – linked to a certain time period.

MRV + M&E of low carbon development, whether funded domestically or internationally supported, are part of international requirements, and in Indonesia will have to be integrated into the legal reporting requirements not only in terms of GHG ER (as required by RAN-GDK and RAD-GDK reporting regulations), but also of other aspects such as: air pollution, energy consumption, Sustainable Development Goals (SDGs) and other indicators that are an integral part of the country's legal framework. However, the system requirements and the level of detail and stringency of the system might vary depending on the main source of funding.

4.2.2.1 Elements under the MRV + M&E system

A starting point for setting up a comprehensive MRV + M&E framework is to figure out what is to be (i) measured, reported and verified and (ii) monitored and evaluated. Most low carbon design concepts to date have a "narrow" understanding of the MRV system. They include only MRV of GHG ER complimented with (often, but not always) MRV of the SD impacts of mitigation actions and MRV of finance (tracking of financial support flows). An example is the GIZ MRV Tool[172].

LCDS developers should evolve beyond basic MRV requirements and set up a more comprehensive and integrated MRV + M&E system. In fact, a LCDS, as any serious and credible development strategy, will also require an M&E framework that can track its implementation progress and its continuous improvement.

[171] http://www.lltcorp.com/content/kpi-s-m-r-t-rule
[172] GIZ, (2013), MRV Tool: How to Set Up National MRV Systems, Draft 4.1. Retrieved from the website of International Partnership for Mitigation Momentum: http://mitigationpartnership.net/sites/default/files/u1585/mrv-tool-20-10-2014.pdf

The proposed MRV + M&E system, which is detailed for each LCM measure in the following pages, will allow the SEZ Management Agency to track the following 5 key aspects:

1. MRV of GHG emissions and emission reductions (MRV of GHG ER);
2. MRV of sustainable development benefits (MRV of SD benefits);
3. MRV of support (M&E of finance);
4. M&E of LCM implementation progress;
5. M&E of continuous improvement processes (CIP);

4.2.2.2 MRV of GHG emission reductions

There exists a wealth of information, guidelines and methodologies on MRV of GHG emissions and their reductions for various sectors, for example the guidelines of the Intergovernmental Panel on Climate Change (IPCC)[173], CDM methodologies, the GHG protocol, and voluntary carbon methodologies[174]. Even though in the context of this LCMT Project, the GHG ER MRV may have a higher degree of flexibility than for the usual CDM-like MRV, and some specific provisions regarding reporting to the UNFCCC or third-party independent verification will have to be defined specifically under this context, it is relatively clear what this would involve.

On the other side, however, not much has been said about a concrete way of assessing other impacts beyond carbon reduction, which in turn results in negligence of these impacts during the LCDS design, or weaker indicators and MRV system provisions. The sections below will therefore focus and provide more details on how an integrated MRV + M&E system should track the non-GHG related components of the implementation.

4.2.2.3 MRV of sustainable development benefits

Measurement and reporting of SD benefits is essential for assessment of the LCDS's SD impact. Moreover, SD benefits can be a decisive factor for international donors and domestic policy makers in prioritising decisions for financing and implementation.

A few methodologies to track the SD benefits of mitigation actions exist, for example the Gold Standard SD Matrix[175] or CDM SD Tool[176]. However, they have certain limitations when applied to an LCMT model. The most comprehensive methodology, recently developed by the South Pole Group for UNDP and targeted specifically at NAMAs (but easily applicable to any Low Carbon Development), is the NAMA Sustainable Development Tool (NAMA SD Tool[177]). It has been designed to assist NAMA developers and policy makers evaluate the SD performance indicators and SD results achieved over the lifetime of a NAMA. The NAMA SD Tool can also help demonstrate to external parties a level of commitment and impacts of the NAMA in relation to SD benefits, and give donor institutions confidence that their support is being utilised effectively.

The analysis and the proposed MRV of SD impacts of the NAMA SD Tool have been adapted to the requirements of this LCDS, and a specific set of SD indicators have been selected for each of the prioritised LCMs. The indicators in the tool are directly linked to the UN's SDGs and are grouped under four domains: 1) environmental conservation, 2) economic opportunities, 3) growth and development and 4) social welfare. The SD benefits are identified and broken down across the specific impacts for each of the domains. Then, for each impact, the relevant parameter or measuring indicator is defined, as well as its relative importance, to evaluate the SD benefits of each intervention for a specific monitoring period. This allows for the establishment of a baseline, a BAU scenario, and a "high impact"

[173] Available at: http://www.ipcc-nggip.iges.or.jp/public/index.html
[174] South Pole Group is the world's leading carbon project developer, having achieved over 30 million of CO_{2eq} emission reductions under a variety of standards, which in turn makes it one of the most advanced companies in relation to MRV services and technologies related to GHG ER.
[175] Gold Standard, (2011), Guidance on Sustainability Assessment. Retrieved from: thttp://www.goldstandard.org/wp-content/uploads/2011/10/Annex_I.pdf
[176] CDM Sustainable Development Tool: http://cdmcobenefits.unfccc.int/Pages/SD-Tool.aspx
[177] South Pole, UNDP, (2014), Sustainable Development Tool. Retrieved from: http://www.undp.org/content/undp/en/home/librarypage/environment-energy/mdg-carbon/NAMA-sustainable-development-evaluation-tool.html

scenario for each indicator. Target values can be set for each impact in relation to specific LCM activities to be able to monitor, report and verify the achieved results and how they compare to the targets.

Using the SD Tool, LCM developers will be able to select the indicators that are most relevant to their domestic policy objectives, to the type and nature of the desired mitigation actions, and to various factors affecting the practicality and feasibility of MRV activities.

The tool is universal and standardised yet flexible enough to ensure compatibility and adaptability across a variety of possible design models and national development goals. Its effectiveness has already been proven in a number of LCDS and NAMA design projects, including NAMA for Rural Electrification with Renewable Energy in Gambia[178], Energy Efficiency NAMA in the Garment Industry in Cambodia[179] and NAMA for Rural Development in Namibia[180]. Figure 53 shows how SD impacts of mitigation actions and their MRV are reflected in the tool.

Serial number	3	
Indicator Name	Biodiversity & Food Security	
Domain	Environment & Social	
Parameter Name	Types of crops	
Baseline Value	0	
Way of monitoring	How	HH survey / National census
	Frequency	3 years
	By whom	Intervention Implementer
Project Value	2	
QA/QC procedures		
	QC check done	Nama Implementer

Serial number	4	
Indicator Name	Biodiversity	
Domain	Environment	
Parameter Name	Number of threatened Species/Habitat	
Baseline Value	80	
Way of monitoring	How	Forest Maps/GIS Images
	Frequency	3 years
	By whom	Intervention Implementer
Project Value	50	
QA/QC procedures		
	QC check done	Nama Implementer

Serial number	5	
Indicator Name	Health	
Domain	Social	
Parameter Name	Avoided gas explosions or fire burns	
Baseline Value	1000	
Way of monitoring	How	
	Frequency	HH survey / National census
	By whom	Intervention Implementer
Project Value	500	
QA/QC procedures		
	QC check done	Nama Implementer

Figure 53: A snapshot of suggested MRV for selected SD impacts in NAMA SD Tool

Source: South Pole Group for UNDP, 2015; example of Renewable Energy NAMA in Gambia

One should keep in mind, however, that the MRV of non-GHG related impacts could impose further burdens and extra costs on those involved in the LCDS design and operation. In Viet Nam, for example, stakeholder consultations for developing the cement sector NAMA showed that the cement plants and key line ministries don’t have enough motivation and capacity for monitoring and reporting additional, non-GHG related data. They consider adding non-GHG impacts in general and especially SD benefits to sector-level and entity-level MRV a burden that should be avoided or at least minimised.

[178] UNDP, South Pole Group, (2015), NAMA Design Document for Rural electrification with Renewable Energy in the Gambia. Retrieved from: http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/MDG%20Carbon%20Facility/The%20Gambia%20NAMA%20final%202.pdf

[179] UNDP, (2015), Energy Efficiency NAMA in the Garment Industry in Cambodia. Retrieved from: http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/MDG%20Carbon%20Facility/Cambodia%20NAMA%20final.pdf

[180] UNDP, (2015), NAMA Rural development in Namibia through electrification with Renewable energies. Retrieved from: http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/MDG%20Carbon%20Facility/NAMIBIA_final%20NAMA.pdf

This barrier should be taken into consideration when designing an MRV + M&E system for the LCDS of the SEZ Bitung. Special awareness raising activities for key stakeholders to explain the importance of including SD benefits in the design and capacity development measures for their MRV should be taken.

Eventually, policymakers will have to provide various incentives to implement mitigation options in a way that harnesses SD benefits and provides incentives to report data not only on GHG ER, but on SD impacts as well.

4.2.2.4 MRV of support (M&E of finance)

MRV of support is related to measuring, reporting and verifying flows and effectiveness of provided financial resources, technology transfer and capacity development activities. MRV of support is necessary to:

- keep track of financial contributions, their delivery and spending;
- build trust among financial supporters, including the private sector, through improved transparency and accountability of financial flows;
- provide a clearer overview of support flows, trends, sources, and purposes.

There are no international requirements for MRV of support yet. Indicators are usually determined by the type and nature of support and the donor's requirements, either domestic or international. Based on previous experience, MRV of support should include information on:

- forms of support (finance, capacity development, technical assistance, technology transfer);
- purpose of support (general LCDS, specific LCMs, or enabling activities);
- scale of contributions, their sources and instruments;
- disbursement of support, scale, channels and instruments;
- effectiveness (cost-benefit impacts in relation to GHG mitigation and SD benefits and leverage effect for catalysing domestic private finance).

The approach is to use a set of KPIs developed around result-based finance consideration.

Verification of support effectiveness should involve comparing MRV data from contributors and recipients of support.

4.2.2.5 M&E of implementation progress

To measure the progress of LCDS and specific LCM implementation, a set of KPI tracking measures related to (i) policy-level objectives, (ii) the level of uptake / implementation status of specific LCMs and readiness activities and (iii) the setting up of the Implementation Framework, have to be developed.

Tracking overall implementation objectives

KPIs should relate to the high-level objectives of the LCDS and the policy objectives of each LCM, which are usually linked to the existing policy targets. Examples of such KPIs are: capacity of newly renewable energy, MW (for a renewable energy LCM); share of alternative fuels in the total energy mix, % (for an industrial sector LCM); total forest cover, % (for a forestry LCM), etc.

Tracking individual LCMs and enabling activities

The implemented LCMs must be assessed against what has been planned. The KPIs will help to measure more precisely how the set targets linked to LCMs are achieved. Indicators can be quantitative or qualitative (but ideally should follow the SMART rule). For example, if the LCM is about creating solar plants and bridging capacity, KPIs will be linked to "x plants built and operational" and "y workshops carried out" or "average score after the workshop completion on the technical test is z% higher than before taking it".

Tracking establishment of Institutional Framework

The progress in setting up a supporting Institutional Framework should also be measured. For example, the establishment of the SMA can be assessed through such indicators as staffing and funding of the SMA, or through a capacity/skills assessment of the SMA staff. To show the degree of advancement in setting up the MRV + M&E system, LCDS/SEZ Bitung developers can use the parameters evaluating a number of monitoring processes, templates for the reporting system, verification process, operation of knowledge management / IT system, etc. To show the level of uptake of a given incentive, or the level of replication or scale-up of the mitigation actions, data retrieving measures and standardised management procedures will be needed.

4.2.2.6 M&E of continuous improvement processes (CIP)

The MRV + M&E system can also serve the purpose of tracking whether or not implementation is continuously improving. In order to do this, KPIs should be in place that can track the implementation of a LCM to measure whether it is becoming progressively more effective. This means that, over time, the LCM will have to create more impact in terms of GHG ERs and SD benefits for the same amount of finance provided, or in less time. This is part of the CIP methodology and management system.

It is worth mentioning that beyond improving the efficiency, speed or volume of the implementation, the MRV + M&E system itself can also be continuously improved throughout implementation as per the following examples (GIZ, 2013):

Measurement / Monitoring:

- Increasing efficiency of data collection and processing;
- Measuring new data previously not available;
- Improving methodologies for measurement;
- Revising baseline assumptions.

Reporting:

- Improving efficiency through developing standardised tools and guidelines.

Verification

- Developing an improvement plan based on the feedback from participants and third party reviewers;

Developing QA/QC procedures to improve cost and time efficiency of verification.

4.2.3 Enabling Activities for LCMT Implementation

The challenges identified in section 2.4 of this report highlighted a lack of technical, institutional and financial readiness to develop and implement the LCMT in the SEZ Bitung. Creating a favourable environment for the implementation of the low carbon strategy is therefore recommended as a priority step towards successful implementation.

Activities:

The following enabling activities should be carried out before implementation of the SEZ starts in 2017. This step will involve numerous and diverse preparation activities that include:

1. Streamlining the LCDS and Implementation Roadmap into the SEZ's Masterplan.
2. Starting a National, Provincial and City-level dialogue on LCDS and the proposed LCMs with relevant stakeholders identified in this report (see Institutional Landscape).
3. Carrying out the necessary readiness activities to adapt the current Institutional Framework to include the needs of the LCDS.
    - Establish a LCDS focal point, i.e. a reporting officer, for each relevant institution including Ministries / Government Offices / Statutory bodies / Academia / CSOs, etc. to serve as an expert and focal contact point on all LCDS related issues.
    - Design and conduct a detailed tender process for the SEZ Management Agency (SMA) to ensure that the institutional set up and roles and responsibilities are considering LCDS needs.
    - Identify and conduct potential institutional amendments for the SEZ Management Council to cater to the LCDS implementation requirements.
4. Carrying out necessary specific policy recommendations for each LCM (see Annex I: LCDS - Policy Recommendations).

5. Conducting a comprehensive Capacity Needs Assessment (CNA) in order to further understand and detail capacity gaps identified in section 2.4 and mobilise / commit funds to address them.
6. Developing and establishing the MRV + M&E system.
7. Carrying out a comprehensive LCDS Capacity Building Programme that covers the following:
    a. Technical Capacity Building, including MRV
    b. Institutional Capacity Building
    c. Regulatory Capacity Building
    d. Financial Capacity Building
8. Carrying out a comprehensive financial support programme that includes: advisory and TA on the establishment of the LCMT Financial Architecture; proposal preparation advisory and training (for preparing SMA and SMC in preparing and securing funding requests); and support SMC in securing the required incremental cost for individual LCM implementation.
9. Facilitating public-private partnerships (PPP) for low carbon development in the SEZ Bitung.
10. Establishing a Project Management Unit (PMU), ideally within the SMA, to act as the TA focal point and project coordinator.

Expected Results:

1. Masterplan is revised to include considerations of LCDS, and the LCMs and associated budget;
2. National, regional and local workshops on LCDS and LCM implementation are held;
3. Reformed, re-configured and/or new institutions are established;
4. TORs for Tendering of the SMA includes LCDS considerations;
5. CNA report is completed;
6. MRV + M&E system is in place;
7. Training workshops on MRV and general topics related to LCDS are held and capacity is enhanced;
8. LCMT Financial Architecture in is place, proposal preparation training is carried out, and the required incremental cost for individual LCMs is secured;
9. PPPs are in place;
10. PMU is established.

Responsible entity:

It is recommended that the SMC remains responsible and oversees the implementation of these activities and results, with a progressive shift of responsibilities towards the SMA, and that key national, provincial and municipal officers are closely involved in developing the above-listed activities.

Executing entity:

The SMC for the SEZ-Bitung, or the Government of North Sulawesi, should execute these activities with the support of the corresponding key government agencies and the City of Bitung.

External Technical Assistance (TA) should be sought to conduct the activities listed above. Where national/local legal authority is required, e.g. legalisation of policies or recommendations for institutional set up, close communications between the respective authority and the provider of TA should be established. Required experience and characteristics of the entity providing the TA are:

- Experience in climate change mitigation projects, climate finance and MRV;
- Experience in organising matchmaking events;
- Experience in Low Carbon Policy Development, ideally in the Indonesian context;
- Experience in developing urban low carbon development strategies, ideally in the Indonesian context;
- Very good understanding of the Indonesian context with regard to the low carbon policy framework, governmental Institutional Framework, and financial and budgetary processes;

- Strong professional network and experience in low carbon strategy development in Indonesia, specifically in North Sulawesi and Bitung City;
- Experience in institutional development for the implementation of mitigation and low carbon strategies, ideally in the Indonesian context;
- Experience in comprehensive capacity needs assessment, ideally in the Indonesian context;
- Experience in designing and setting up MRV + M&E systems, ideally in the Indonesian context;
- Experience in conducting capacity building programmes (technical, institutional, regulatory, financial), ideally in the Indonesian context; and
- Experience in developing comprehensive financial support programmes and financial architectures, ideally in the Indonesian context.

Start: ASAP

Duration: 18-24 months

Estimated costs:

The estimated costs for these activities are presented below[181]:

Table 159: Cost Overview of LCMT Enabling Activities

#	Activity	Budget	Timeline
EA1	Streamline LCDS into SEZ Masterplan	70,000 USD	S1 2016
EA2	National & Sub-national Dialogue	230,000 USD	S1 2016
EA3	Institutional Improvements	150,000 USD	S1 2016
EA4	Policy Recommendations	70,000 USD	S1 2016
EA5	Capacity Needs Assessment (CNA)	130,000 USD	S2 2016
EA6	MRV and M&E system set-up	350,000 USD	2016-2017
EA7	Capacity Building Programme[182]: I.5 Technical (including MRV[183]) I.6 Institutional I.7 Regulatory I.8 Financial	350,000 USD 125,000 USD 50,000 USD 50,000 USD 125,000 USD	2016-2017
EA8	Financial Support Programme	150,000 USD	2016-2017
EA9	PPP Support Programme	250,000 USD	
EA10	Project Management Unit (PMU)	750,000 USD	2016-2017
TOTAL		**2,500,000 USD**	

Source: Own elaboration

Possible finance source:

The financial resources should be partly financed through national budgetary resources (i.e. domestic public finance sources) as a means of in-kind contributions from government agency officers (i.e. time spent working on this activity). However, international financial institutions (IFIs) could co-finance some of the above, in particular to recruit international experts to carry out the envisaged TA activities. In the case that this activity could not be included in the budget of the next financial year (2016-2017), it should be tabled as a supplementary budget. The section on Financial Considerations (section 4.2.5) elaborates further on elements of the financial architecture, the most appropriate financial mechanisms and on potential financial sources for the implementation of the LCMT.

[181] These values include in-kind contributions from the Indonesian government and TA from the international donor community.
[182] This estimate considers that this activity will build on the outcomes from the national MRV strategy and work conducted to date in regards to MRV.
[183] This item could also include a "train the trainer" activity, which would increase its cost to the maximum range, but would ensure that this step could be done through domestic public sources.

4.2.4 LCM Overview

This section provides a comprehensive overview of all 10 selected and analysed LCMs. The overview covers the following aspects for each LCM:

- **Description:** Summarises the LCM rationale and individual LCM activities.
- **Objective:** Illustrates how each LCM will contribute to specific policy objectives at the national, provincial, city and SEZ Bitung level.
- **Impacts:** Provides an overview of LCM impacts with regards to GHG ER and SD benefits.
- **MRV & M&E System:** Recommends a comprehensive MRV & M&E system including SMART KPIs, BAU baselines and impact targets for GHG ER, SD, Progress of Implementation and CIP.
- **Institutional and Regulatory Framework:** Provides an overview of institutions involved in LCM implementation and MRV + M&E processes, including recommended roles and responsibilities.
- **Financial Feasibility:** Summarises the financial feasibility of the LCM including required capital investment, net costs, net benefits and cost-benefit ratio.

Table 160: LCM 1 – Utilization of Clean Energy

LCM OVERVIEW

LCM Title: Utilisation of Clean Energy (example with Geothermal Energy)

Sector	Subsector	Activity
Energy	Energy Generation	Utilisation of Clean Energy (example: utilisation of Geothermal Energy from a Geothermal Power Plant)

Description: This LCM aims to develop a clean source of energy (in this case, a geothermal power plant, GPP) to supply clean and renewable energy to residential, commercial and industrial facilities within the SEZ Bitung and Bitung City. It is assumed that the GPP will be installed outside the boundaries of the SEZ Bitung, in the "Dua Saudara" mountain (approximately 10 km from Bitung city and the SEZ) and will have an overall power capacity of approximately 120 MW. The GPP will progressively (i) contribute to a higher RE share in the PLN high-voltage power grid from North and Central Sulawesi (PLN Suluttenggo); and (ii) replace the use of diesel generators to support electricity grid supply. The GPP is expected to start operation in 2025, and represents the ideal primary clean energy source for the sustainable long-term vision of SEZ Bitung and Bitung City.

Note: The development and construction of the GPP itself is outside the scope of the SEZ Bitung since its impact and investment requirements are beyond the SEZ development scenario. Nevertheless, this option has been included into the assessment of high potential LCMs as the development of a GPP has been clearly stated as long-term vision for the region. Also, the impact and potential contribution to the future low carbon development path of SEZ Bitung is considered significant and the results of a detailed quantitative analysis presents a strong argument for the local and national authorities to further support the GPP development.

LCM OBJECTIVES

The main objective of this LCM is to contribute to national efforts to shift the primary energy mix from fossil-fuel based sources towards clean renewable energy (RE) sources. Geothermal energy development is part of Indonesia's future energy strategy, rooted in the National Energy Strategy (KEN).
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the National Energy Strategy (KEN)'s objective to increase the share of RE in the national energy mix. • Contribute to the LCDS of the SEZ Bitung and in turn to RAD-GRK.

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: The utilisation of geothermal energy is expected to result in high CO_2 emission reductions during phase IV and phase V of the SEZ Bitung's five development phases.

GHG ER Impact (tCO_2, cumulative)	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario – Energy Sector	1,631,547	2,573,580
Emissions reduction estimate	146,716	256,753
Emission Reduction estimate (in percentage of BAU)	9%	10%

Sustainable development benefits: The replacement of fossil-fuel based electricity generation with electricity from a GPP is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Environment	Reduction in air pollution	Avoids the release of air polluting gases resulting from the combustion of coal and diesel (PM10, PM2,5, CO_2 and NO_x)
Growth & Development	Access to clean and sustainable energy	Increases the share of people with access to clean and sustainable energy
	Energy security	Reduces the need for national oil imports
Economic	Job creation	Creates long-term job opportunities at the geothermal power plant

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Generation of electricity at the GPP	Replaces fossil-fuel based electricity from PLN power grid	**M:** based on metering of GPP monitoring system **R:** the amount of electricity (in terms of MWh) produced by individual GPP units **V:** based on the verification of metering systems
Emission Factor	GHG intensity of current power generation mix in the grid	The grid emission factor of PLN's high-voltage power grid from North and Central Sulawesi Grid (PLN Suluttenggo) is 0.746 tCO_2e per MWh.

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Environment	Reduction in air Pollution	Avoided air polluting gases (PM10 and PM2.5, NOx)	See BAU values in Table 63	See target values in Table 63
Growth & Development	Access to clean and sustainable energy	Share of people with access to sustainable electricity	See BAU values in Table 63	See target values in Table 63
	Energy Security	Amount of imported oil for power generation avoided	See BAU values in Table 63	See target values in Table 63
Economic	Job creation	Number of jobs created	See BAU values in Table 63	See target values in Table 63

M&E of implementation progress & continuous improvement:

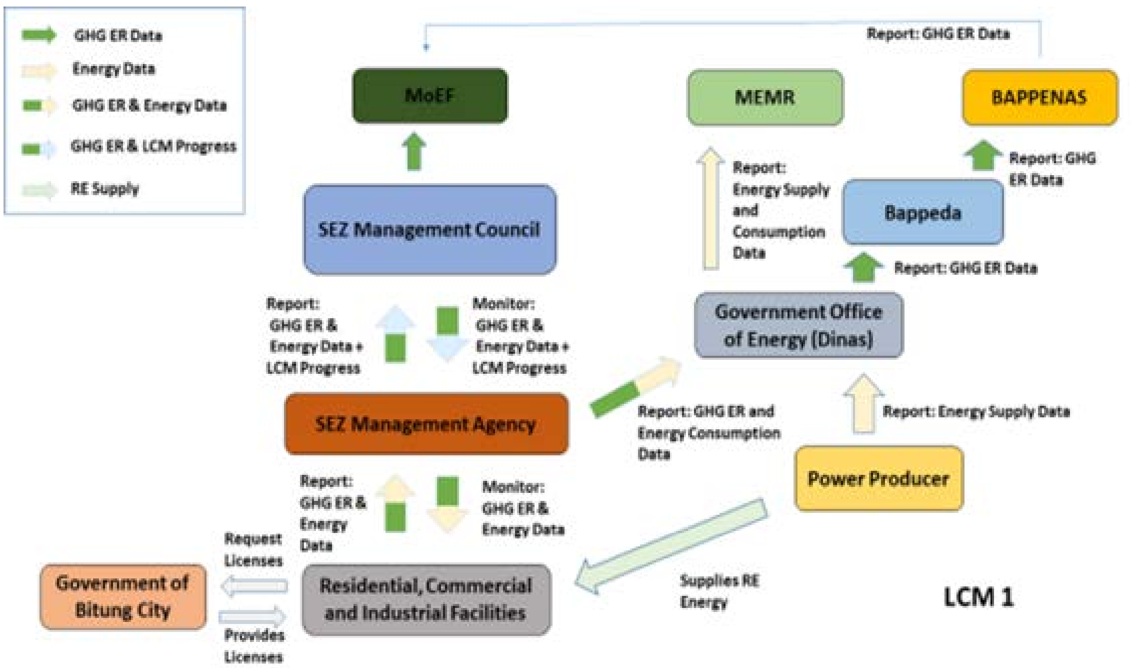
Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM to achieve the defined policy objectives	Share of RE in electricity mix	10% in 2014	25% until 2025
		GHG ER achieved (RAD-GRK)	tbd[184]	tbd
Progress of implementation	Measures the progress of the GPP in generating electricity from geothermal energy and then selling it to grid	Amount of electricity generated by GPP and fed into the PLN Suluttenggo grid (MWh)	0	893,520 MWh/year[185]
		Number of individual GPP power generation units developed	0	6
Continuous improvement	Measures whether and how the GPP developer is improving processes and overall implementation quality	Time required to construct GPP power generation units	5	3

[184] RAD-GRK numerical targets are still being developed.
[185] Electricity generation is expected to begin in the year 2025.

INSTITUTIONAL AND REGULATORY FRAMEWORK

The recommended institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
SEZ Industrial, Commercial and Residential Facilities	• Uses RE from Geothermal Power Plant (GPP) • Report GHG ER and energy consumption data to SEZ Management Agency (SMA) • Request operating licenses from Bitung City Government
Power Producer	• Responsible for power generation and distribution to PLN power grid • Reports energy supply data to the Provincial Government Office of Energy (Dinas Energy)
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and energy consumption data to Dinas Energy • Enforces low carbon regulations for the SEZ and reports compliance of facilities to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Bitung City Government	• Provides operating licenses to facilities of the SEZ Bitung
Government Office of Energy, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda and energy data (consumption and supply) to MEMR
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

The development of the GPP is expected to start in 2017 with an assumed project lifetime of 30 years. The total costs and benefits during project lifetime are summarized as follows:

	Total
Capital Investment	~ $600,000,000
O&M	~ $640,000,000
Net Costs	~ $472,600,000
Net Benefits	~ $850,950,000
Cost-Benefit Ratio	1.8

Abovementioned capital investment costs include the purchase of GPP units and the cost of installation.

The benefits include the sale of produced electricity to PLN with the national FiT of 226 USD / MWh.

Note: The actual development of the GPP is outside the scope of the SEZ Bitung development and will depend on whether and when a GPP project developer can be found. Therefore, the scope, related cost requirements and potential benefits of the GPP development can only be assumed at the time of this LCMT feasibility study.

Source: Own elaboration

Table 161: LCM 2 - Use of Photo Voltaic (PV) panels on buildings

LCM OVERVIEW

LCM Title: Use of Photo Voltaic (PV) panels on buildings

Sector	Subsector	Activity
Energy	Energy Generation	Use of Photo Voltaic (PV) panels on buildings

Description: This LCM will generate clean and renewable energy through the installation and appliance of PV panels on residential, commercial and industrial building rooftops within the SEZ. Residential, commercial and industrial buildings can either directly utilize generated electricity (i.e. self-consumption); or rent available roof space to independent power producers (IPPs), which will in turn develop PV systems and sell generated energy to the PLN electricity grid under the current Feed-in-Tariff (FiT) scheme. By replacing fossil-fuel based energy with a clean RE source, GHG emissions from energy generation can be avoided while achieving additional national and local sustainable development benefits.

LCM OBJECTIVES

The main objective of this LCM is to contribute to national efforts to shift the primary energy mix from fossil-fuel based sources towards more RE sources. Solar energy development is part of Indonesia's future energy strategy, rooted in the National Energy Strategy (KEN).
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the National Energy Strategy (KEN)'s objective of increasing the share of RE in the national energy mix. • Contribute to the LCDS of the SEZ Bitung and in turn to RAD-GRK.

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: The use of PV panels on rooftops is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung. This will lead to a deviation from the emission baseline (BAU Scenario), hence contributing to the low carbon development path of the SEZ Bitung.

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario – Energy Sector	145,563	331,962	575,656	1,631,547	2,573,580
Emissions reduction estimate	976	2,225	3,858	10,935	17,249
Emission Reduction estimate (in percentage of BAU)	0.7%	0.7%	0.7%	0.7%	0.7%

Sustainable development benefits: The replacement of fossil-fuel based with solar power based energy generation is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Environment	Reduction in air pollution	Avoids the release of air polluting gases resulting from the combustion of coal and diesel (PM10, PM2,5 and NO_x)
Growth & Development	Access to clean and sustainable energy	Increases the share of people with access to clean and sustainable solar energy
Economic	Income generation / expenditure reduction	Creates an income opportunity for owners of facilities and for IPPs by selling solar energy to the grid; and/or reduces the energy costs for facilities in case of self-consumption

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Generation of solar energy	Replaces fossil-fuel based electricity from PLN power grid	**M:** based on PV monitoring system (e.g. LCD inverter) **R:** the amount of electricity (in terms of MWh) produced by various PV sources **V:** based on the verification of metering systems
Emission Factor	GHG intensity of the current power generation mix in the grid	The grid emission factor of PLN's high-voltage power grid from North and Central Sulawesi Grid (PLN Suluttenggo) is 0.746 tCO2e per MWh.

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Environment	Reduction in air pollution	Avoided air polluting gases (PM10 and PM2.5, NOx)	See BAU values in Table 63	See target values in Table 63
Growth & Development	Access to clean and sustainable energy	Share of people with access to sustainable electricity	See BAU values in Table 63	See target values in Table 63
Economic	Income generation / expenditure reduction	Income generated / expenditure reduced	See BAU values in Table 63	See target values in Table 63

M&E of implementation progress & continuous improvement:

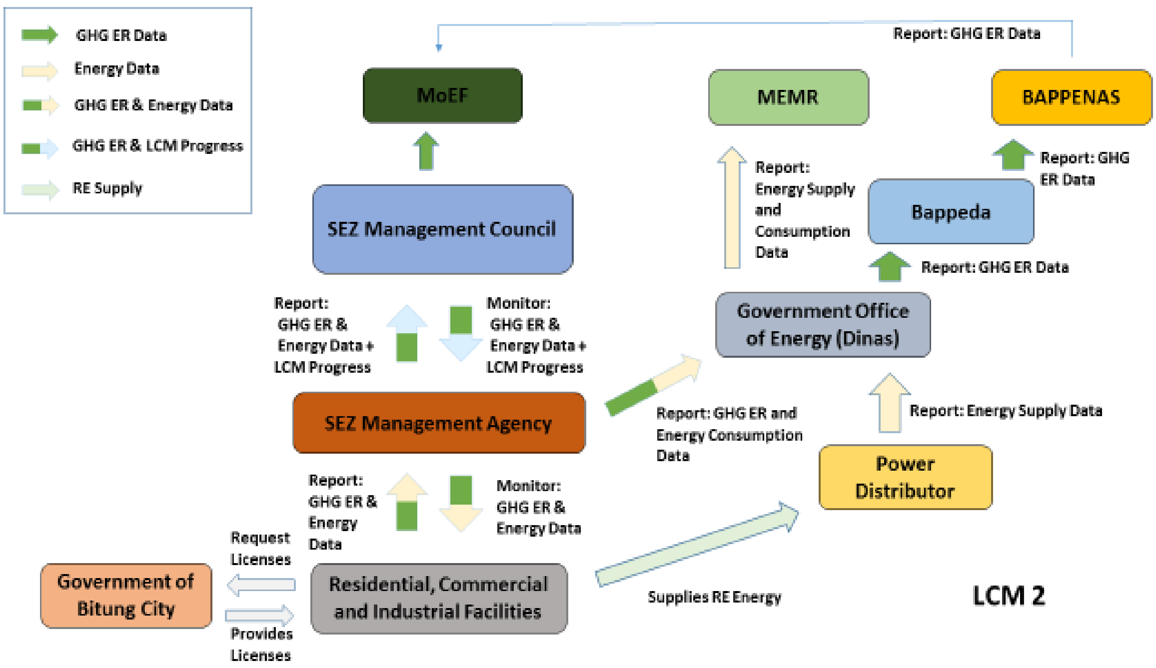
Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM to achieve the defined policy objectives	Share of RE in electricity mix	10% in 2014	25% until 2025
		GHG ER achieved (RAD-GRK)	tbd[186]	tbd
Progress of implementation	Measures the progress of residential, commercial and industrial facilities in generating electricity from solar power and then selling it to grid	Share of total residential, commercial and industrial facilities with PV systems installed (beginning – end of SEZ development)	0%	10%
		Amount of electricity generated by PV panels (MWh)	0	3,000 MWh by 2031
		Number of Power Purchase Agreements (PPAs) signed between IPPs and PLN	0	10% of total number of residential, commercial and industrial facilities
Continuous improvement	Measures whether implementers are improving processes and overall implementation quality and how relevant this is	Time required to sign PPA with PLN	10 month	6 month

[186] RAD-GRK numerical targets are still being developed.

INSTITUTIONAL AND REGULATORY FRAMEWORK

The recommended institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
SEZ Industrial, Commercial and Residential Facilities	• Purchase, operate and maintain PV panels • Produce RE from PV and sell to power distributor • Report GHG ER and energy supply data to SMA • Request operating licenses from Bitung City Government
Power Distributor	• Responsible for taking power from IPPs and distributing it to energy consumers • Reports energy supply data to Dinas Energy
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and energy data to Dinas Energy • Enforces low carbon regulation for the SEZ and reports compliance of facilities to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Bitung City Government	• Provides operating licenses to facilities of the SEZ Bitung
Government Office of Energy, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda and energy data (consumption and supply) to MEMR
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

The use of PV panels will be implemented along the five-phase implementation cycle of the SEZ Bitung. The expected total capital investment, net costs, net benefits and cost-benefit ratio for a total power capacity of 2 MW by 2031 are as follows:

	Total
Capital Investment*	~ $2,000,000
O&M*	~ $200,000
Net Costs	~ $900,000
Net Benefits	~ $1,000,000
Cost-Benefit Ratio	1.14

* Capital investment and O&M costs refer to the investment required until completion of the SEZ Bitung development (i.e. 15 years). Net costs and net benefits are based on the specific investment lifetime of this LCM (i.e. 8 years).

Abovementioned capital investment costs include the purchase of PV panels and the cost of installation.

Note: The exact scope and related cost requirements of the use of solar PV will be highly dependent on the magnitude of residential, commercial and industrial expansion in each phase of the SEZ development.

Source: Own elaboration

Table 162: LCM 3 - Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater

LCM OVERVIEW

LCM Title: Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater

Sector	Subsector	Activity
Energy	Energy Generation	Methane capture and anaerobic digestion (AD) system for Solid Waste and Wastewater

Description: This LCM aims to (i) centralise municipal solid waste (MSW) disposal from and the SEZ Bitung and Bitung City through the development of a sanitary landfill, and (ii) generate RE energy from biogas resulting from anaerobic digestion (AD) of biodegradable waste and wastewater. After waste sorting upon arrival at the sanitary landfill, biodegradable waste goes into a Mechanical Biological Treatment (MBT) plant where biogas resulting from AD will be converted into electricity. The MBT is expected to be developed by an IPP which will sell generated RE energy to the PLN electricity grid (PLN Suluttenggo Grid). GHG emissions will be reduced through the avoidance of methane entering the atmosphere and through the replacement of fossil-fuel with a **waste to energy** (renewable) energy source.

Note: This LCM has been developed in combination with LCM 10 (see Table 169*) in order to maximize the utilization of the sanitary landfill and the envisioned waste to energy system.*

LCM OBJECTIVES

The main objective of this LCM is to contribute to national efforts to shift the primary energy mix from fossil-fuel based sources towards more RE sources and to improve overall MSW treatment and management. Biogas energy development is part of Indonesia's future energy strategy, rooted in the National Energy Strategy (KEN). Improved SWM practices are also part of the country's Waste Management Strategy[187]
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the National Energy Strategy (KEN)'s objective to increase the share of RE in the national energy mix • Contribute to the National Waste Management Strategy • Contribute to the LCDS of the SEZ Bitung and in turn to RAD-GRK.

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: This LCM is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung as follows:

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario – Energy Sector	145,563	331,962	575,656	1,631,547	2,573,580
Emissions reduction estimate	13,007	26,118	39,324	72,665	92,824
Emission Reduction estimate (in percentage of BAU)	8.9%	7.9%	6.8%	4.5%	3.6%

Sustainable development benefits: The avoidance of methane release and the replacement of fossil-fuel based electricity generation with electricity from biogas is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Environment	Reduction in air pollution	Avoids the release of air polluting gases resulting from methane and the combustion of coal and diesel (PM10, PM2,5 and NO_x)
Social	Health	Avoids the release of unpleasant odours and prevents disease-causing suspended particular matter (SPM) from solid waste and wastewater from entering soil, freshwater reservoirs (groundwater) and water streams (e.g. rivers)
Growth & Development	Energy security	Reduces the need for national oil imports

[187] According to Government Regulation no.03/2001, the regional government has the main authority to manage waste in their respective jurisdiction area. In 2006, The Minister of Public Works issued National Regulation no. 21/PRT/M/2006 on the National Policy and Strategies for the Development of Waste Management System. An updated National Waste Management Strategy is under development.

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Generation of electricity at MBT plant	Replaces fossil-fuel based electricity from PLN power grid	**M:** based on net-metering of MBT plant monitoring system **R:** the amount of electricity (in terms of MWh) produced by the MBT plant **V:** based on the verification of metering systems
Methane captured	Methane prevented from entering the atmosphere	**M:** based on a flame ionization detector (FID) **R:** the amount of methane captured at the MBT plant (in terms of tCO_{2e} based on the GWP conversion rate) **V:** based on the verification of metering systems
	GHG intensity of current power generation mix in the grid	The grid emission factor of PLN's high-voltage power grid from North and Central Sulawesi Grid (PLN Suluttenggo) is 0.746 tCO2e per MWh

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Environment	Reduction in air pollution	Avoided air polluting gases (PM10 and PM2.5, NOx)	See BAU values in Table 63	See target values in Table 63
Social	Health	Amount of suspended particulate matter avoided	See BAU values in Table 63	See target values in Table 63
Growth & Development	Energy security	Amount of imported oil for power generation avoided through total energy supply from MBT plant	See BAU values in Table 63	See target values in Table 63

M&E of implementation progress & continuous improvement:

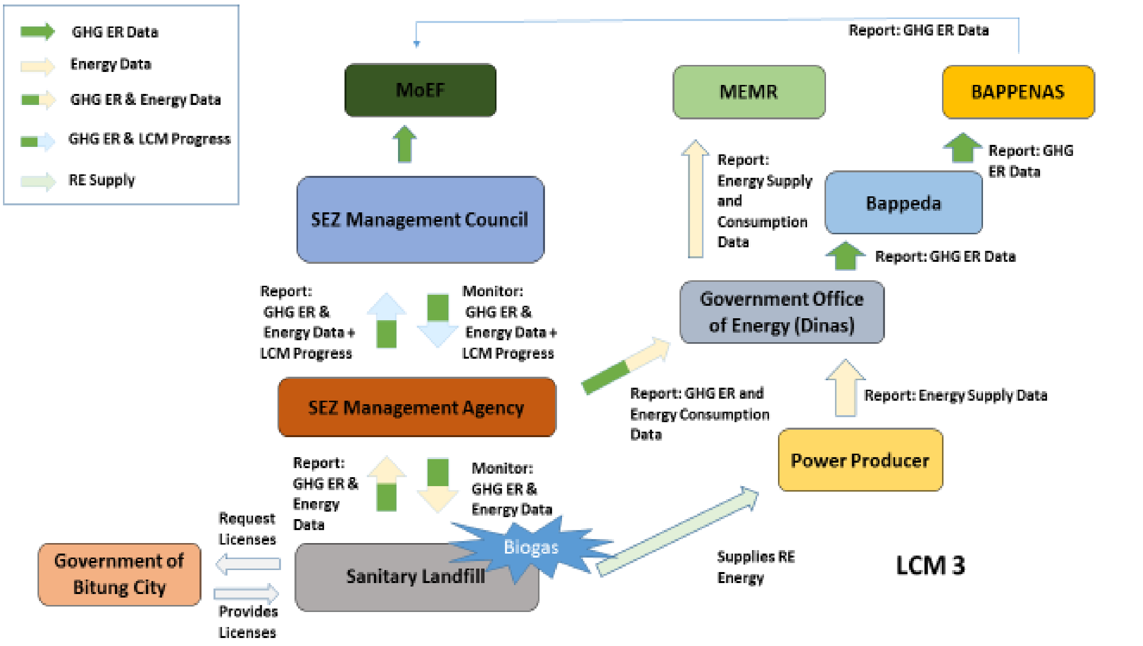
Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM in achieving the defined policy objectives	Share of RE in electricity mix	10% in 2014	25% until 2025
		GHG ER achieved (RAD-GRK)	tbd[188]	tbd
Progress of implementation	Measures the progress of the sanitary landfill and MBT plant development	Percentage of MSW (SEZ Bitung) treated at the sanitary landfill	0	100%
		Installed electricity generation capacity by MBT plant (MW)	0	1.4 MW by 2031
Continuous improvement	Measures whether and how sanitary landfill and MBT plant processes are improving	MSW treatment capacity of sanitary landfill	0	150 t/day

[188] RAD-GRK numerical targets are still being developed.

INSTITUTIONAL AND REGULATORY FRAMEWORK

The recommended institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
Sanitary Landfill	• Produce RE from methane (biogas) and sell to power distributor • Report GHG ER and energy supply data to SMA • Request operating licenses from Bitung City Government
Power Distributor	• Responsible for up-taking of power from IPP and distribution • Reports energy supply data to Dinas Energy
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and energy data to Dinas Energy • Enforces low carbon regulation for the SEZ and reports compliance of facilities to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Bitung City Government	• Provides operating licenses to facilities of the SEZ Bitung
Government Office of Energy, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda and energy data (consumption and supply) to MEMR
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

The methane capture and AD system will be implemented along the five-phase implementation cycle of the SEZ Bitung. The expected total capital investment, net costs, net benefits and cost-benefit ratio are as follows:

	Total
Capital Investment	~ $6,000,000
O&M	~ $3,200,000
Net Costs	~ $7,400,000
Net Benefits	~ $7,100,000
Cost-Benefit Ratio	0.96

Abovementioned capital investment costs include the construction of the sanitary landfill (capacity treatment 150t/day) and the construction of the MBT plant with AD system.

Note: The scope and related cost requirements of this LCM will be highly dependent on the actual amount of waste being treated at the sanitary landfill.

Source: Own elaboration

Table 163: LCM 4 - Thermal energy generation from agricultural waste

LCM OVERVIEW

LCM Title: Thermal energy generation from agricultural waste

Sector	Subsector	Activity
Energy	Energy Generation	Thermal energy generation from agricultural waste

Description: This LCM aims to utilize agricultural waste (e.g. coconut shells) as clean and renewable source to replace coal and fuel oil in industrial thermal energy processes (i.e. heating and steaming in industrial boilers). It is expected that several coconut industries will be operating in the SEZ, potentially generating a considerable amount of organic waste which could be recovered and reutilized. In addition, several coconut plantations are located in the region, providing additional potential sources for biomass feedstock. The use of biomass boilers and the replacement of fossil fuel as main thermal energy source will lead to GHG emission avoidance and a potential reduction of industrial energy costs.

Note: A further option to enhance the scope of this LCM is the installation of a Combined Heat and Power (CHP) system at individual biomass boilers. Such systems can use excessive heat to generate additional electricity.

LCM OBJECTIVES

The main objective of this LCM is to contribute to the national efforts to shift the primary energy mix from fossil-fuel based sources towards more RE sources. Biomass energy development is part of Indonesia's future energy strategy, rooted in the National Energy Strategy (KEN).
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the National Energy Strategy (KEN) objective to increase the share of RE in the national energy mix • Contribute to the LCDS of the SEZ Bitung and in turn to RAD-GRK

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: This LCM is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung as follows:

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario –Energy Sector	145,563	331,962	575,656	1,631,547	2,573,580
Emissions reduction estimate	2,401	7,204	12,007	32,420	49,320
Emission Reduction estimate (in percentage of BAU)	1.6%	2.2%	2.1%	2%	1.9%

Sustainable development benefits: The replacement of fossil-fuels as the primary source for industrial heating and steaming processes is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Environment	Reduction in air pollution	Avoids the release of air polluting gases resulting from the combustion of coal and diesel (PM10, PM2,5 and NO_x)
Growth & Development	Energy security	Reduces the need for national oil imports
Economic	Expenditure reduction	Reduces the energy costs of industrial facilities for heating and steaming processes

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Reduction of fossil fuel as the primary source for heating and steaming processes	Reduces the amount of fossil fuel used to fuel industrial boilers	**M:** based on coal and fuel oil used (in tonne/litre) **R:** the amount of coal and fuel oil used **V:** based on the verification of metering systems (reduction of fossil-fuel based energy consumption)
Increase of biomass as primary source for heating and steaming processes	Increases the share of biomass used to fuel industrial boilers	**M:** based on the amount of biomass used (tonne) **R:** the amount of biomass used (tonne) **V:** based on the verification of metering systems (reduction of fossil-fuel based energy consumption)
Emission Factor	GHG emission factor applied for coal and fuel oil avoided	**Emission Factor Coal:** 96.1 (tCO_2e / TJ) **Emission Factor Fuel Oil:** 74.1 (tCO_2e / TJ)

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Environment	Reduction in air pollution	Avoided air polluting gases (PM10 and PM2.5, NOx)	See BAU values in Table 63	See target values in Table 63
Growth & Development	Energy security	Amount of coal/fuel oil imported for power generation avoided through use of biomass	See BAU values in Table 63	See target values in Table 63
Economic	Expenditure reduction	Reduced costs for boiler fuel source	See BAU values in Table 63	See target values in Table 63

M&E of implementation progress & continuous improvement:

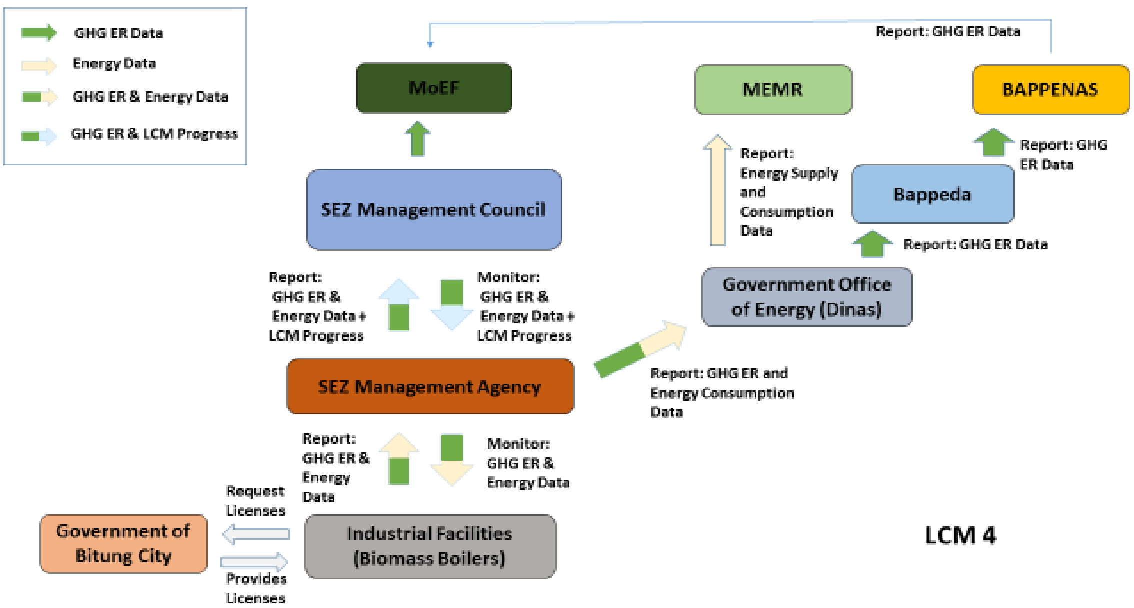
Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM in achieving the defined policy objectives	Share of RE in electricity mix	10% in 2014	25% until 2025
		GHG ER achieved (RAD-GRK)	tbd[189]	tbd
Progress of implementati on	Measures the progress of the use of biomass boilers and biomass as the primary fuel source	Number of biomass boilers in operation	0	5
		Amount of biomass used for heating and steaming processes	0	3.2 tonne/boiler/day
		Number of biomass feedstock supplier available for industrial facilities within the SEZ	0	5
Continuous improvement	Measures whether and how the use of biomass boilers and biomass fuel processes are improving	Quality of available biomass	tbd[190]	tbd

[189] RAD-GRK numerical targets are still being developed.
[190] A detailed biomass assessment will be required to set the BAU and target quality for the biomass

INSTITUTIONAL AND REGULATORY FRAMEWORK

The recommended institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
SEZ Industrial Facilities	• Purchase, operate and maintain biomass boilers • Replace fossil fuel (coal, fuel oil) with biomass as boiler fuel • Report GHG ER and energy consumption data to SMA • Request operating licenses from Bitung City Government
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and energy consumption data of industrial facilities to Dinas Energy • Enforces low carbon regulation for the SEZ and reports compliance of facilities to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Bitung City Government	• Provides operating licenses to industrial facilities of the SEZ Bitung
Government Office of Energy, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda and energy data (consumption and supply) to MEMR
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

Thermal energy generation from agricultural residues will be implemented along the five Implementation Phases. The expected total capital investment, net costs, net benefits and cost-benefit ratio are as follows:

	Total
Capital Investment	~ $3,000,000
O&M	~ $1,700,000
Net Costs	~ $2,200,000
Net Benefits	~ $1,800,000
Cost-Benefit Ratio	0.78

Abovementioned capital investment costs include the purchase and installation of biomass boilers.
Note: The exact scope and related cost requirements of this LCM will be highly dependent on the magnitude of industrial expansion in each phase of the SEZ development, the number of biomass boiler in use as well as on the availability of biomass feedstock.

Source: Own elaboration

Table 164: LCM 5 - Comprehensive EE Programme for Industrial Buildings, Appliances and Processes

LCM OVERVIEW

LCM Title: Comprehensive EE Programme for Industrial Buildings, Appliances and Processes

Sector	Subsector	Activity
Energy	Industry	EE Programme for Industrial Buildings, Appliances and Processes

Description: This LCM aims to reduce energy consumption in the SEZ's industrial sector by implementing EE programmes for various industrial production activities. By reducing energy consumption, GHG emissions resulting from fossil-fuel based energy generation (i.e. energy generation through the combustion of coal and diesel) can be avoided while achieving additional national and local sustainable development benefits.
The LCM comprises the following three EE components:

- EE in industrial equipment and appliances, i.e. implementing EE measures in energy end-uses such as lighting, cooling, motor systems and other uses (e.g. electronic devices);
- EE in industrial processes, i.e. implementing EE measures in industrial processes through process optimisation and improvements such as intelligent production scheduling, process control and measurement, alternative product use (e.g. natural refrigerants); and
- EE in industrial building design, i.e. applying EE building concepts such as natural lighting, natural cooling, natural ventilation and insulation.

LCM OBJECTIVES

The main objective of the industrial EE programme is to contribute to national ambitions of achieving Indonesia's energy saving potential through energy efficiency and conservation measures. EE measures are explicitly identified as priority actions in the country's National Energy Conservation Development Plan (*RIKEN*) as means of achieving individual sectoral conservation targets.
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the National Energy Conservation Development Plan (RIKEN) objective to achieve Indonesia's energy saving potential and reduce energy elasticity through energy efficiency and conservation measures in the industrial sector. • Contribute to the LCDS of the SEZ Bitung and in turn to RAD-GRK.

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: The industrial EE programme is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung. This will lead to a deviation from the emission baseline (BAU Scenario), hence contributing to the low carbon development path of the SEZ Bitung.

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario – Industrial Energy Sector	130,965	298,669	517,923	1,467,918	2,315,474
Emissions reduction estimate	7,160	16,950	30,214	88,438	140,602
Emission Reduction estimate (in % of BAU)	5.5%	5.7%	5.8%	6%	6.1%

Sustainable development benefits: The reduction of fossil-fuel based energy consumption and the appliance of EE technology is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Growth & Development	Energy security	Reduces the need to import fossil fuel for industrial activities in Indonesia
	EE capacity enhancement	Increases knowledge and capacity on industrial EE technology and its appliance/operation
Economic	Expenditure reduction	Reduces the energy costs for industrial facilities

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Reduction of Energy Consumption	Reduced consumption of electricity from PLN power grid	**M:** based on net-metering **R:** the amount of grid electricity (in terms of MWh) used by various power sources (reported by individual industrial facilities to SEZ Management Agency) **V:** based on the verification of metering systems and the sampling[191] of monthly generation reports
Emission Factor	GHG intensity of current power generation mix in the grid	The grid emission factor of PLN's high-voltage power grid from North and Central Sulawesi (PLN Suluttenggo) is 0.746 tCO_2e per MWh

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Growth & Development	Energy security	Reduction of fossil fuel used for electricity generation (litre of fossil fuel)	See BAU values in Table 63	See target values in Table 63
	EE capacity enhancement	Knowledge before and after implementation of EE strategies, number and kind of EE technology applied	See BAU values in Table 63	See target values in Table 63
Economic	Expenditure reduction	Electricity expenditure reduced (IDR/USD)	See BAU values in Table 63	See target values in Table 63

M&E of implementation progress & continuous improvement:

Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM in achieving the defined policy objectives	Reduction in energy consumption in the industrial sector	Sectoral BAU 2010	17%, (2011-2025)
		GHG ER achieved (RAD-GRK)	tbd[192]	tbd
Progress of implementation	Measures the progress of industrial facilities in applying EE measures	Share of industrial facilities which submit energy consumption reports to the SEZ Management Agency (submission interval to be defined)	0%	80%
		Share of industrial facilities conducting energy awareness campaigns and training (yearly)	0%	80%
		Share of industrial facilities applying EE principles as suggested in this report (end of each phase)	0%	80%

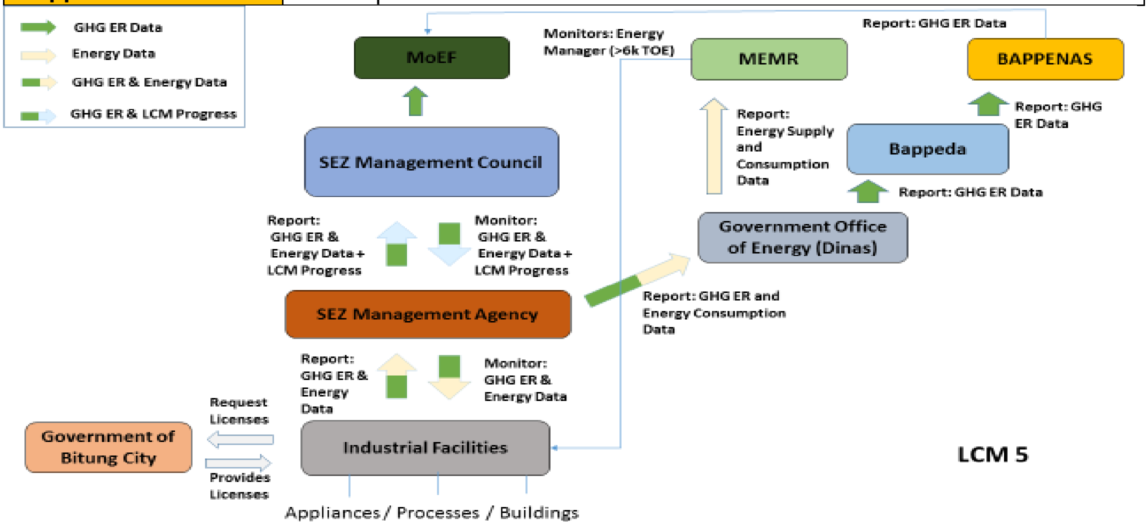
[191] This could be based on 'Guideline: Sampling and surveys for CDM project activities and programmes of activities' https://cdm.unfccc.int/filestorage/I/J/9/IJ9FVMQKZ2BU4YSE1RH370WXCG6P8A/eb75_repan08.pdf?t=ajV8bnlrMHR3fDBMdxncIIXpHjys8DG6p4DV

		Inclusion of industrial EE principles in local development plans	Not included	included
Continuous improvement	Measures whether implementers are improving processes the relevance of these improvements and overall implementation quality	Quality of energy consumption reports submitted from industrial facilities to the SEZ Management Agency (completeness, accuracy, timely submission - submission interval to be defined)	20% of total reports submitted are accurate, complete and on time	80% of total reports submitted are accurate, complete and on time
		Quality of industrial energy awareness campaigns and trainings for industrial facility staff and local government employees working on energy related development planning (knowledge gained by participants assessed through questionnaire before and after sessions, on a yearly basis)	30% share of participants have gained significant knowledge on EE principles	80% share of participants have gained significant knowledge on EE principles

INSTITUTIONAL AND REGULATORY FRAMEWORK

The indicative institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
SEZ Industrial Facilities	• Implement EE programmes for industrial appliances, processes and buildings (purchase, maintenance and operation of EE technology and low carbon buildings measures) • Hire facility energy manager (if energy consumption is more than 6000 Ton Oil Equivalent per year) • Report GHG ER and energy consumption data to SMA • Request operating licenses from Bitung City Government
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and energy consumption data of industrial facilities to Dinas Energy • Enforces low carbon regulation for the SEZ and reports compliance of facilities to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Bitung City Government	• Provides operating licenses to industrial facilities of the SEZ Bitung
Government Office of Energy, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda and energy data (consumption and supply) to MEMR
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

The EE programme for industries will be implemented along the five-phase implementation cycle of the SEZ Bitung. The expected total capital investment, net costs, net benefits and cost-benefit ratio are as follows:

	Total
Capital Investment*	~ $10,000,000
O&M*	~ $1,500,000
Net Costs	~ $3,100,000
Net Benefits	~ $4,200,000
Cost-Benefit Ratio	1.34

* The capital investment and O&M costs refer o the investment required until completion of the SEZ Bitung development (i.e. 15 years). Net costs and net benefits are based on the specific investment lifetime of this LCM (i.e. 8 years).

Abovementioned capital investment costs are incremental costs, i.e. only additional costs resulting from investments in EE technology as compared to conventional technology. Considered EE technology includes lighting, process cooling, and motor systems.

Note: The exact scope and related cost requirements of industrial EE activities will be highly dependent on the magnitude of industrial expansion in each phase of the SEZ development.

Source: Own elaboration

Table 165: LCM 6 - Comprehensive EE Programme for Residential & Commercial Buildings and Appliances

LCM OVERVIEW

LCM Title: Comprehensive EE Programme for Residential & Commercial Buildings and Appliances

Sector	Subsector	Activity
Energy	Residential & Commercial	EE Programme for Residential & Commercial Buildings and Appliances

Description: This LCM aims to reduce energy consumption in the SEZ's residential and commercial sector by applying EE principles to buildings and appliances. By reducing energy consumption, GHG emissions resulting from fossil-fuel based energy generation (i.e. energy generation through the combustion of coal and diesel) can be avoided while achieving additional national and local sustainable development benefits. The LCM comprises the following three EE components:

- EE in industrial equipment and appliances, i.e. implementing EE measures in energy end-uses such as lighting, cooling and other uses (e.g. electronic devices)
- EE in residential and commercial building design, i.e. applying EE building concepts such as natural lighting, natural cooling, natural ventilation and insulation

LCM OBJECTIVES

The main objective of the residential and commercial EE programme is to contribute to national ambitions of achieving Indonesia's energy saving potential through energy efficiency and conservation measures. EE measures are explicitly identified as priority actions in the country's National Energy Conservation Development Plan (*RIKEN*) as a means of achieving individual sectoral conservation targets.
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the National Energy Conservation Development Plan (RIKEN) objective of achieving Indonesia's energy saving potential through energy efficiency and conservation measures • Contribute to the LCDS of the SEZ Bitung and in turn to RAD-GRK

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: The residential and commercial EE programme is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung. This will lead to a deviation from the emission baseline (BAU Scenario), hence contributing to the low carbon development path of the SEZ Bitung.

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario – Residential and Commercial Energy Sector	14,599	33,293	57,733	163,629	258,107
Emissions reduction estimate	2,491	5,681	9,851	27,922	44,045
Emission Reduction estimate (in % of BAU)	17.1%	17.1%	17.1%	17.1%	17.1%

Sustainable development benefits: The reduction of fossil-fuel based energy consumption and the appliance of EE technology is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Growth & Development	Energy security	Reduces the need to import fossil fuel for residential and commercial activities in Indonesia
	EE capacity enhancement	Increases knowledge and capacity on residential and commercial EE technology and its appliance/operation
Economic	Expenditure reduction	Reduces the energy costs for residential and commercial facilities

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Reduction of Energy Consumption	Reduced consumption of electricity from PLN power grid	**M:** based on net-metering **R:** the amount of grid electricity (in terms of MWh) used by various power sources (reported by individual residential and commercial facilities to SEZ Management Agency) **V:** based on the verification of metering systems
Emission Factor	GHG intensity of current power generation mix in the grid	The grid emission factor of PLN's high-voltage power grid from North and Central Sulawesi (PLN Suluttenggo) is 0.746 tCO2e per MWh

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Growth & Development	Energy security	Reduction of fossil fuels used for electricity generation (litre of fossil fuel)	See BAU values in Table 63	See target values in Table 63
	EE capacity enhancement	Knowledge before and after implementation of EE strategies, number and kind of EE technologies applied	See BAU values in Table 63	See target values in Table 63
Economic	Expenditure reduction	Electricity expenditure reduced (IDR/USD)	See BAU values in Table 63	See target values in Table 63

M&E of implementation progress & continuous improvement:

Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM in achieving the defined policy objectives	Reduction in energy consumption in the commercial and residential sector	Sectoral BAU 2010	15% in each sector,
		GHG ER achieved (RAD-GRK)	tbd[193]	tbd
Progress of implementation	Measures the progress of residential and commercial facilities in applying EE measures	Share of residential and commercial facilities which submit energy consumption reports to the SEZ Management Agency (submission interval to be defined)	0%	80%
		Share of commercial facilities conducting energy awareness campaigns and trainings (yearly)	0%	80%
		Share of of residential and commercial facilities applying EE principles as suggested in this report; (end of each phase)	0%	80%

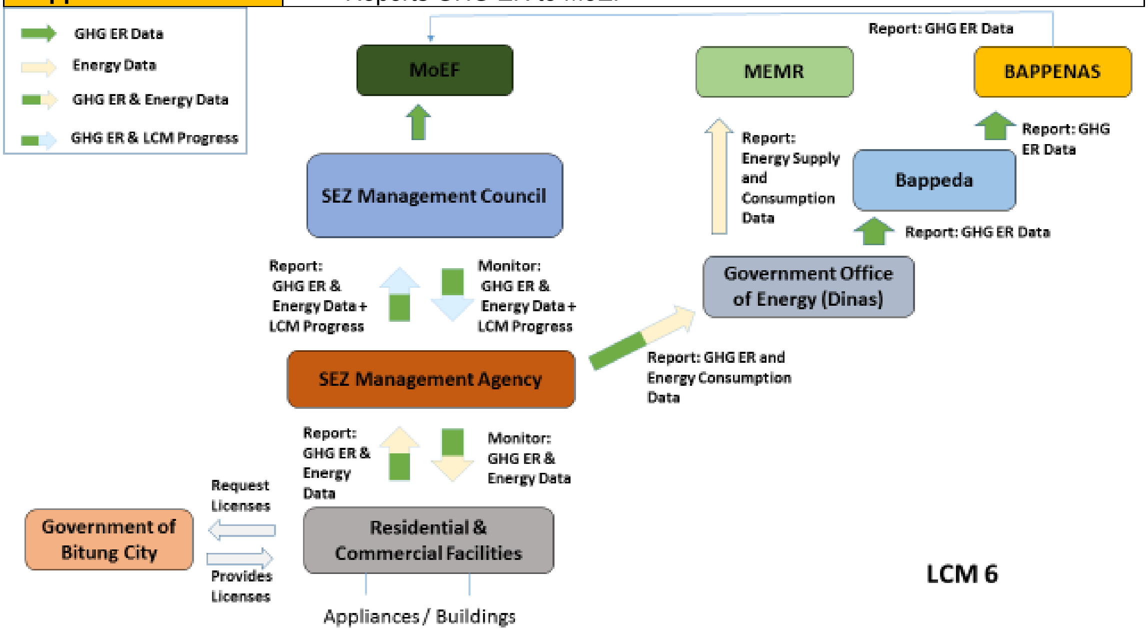
[193] RAD-GRK numerical targets are still being development.

		Inclusion of residential and commercial EE principles in local development plans	Not included	included
Continuous improvement	Measures whether and how implementers are improving processes and overall implementation quality	Quality of energy consumption reports submitted from commercial facilities to the SEZ Management Agency (completeness, accuracy, timely submission; submission interval to be defined)	20% of total reports submitted are accurate, complete and on time	80% of total reports submitted are accurate, complete and on time
		Quality of commercial energy awareness campaigns and trainings for staff and local government employees working on energy related development planning (knowledge gained by participants assessed through questionnaire before and after sessions, yearly)	30% share of participants have gained significant knowledge on EE principles	80% share of participants have gained significant knowledge on EE principles

INSTITUTIONAL AND REGULATORY FRAMEWORK

The recommended institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
SEZ Commercial and Residential Facilities	• Implement EE programmes for commercial and residential appliances and buildings (purchase, maintenance and operation of EE technology and low carbon buildings measures) • Report GHG ER and energy consumption data to SMA • Request operating licenses from Bitung City Government
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and energy consumption data of commercial and residential facilities to Dinas Energy • Enforces low carbon regulation for the SEZ and reports compliance to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Bitung City Government	• Provides operating licenses to commercial and residential facilities in SEZ Bitung
Government Office of Energy, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda and energy data (consumption, supply) to MEMR
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

The EE programme for the residential and commercial sector will be implemented along the five-phase implementation cycle of the SEZ Bitung. The expected total capital investment, net costs, net benefits and cost-benefit ratio are as follows:

	Total
Capital Investment*	~ $4,500,000
O&M	~ $200,000
Net Costs	~ $1,400,000
Net Benefits	~ $2,000,000
Cost-Benefit Ratio	1.41

* Capital investment and O&M costs refer to the investment required until completion of the SEZ Bitung development (i.e. 15 years). Net costs and net benefits are based on the specific investment lifetime of this LCM (i.e. 8 years).

Abovementioned capital investment costs represent incremental costs, i.e. additional costs resulting from investments in EE technology compared to conventional technology. Considered EE technology include lighting, refrigeration, cooking, water heating and room conditioning.

Note: The exact scope and related cost requirements of residential and commercial EE activities will be highly dependent on the magnitude of residential and commercial expansion in each phase of the SEZ development.

Source: Own elaboration

Table 166: LCM 7 - Bus Rapid Transit

LCM OVERVIEW

LCM Title: Bus Rapid Transit

Sector	Activity
Transportation	Development of a Bus Rapid Transit (BRT) system

Description: This LCM aims to develop a Bus Rapid Transit (BRT) public transportation system within the SEZ Bitung, in order to shift travel from private vehicles (i.e. motorcycles and passenger cars) to the use of articulated buses. The development of the BRT system will require the construction of dedicated bus lanes, bus stops and the purchase and operation of articulated buses. GHG ERs will be achieved through energy savings from articulated buses (due to the higher occupancy ratio compared to regular buses) and fuel savings, as people shift from conventional means of travel to a low carbon alternative.

LCM OBJECTIVES

The main objective of the BRT is to contribute to national ambitions to achieve sustainable transport and reduced emissions and air pollution from transport systems. This aligns to different government regulations in relation to Sustainable Transport, Public Transport Systems, urban mobility and others[194]; such as the Minister of Transport Decree #48, SISTRANAS, the Strategic Transport Plan (RENSTRA Transport) and the National Medium Term Development Plan (RPJBM).
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the national sustainable transport and urban mobility objectives as per SISTRANAS and RENSTRA Transport • Contribute to the overall objectives of the LCDS of the SEZ Bitung and the GHG ER objectives of RAD-GRK

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: The BRT is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung as follows:

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario – Transport Sector	13,564	30.934	53,643	152,036	239,819
Emissions reduction estimate	393	891	1,599	4,933	7,940
Emission Reduction estimate (in % of BAU)	2.9%	2.9%	3%	3.2%	3.3%

Sustainable development benefits: The introduction a BRT is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Environment	Reduction of air pollution	Reduces the release of air polluting gases resulting from the combustion gasoline and diesel (PM10, PM2,5 and NO_x)
	Noise reduction	Reduces traffic noise due to lower number of vehicles on the streets
Social	Time savings	Reduces overall traffic volume and therefore reduces time spent to get from point A to point B

[194] The government's national transport strategy growth is guided overall by Minister of Transportation Regulation No. KM 49 of the Year 2005 about the National Transportation System (SISTRANAS), within the framework of the Government of Indonesia's 20-year national development plan (Law No. 17/2007: 2005–2025 National Long-Term Development Plan [RPJPN 2005–2025]). The RPJMN19 for 2010–2014 emphasises enhanced domestic connectivity through major infrastructure development and transport sector reform.

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Fuel savings	Reduced fuel consumption due to the shift of people from private vehicles to public buses	**M:** based on the bus occupation rate and the number of private vehicles used within the SEZ Bitung, compared with the expected number people located within the SEZ Bitung and the expected number of private vehicles without the BRT **R:** the amount of fuel saved (litre of gasoline and diesel) due to shift in passengers to the BRT
	Reduced fuel consumption due to the use of more efficient articulated buses	**M:** number of articulated buses in operation and their occupation rate **R:** estimation of how many regular buses would be necessary to transport the same number of people and the amount of resulting fuel savings due to the use of articulated buses **V:** number of articulated buses in operation and their occupation rate
Bus fuel performance	Regular & articulated bus fuel performance	Regular Bus: 3.45 litre/km Articulated Bus: 1.8 litre/km
Emission Factor	Emission factor of gasoline and diesel	Gasoline: 2.33 kg CO2e/litre Diesel: 2.62 kg CO2e/litre

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Environment	Reduction of air pollution	Avoided air polluting gases (PM10 and PM2.5, NOx)	See BAU values in Table 64	See target values in Table 64
	Noise reduction	Traffic noise before and after BRT operation (in decibel dB)	See BAU values in Table 64	See target values in Table 64
Social	Time savings	Time required to get from point A to point B	See BAU values in Table 64	See target values in Table 64

M&E of implementation progress & continuous improvement:

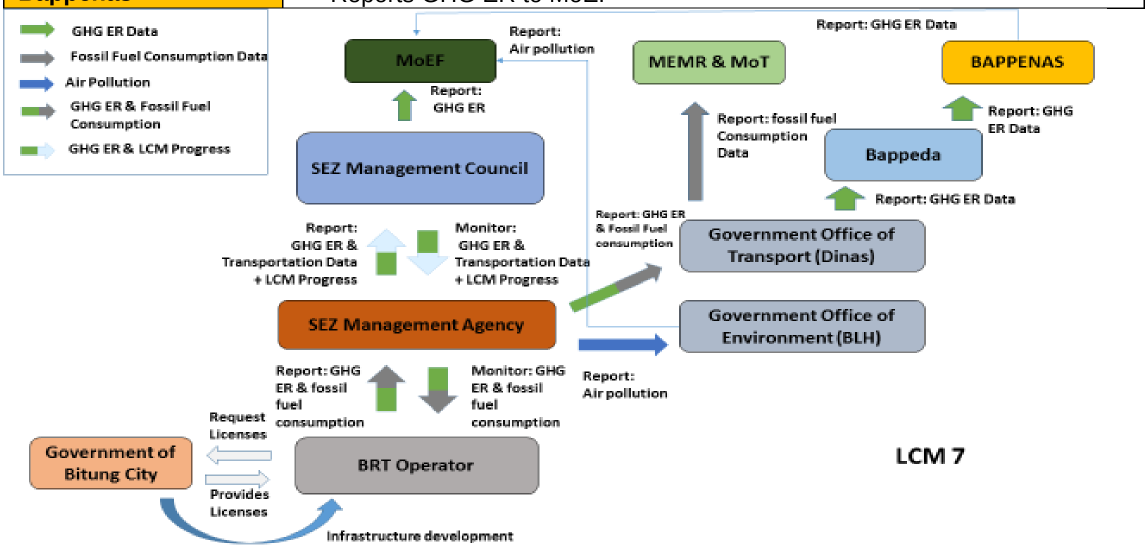
Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM to achieving the defined policy objectives	GHG ER achieved (RAD-GRK)	tbd[195]	tbd
Progress of implementation	Measures the progress of BRT implementation	Number of articulated buses operating in the SEZ Bitung	0	25 by 2031
		Number of bus stops served by articulated buses	0	tbd[196]
		Share of people located in the SEZ Bitung expected to use the BRT	0	30%
Continuous improvement	Measures whether implementers are improving processes and the relevance of such improvements and overall implementation quality	Time needed to construct bus stops	Tbd[12]	tbd
		Time required to purchase articulated buses	Tbd[12]	tbd

[195] RAD-GRK numerical targets are still being developed.
[196] This estimation should be conducted through a detailed BRT technical design study, which is not part of this feasibility study.

INSTITUTIONAL AND REGULATORY FRAMEWORK

The indicative institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
BRT Operator	• Operation of the BRT system including purchase, operation and maintenance of articulated buses • Report GHG ER and fossil fuel consumption data to SMA • Request operating licenses from Bitung City Government
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and fossil fuel consumption data of the BRT to Dinas Transport • Reports air pollution data to BLH • Enforces low carbon transport regulation for the SEZ and reports compliance of facilities to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Bitung City Government	• Provides operating licenses to the BRT operator • Develops BRT infrastructure (bus lanes, bus stops etc.)
Government Office of Transport, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda • Reports fossil fuel consumption data to MoT and MEMR
Government Office of Environment (BLH)	• Reports air pollution data to MoEF
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

The BRT will be implemented along the five-phase implementation cycle of the SEZ Bitung. The expected total capital investment, net costs, net benefits and cost-benefit ratio are as follows:

	Total
Capital Investment	~ $6,200,000
O&M	~ $1,200,000
Net Costs	~ $4,100,000
Net Benefits	~ $2,600,000
Cost-Benefit Ratio	0.65

Abovementioned capital investment costs include BRT infrastructure development (bus lanes, bus stops, road adaptation) and the purchase of articulated buses.
Note: The exact scope and related cost requirements of the BRT will be highly dependent on the magnitude of SEZ expansion and the related transportation demand.

Source: Own elaboration

Table 167: LCM 8 – NMT & TOD

LCM OVERVIEW

LCM Title: Non-Motorised Transport (NMT) and Transit-Oriented-Development (TOD)

Sector	Activity
Transportation	Development of Non-Motorised Transport (NMT) and Transit-Oriented infrastructure Development (TOD)

Description: This LCM aims to develop a smart transportation infrastructure which encourages the use of non-motorised and public transportation (walking, use of bicycles, inline skater, BRT etc.), in which residential and commercial facilities are located short distances to each other and close to transportation hubs. This leads to the reduction of GHG emissions through the avoidance of conventional vehicle use and increases comfort and overall quality of life within the SEZ.

NMT and TOD infrastructure development includes the following:

- Sidewalks, crosswalks, paths, bicycle lanes
- Pedestrian oriented land use and building design,
- Increased road and path connectivity with special non-motorised shortcuts
- Bicycle parking
- Bicycle integration in transit systems (e.g. racks on bus)
- Traffic calming through traffic speed reductions, vehicle restrictions and road space reallocation

LCM OBJECTIVES

The main objective of the NMT and TOD LCM is to contribute to national ambitions to achieve sustainable transport and reduced GHG emissions and air pollution from transport systems. This aligns with different government regulations in relation to Sustainable Transport, Public Transport Systems, urban mobility and others[197], such as the Minister of Transport Decree #48, SISTRANAS, the Strategic Transport Plan (RENSTRA Transport) and the National Medium Term Development Plan (RPJBM).
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the national sustainable transport and urban mobility objectives as per SISTRANAS, RENSTRA Transport and RPJBM. • Contribute to the overall objectives of the LCDS of the SEZ Bitung and the GHG ER objectives of RAD-GRK.

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: The NMT and TOD is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung as follows:

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario – Transport Sector	13,564	30.934	53,643	152,036	239,819
Emissions reduction estimate	9.6	45	117	638	1,292
Emission Reduction estimate (in % of BAU)	0.1%	0.2%	0.2%	0.4%	0.5%

Sustainable development benefits: NMT and TOD is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Environment	Reduction of air pollution	Reduces the release of air polluting gases resulting from the combustion gasoline and diesel (PM10, PM2,5 and NO_x)
	Noise reduction	Reduces traffic noise due to the lower number of vehicles on the streets
Social	Health	Encourages physical activities by providing a smart and comfortable outdoor and transportation environment

[197] The government's national transport strategy growth is guided overall by Minister of Transportation Regulation No. KM 49 of the Year 2005 about the National Transportation System (SISTRANAS), within the framework of the Government of Indonesia's 20-year national development plan (Law No. 17/2007: 2005–2025 National Long-Term Development Plan [RPJPN 2005–2025]). The RPJMN19 for 2010–2014 emphasizes enhanced domestic connectivity through major infrastructure development and transport sector reform.

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Fuel savings	Reduced fuel consumption due to the shift of people from private vehicles to NMT and TOD	**M:** number of people located in the SEZ Bitung who are using bicycles on a regular basis **R:** the amount of fuel saved (litre of gasoline and diesel) due the shift in passengers to NMT and TOD
Emission Factor	Emission factor of gasoline and diesel	Gasoline: 2.33 kg CO2e/litre Diesel: 2.62 kg CO2e/litre

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Environment	Reduction of air pollution	Avoided air polluting gases (PM10 and PM2.5, NOx)	See BAU values in Table 64	See target values in Table 64
	Noise Reduction	Traffic noise before and after NMT and TOD development (in decibel dB)	See BAU values in Table 64	See target values in Table 64
Social	Health	Average number of outdoor activities per week/month	See BAU values in Table 64	See target values in Table 64

M&E of implementation progress & continuous improvement:

Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM in achieving the defined policy objectives	GHG ER achieved (RAD-GRK)	tbd[198]	tbd
Progress of implementation	Measures the progress of NMT and TOD implementation	Number of bicycles purchased for the SEZ Bitung	0	750 by 2031
		Number of environmental awareness campaigns	0	one per year
		Share of constructed NMT and TOD infrastructure	0	100% [199]
Continuous improvement	Measures whether and how relevant implementers are improving processes and overall implementation quality	Time needed to construct individual infrastructure elements	tbd[15]	tbd

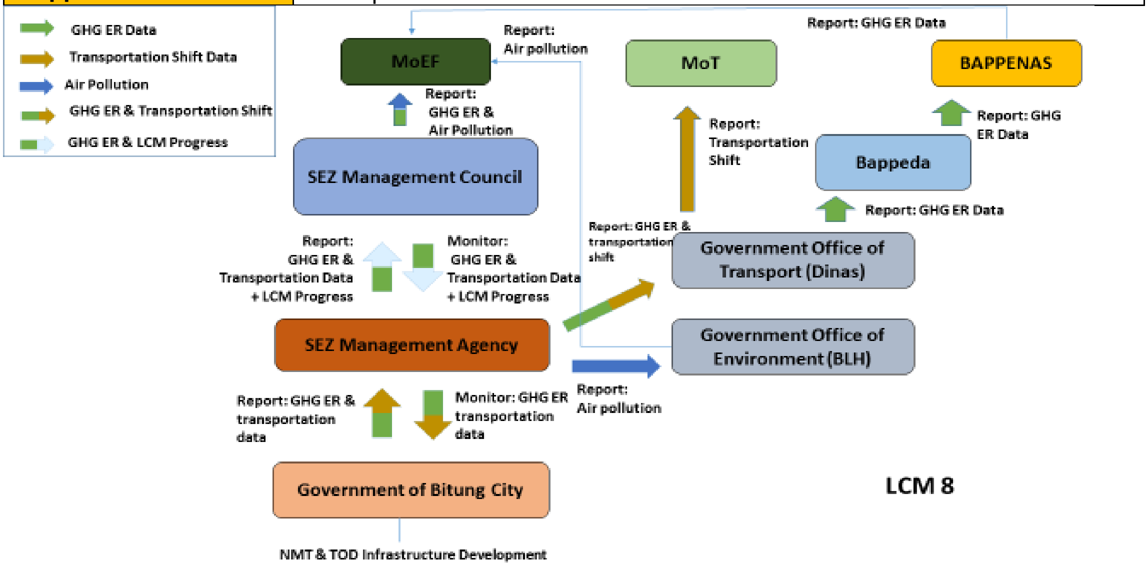
[198] RAD-GRK numerical targets are still being developed.

[199] This estimation should be conducted through a detailed NMT and TOD technical design study, which is not part of this feasibility study.

INSTITUTIONAL AND REGULATORY FRAMEWORK

The indicative institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
Bitung City Government	• Develops NMT & TOD Infrastructure (Sidewalks, crosswalks, paths, bicycle lanes, pedestrian oriented land use and building design, increase road and path connectivity with special non-motorised shortcuts, traffic calming through traffic speed reductions, vehicle restrictions and road space reallocation etc.) • Report GHG ER and transportation data to SMA
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and transportation data to Dinas Transport • Reports air pollution data to BLH • Enforces low carbon transport regulation for the SEZ and reports compliance of facilities to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Government Office of Transport, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda • Reports transportation data to MoT
Government Office of Environment (BLH)	• Reports air pollution data to MoEF
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

NMT and TOD will be implemented along the five-phase implementation cycle of the SEZ Bitung. The expected total capital investment, net costs, net benefits and cost-benefit ratio are as follows:

	Total
Capital Investment	~ $440,000
O&M	~ $110,000
Net Costs	~ $450,000
Net Benefits	~ $390,000
Cost-Benefit Ratio	0.85

Abovementioned capital investment costs include NMT and TOD infrastructure development (sidewalks, bicycle lanes, road connectivity, road space reallocation etc.), purchase of bicycles and environmental awareness campaigns.

Note: The exact scope and related cost requirements of the NMT and TOD will be highly dependent on the magnitude of SEZ expansion and the related transportation demand.

Source: Own elaboration

Table 168: LCM 9 - Urban Forestry and Urban Greening

LCM OVERVIEW

LCM Title: Urban Forestry and Urban Greening

Sector	Activity
AFOLU	Urban Forestry and Urban Greening

Description: The main objective of this LCM is to increase the amount of green spaces through urban greening activities and to improve the land use management of areas with high recreational, social or environmental benefits (e.g. forest areas). Urban greening activities includes the development of parks, green pedestrian walkways, green roadways, green building façades and green watersides, whereas land use management activities focus on the revision of land-zone usage or planning of additional reforestation activities.

LCM OBJECTIVES

The main objective of this LCM is to contribute to the national ambition of achieving greener and more liveable cities, with reduced GHG emissions and air pollution from carbon sinks. This aligns to different government regulations, most importantly the Regulation of the Minister of Home Affairs Decree No. 1 of 2007 on Spatial Planning, whose directive indicates that the minimum proportion of green open space in urban areas should be 30%.
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the national objective of achieving a green and sustainable city environment as per the Spatial Planning regulation. • Contribute to the overall GHG ER objectives of the LCDS of the SEZ Bitung and in turn of those of RAD-GRK.

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: This LCM is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung as follows:

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario – AFOLU Sector	404	506	651	1,818	2,555
Emissions reduction estimate	95	219	384	1,086	1,707
Emission Reduction estimate (in % of BAU)	24%	43%	59%	60%	67%

Sustainable development benefits: Urban Forestry and Urban Greening is expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Environment	Reduction of air pollution and soil improvement	Reduces the release of air polluting gases resulting from the combustion gasoline and diesel (PM10, PM2,5 and NO_x)
Social	Livelihood	Increases livelihood through shade cover and cooling, improving air quality and providing outdoor activity opportunities
Economic	Job creation	Creates jobs for urban greening design planning, and continuous planting & maintaining of trees and plants

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Number of planted trees and other plants	Number of plants which absorb GHG from the air, remove and store the carbon and release oxygen back into the air	**M:** number of trees and other plants planted / plantation area covered (ha) **R:** number of trees and other plants planted / plantation area covered (ha) **V:** number of trees and other plants planted / plantation area covered (ha)
Carbon sink capacity	Amount of carbon sink capacity (amount of carbon that can be absorbed) of individual tree and plant species	**M:** tree and plant species planted **R:** the amount of GHG absorption potential of planted trees and plants **V:** tree and plant species planted

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Environment	Production and use of compost, Manure nutrient	Production and use of compost, manure nutrient	See BAU values in Table 66	See target values in Table 66
Social	Livelihood	Number of green recreation areas developed, number of green outdoor activity offerings	See BAU values in Table 66	See target values in Table 66
Economic	Job creation	Number of jobs created	See BAU values in Table 66	See target values in Table 66

M&E of implementation progress & continuous improvement:

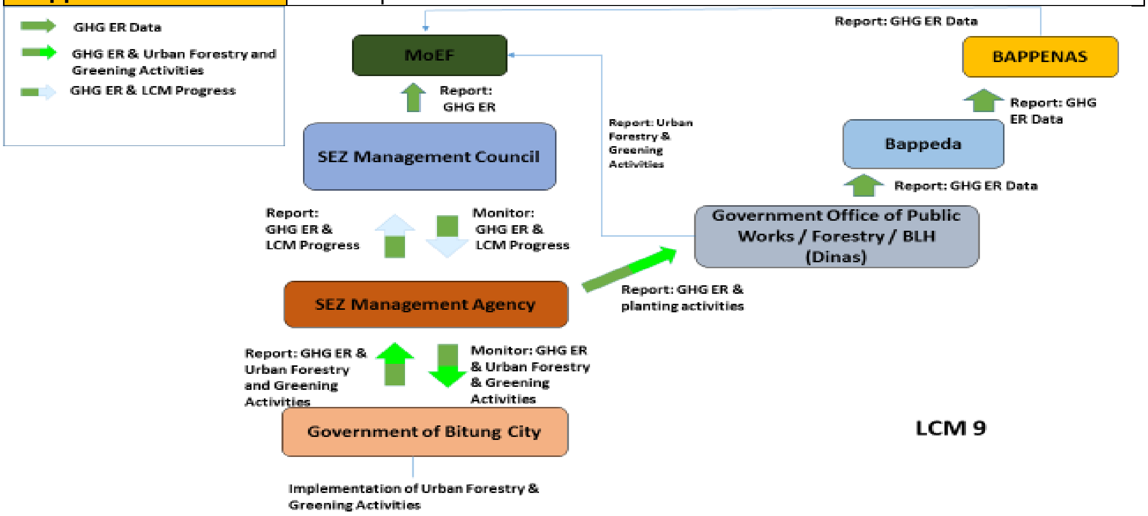
Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM to achieve the defined policy objectives	Share of total green space land use in urban areas	0%	50%
		GHG ER achieved (RAD-GRK)	tbd[200]	tbd
Progress of implementation	Measures the progress of urban forestry and urban greening implementation	Number of trees and plants planted	0	460 by 2031
Continuous improvement	Measures whether and how relevant implementers are improving processes and overall implementation quality	Time needed to plan and conduct planting, nursery and maintenance activities	tbd[201]	tbd

[200] RAD-GRK numerical targets are still being developed.
[201] This estimation should be conducted through a detailed Urban Forestry and Urban Greening design study.

INSTITUTIONAL AND REGULATORY FRAMEWORK

The indicative institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
Bitung City Government	• Implements urban forestry and greening activities (tree selection, purchase, planting and nursing, afforestation, development of planting strategies and schedules etc.) • Report GHG ER and urban forestry and greening activities to SMA
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and urban forestry and greening activities to BLH/Dinas Public Works/Dinas Forestry • Enforces urban greening regulation for the SEZ and reports compliance to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Government Office of Public Works/Forestry/BLH, North Sulawesi	• Reports GHG ER data to Bappeda • Reports urban forestry and greening activities to MoEF
Government Office of Environment (BLH)	• Reports air pollution data to MoEF
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

Urban forestry and urban greening will be implemented along the five-phase implementation cycle of the SEZ Bitung. The expected total capital investment, net costs, net benefits and cost-benefit ratio are as follows:

	Total
Capital Investment	~ $60,000
O&M	~ $45,000
Net Costs	~ $83,000
Net Benefits*	-
Cost-Benefit Ratio	-

*No direct financial returns are expected from this LCM

Abovementioned capital investment costs include the development of necessary infrastructure and the purchase of required utilities.
Note: The exact scope and related cost requirements of this LCM will highly depend on the the applied density ratio in urban areas (tree/ha) and the magnitude of infrastructure development.

Source: Own elaboration

Table 169: LCM 10 - Integrated Solid Waste Management (SWM) System and 3R (Reduce, Reuse, Recycle) Strategy

LCM OVERVIEW

LCM Title: Integrated Solid Waste Management (SWM) System and 3R (Reduce, Reuse, Recycle) Strategy

Sector	Activity
Waste	Development of an integrated Solid Waste Management (SWM) system and promotion of a 3R (Reduce, Reuse and Recycle) Strategy

Description: This LCM has been developed in combination wth LCM 3 (see Table 162) in order to maximize the utilization of the sanitary landfill and the envisioned waste to energy system. Consequently, this LCM consists of two main activities. Firstly, bio solids remaining after the anerobic digestion process to generate RE (LCM 3 activity) will be converted into high quality compost to be reutilised as manure (e.g. for the green urban areas). Secondly, 3R strategies (Reduce, Reuse, Recycle) will be implemented, aiming to reduce the overall amount of Municipal Solid Waste (MSW) generated within the SEZ Bitung.

LCM OBJECTIVES

The main objective of this LCM is to contribute to national efforts to improve overall MSW treatment and management. Improved MSW practices are part of the country's Waste Management Strategy.[202]
The key policy objectives of this LCM are:

Policy Objectives	
LCM Policy Objective	• Contribute to the National Waste Management Strategy. • Contribute to the GHG ER objectives of the LCDS of the SEZ Bitung and in turn of those of RAD-GRK.

LCM IMPACTS (GHG ER and SD benefits)

GHG emissions reduction: This LCM is expected to result in CO_2 emission reductions during the five development phases of the SEZ Bitung as follows:

GHG ER Impact (tCO_2, cumulative)	End of Phase 1 2019	End of Phase 2 2021	End of Phase 3 2024	End of Phase 4 2028	End of Phase 5 2031
Emission Baseline BAU Scenario - Waste Sector	8,135	18,600	32,342	92,392	146,459
Emissions reduction estimate	1,086	3,002	5,840	20,890	36,861
Emission Reduction estimate (in % of BAU)	13.4%	16.1%	18.1%	22.6%	25.2%

Sustainable development benefits: The integrated solid waste management system and the promotion of 3R strategies are expected to result in the following SD benefits:

SD Impacts (SD benefits)		
Impact Domain	**Specific Impact**	**Description**
Environment	Soil pollution/quality	Production and use of compost, manure nutrient
Social	Improved livelihood	Reduces the occurrence of waste dumping in urban areas and avoids related odour and pollution
Growth & Development	Education	Waste campaigns increase the awareness and knowledge of waste management and 3R strategies

[202] According to Government Regulation no.03/2001, the regional government has the main authority to manage waste in their respective jurisdiction area. In 2006, The Minister of Public Works issued National Regulation no. 21/PRT/M/2006 on the National Policy and Strategies for the Development of Waste Management System. An updated National Waste Management Strategy is under development.

MRV and M&E system

The MRV and M&E procedures for measuring the LCM impacts are as follows (more details on who monitors, reports and verifies can be seen in the institutional and regulatory framework):

MRV of GHG Emission Reductions:

Parameter	Explanation	MRV system requirement
Organic waste treated	Amount of organic waste converted to compost	**M:** amount of organic waste treated / amount of compost generated **R:** amount of organic waste treated / amount of compost generated **V:** based on the amount of compost generated through the organic waste
Methane avoidance	Methane GWP potential avoided trough the conversion of organic waste to compost	**M:** amount of organic waste treated / amount of compost generated **R:** The amount of methane avoided through treatment (in terms of tCO_{2e} based on the GWP conversion rate) **V:** based on the amount of compost generated through the organic waste

MRV of Sustainable Development (SD benefits):

Impact Domain	Specific Impact	KPI	BAU Assumption	Target
Environment	Soil pollution/quality	Production and use of compost, manure nutrient	See BAU values in Table 65	See target values in Table 65
Social	Improved livelihood	Amount of waste reduced, recycled and reused	See BAU values in Table 65	See target values in Table 65
Growth & Development	Education	Knowledge about waste management and 3R principles before and after environmental promotion campaigns	See BAU values in Table 65	See target values in Table 65

M&E of implementation progress & continuous improvement:

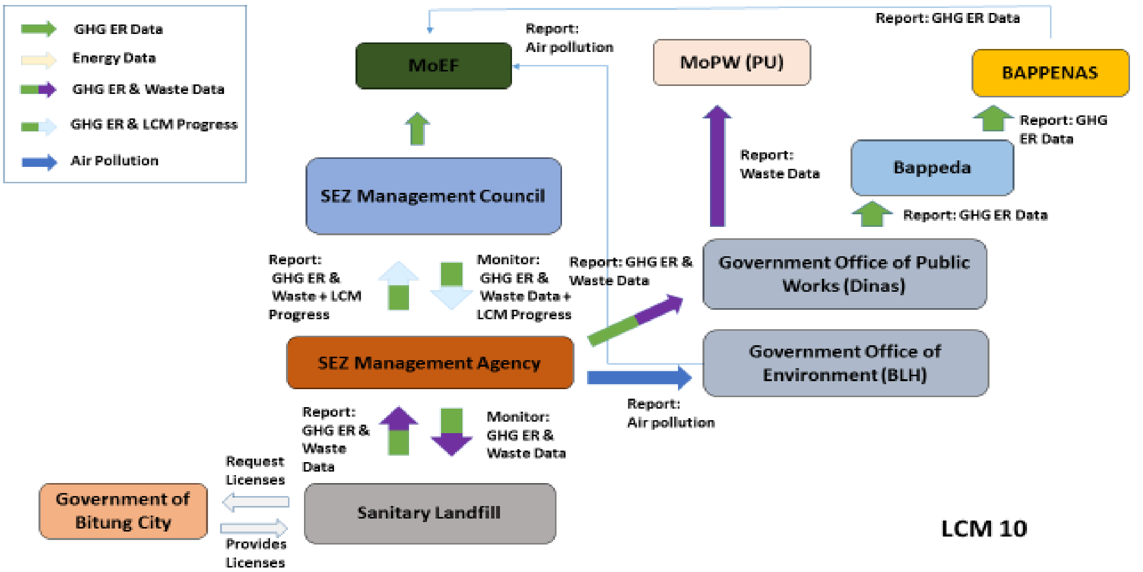
Criteria	Description	Indicators	BAU	Target
Contribution to Policy Objective	Measures the contribution of the LCM to achieve the defined policy objectives	GHG ER achieved (RAD-GRK)	tbd[203]	tbd
Progress of implementation	Measures the progress of the development of composting facilities within the sanitary landfill	Percentage of total organic waste (SEZ Bitung) treated at the composting facilities	0	100%
		Number of environmental awareness raising campaigns	0	15 by 2031
Continuous improvement	Measures whether and how the composting processes at the sanitary landfill are improving	Organic waste treatment capacity of sanitary landfill	0	100% of all organic waste of SEZ

[203] RAD-GRK numerical targets are still being developed.

INSTITUTIONAL AND REGULATORY FRAMEWORK

The recommended institutional and regulatory framework for the implementation of this LCM is as follows:

Institution	Responsibility/Role
Sanitary Landfill	• Purchases, operates and maintains compost production facilities • Produces compost from organic waste brought to the landfill • Reports GHG ER and waste data to SMA • Request operating licenses from Bitung City Government
SEZ Management Agency (SMA)	• Monitors and reports LCM progress (GHG ER, SD, Implementation Progress, Continuous Improvement Processes - CIP) to SMC • Reports GHG ER and waste data to Dinas Public Works • Reports air pollution data to BLH • Enforces low carbon waste regulation for the SEZ and reports compliance to SMC
SEZ Management Council (SMC)	• Monitors LCM progress at SMA level • Reports GHG ER to MoEF
Bitung City Government	• Provides operating licenses to the landfill operator
Government Office of Public Works, North Sulawesi (DInas)	• Reports GHG ER data to Bappeda • Reports waste data to MoPW
Government Office of Environment (BLH)	• Reports air pollution data to MoEF
Bappeda	• Monitors GHG ER data at SMA level and reports to Bappenas
Bappenas	• Reports GHG ER to MoEF



FINANCIAL OVERVIEW

The integrated solid waste management system with 3R strategy promotion will be implemented along the five-phase implementation cycle of the SEZ Bitung. The expected total capital investment and cost-benefit ratio is as follows:

	Total
Capital Investment	~ $1,200,000
O&M	~ $5,800,000
Cost-Benefit Ratio*	1.04

*the cost-benefit ratio includes the potential sale of electricity generated by a biomass power plant

Abovementioned capital investment costs include the construction of an integrated waste management centre and the purchase of a waste collection vehicle fleet.
Note: The scope and related cost requirements of this LCM will depend on the actual amount of waste generated and treated within the SEZ.

Source: Own elaboration

4.2.5 Finance Considerations for Implementation: Financial Architecture, Financial Instruments and Available Support

4.2.5.1 Financial Architecture: Definition, Objectives and Principles

Definition of Financial Architecture (FA)

The Financial Architecture for the LCMT can be interpreted as a comprehensive business plan and incentive structure for the LCDS (in general) and for each LCM (in particular) to encourage:

a) implementation of the LCDS and each specific LCM
b) participation in the related MRV + M&E activities

At the same time, the FA can also be seen as an instrument to attract public and private, and domestic and international finance.

Some of the incentives that a FA needs to ensure include: command & control regulation (part of regulatory and Institutional Framework), financial incentives, or market-based approaches (e.g. carbon market schemes). The Financial Architecture will have to describe how the provision of incentives and funds are re-financed, disbursed, replenished; how cash-flow is managed; and how fiduciary and guarantee procedures are set up; in other words, it should explain and justify all elements of the proposed Financial Management Scheme, and depict and detail all financial mechanisms, flow of funds and financial provisions.

While a thorough design of the financial architecture required for implementation is beyond the scope of this study, the following pages will briefly present some basic principles, a list of potential mechanisms and available sources of finance. The purpose of this section is to facilitate implementation of the LCMT by highlighting and presenting some options so it can be considered solid, bankable and generally appealing to potential investors. This will ensure that LCDS for the SEZ Bitung can easily be integrated into the SEZ Bitung Masterplan, and in turn that each of the 10 proposed LCMs attract the necessary level of incremental finance required.

One of the basic principles in ensuring the success of the financial architecture is its integration into the existing domestic policy, planning and budgetary processes. As is the case with the Institutional Framework (which has to be aligned with and build as much as possible on the existing institutional set-up), the LCMT Financial Architecture will have to be strongly integrated within the: (i) National Planning; (ii) the Provincial Planning of North Sulawesi; (iii) the SEZ Bitung Masterplan; and with their related budgetary systems for implementation. In fact, and depending on the specific nature of each specific LCM, their development will very likely require revisions of existing policies and related budgets (to reflect the incremental cost of low carbon), rather than the creation of entirely new ones.

The domestic budget is therefore one of the most important considerations in defining the financial aspects of implementation. The budget contains information about the focus areas that are currently being costed, and how financing - including that used for current development activities - is allocated and administered. Besides budgetary accounts, it also provides information on the status of current expenditures, which are an indication of how implementation plans are progressing. With budget information to hand, the financial structuring of the LCDS will become much more reliable, which in turn will make the evaluation of financing needs from third parties more credible and adjusted to real needs (UNDP, UNFCCC, UNEP Risø 2013).

However, potential private and public developers and government administrators may find it difficult to obtain a precise picture of an LCM's operation by looking at the budget in isolation, let alone to assess the climate finance expenditures (or climate-relevant expenditures, that may or may not include climate-specific finance alone, but that could also encompass other expenditures on activities that have a climate mitigation impact, whether it is explicitly recognised as such or not).

Initiatives such as the Climate Public Expenditure and Institutional Review (CPEIR)[204] can bridge this gap and have the potential for acting as a starting point for longer-term, government-led stakeholder dialogues. An analysis of the Climate Public Expenditure, together with the identification of international best practices in relation to climate finance, will provide information on the availability and potential of the different sources of finance and financial mechanisms.

Other cross-sectoral, international best practices related to the set-up of a successful financial architecture include:

- Optimal funding for LCDS and LCMs is able to address multiple barriers at the same time, always, as seen above, in a way that is tailored to the national context;
- Funding commitments by donors should be reliable, predictable, long-term and of sufficient scale (AGF, 2010);
- Public funds should be used efficiently and effectively (UNDP, 2011). This implies, for example, that public funds should be focussed on LCMs where the private sector is not active of its own accord (such as LCM 9 – Urban Forestry and urban greening, or LCM 7 - BRT). It also means that the LCM with best net benefits (or cost benefit ratio), such as LCM 1 – Utilisation of Clean Energy or LCM 6 – Energy Efficiency for Commercial and Residential, should be undertaken before more costly or less attractive LCMs, such as LCM 4 – Thermal energy generation from agricultural waste and LCM 8 – NTM and TOD.

Generally speaking, the four basic sources of funding for the LCDS will be: (i) public finance; (ii) private finance; (iii) domestic (or national) finance; and (iv) international finance.

Public sector finance will need to come first, in order to create the enabling conditions that can inspire and leverage private-sector investment. The national private sector, however, will rarely have any leveraging power over a foreign public donor. The role of the government will primarily be focussed on setting up the institutional, policy and regulatory frameworks to mobilise and channel public and private investments, and provide seed funding. The leveraging effort will mainly consist of presenting the main ideas behind the LCDS, the selected LCMs and the potential funding commitments (i.e. the domestic portion of the funding) to international donors, before the public sector starts deploying its finance with the aim of securing private sector involvement. The bulk of the required investments, in most cases, will come from international public finance institutions and the national (and eventually international) private sector, while public finance will focus on creating the appropriate risk/return profile for investments to encourage private sector participation (UNEP, UNEP Risø 2013). Ultimately, funding from the domestic budget will help attract international donor funding, which in turn will leverage national and international private funding.

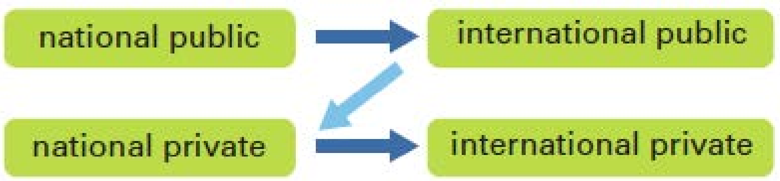


Figure 54: Order of leveraging public and private, domestic and international funding

Source: UNDP, UNFCCC, UNEP Risø 2013

[204] CPEIRs were first used by UNDP and the Overseas Development Institute (ODI) in 2012 and have already been developed for a number of countries. They offer guidance on how to examine public expenditures on climate-change actions in three main areas of analysis: policy, institutional and budget review. They provide a better understanding of the formulation of climate-change policy and its links to expenditure through national strategies and action plans; improve the understanding of the roles, responsibilities and interaction of institutions involved in managing the response to climate change; and quantify climate-change-related expenditures in the national budget as well as through other funding channels, providing a baseline for future analysis (UNDP/UNEP; 2013)

The LCMT Financial Architecture should therefore be seen as an instrument that seeks to bring together a wide range of players and sources of finance (public and/or private; domestic and/or international) into a coordinated operational framework by combining domestic and international resources to be able to scale-up the most promising (i.e. environmentally and economically effective[205]) mitigation actions.

4.2.5.2 Overview of Financial Instruments

A wide range of diverse financing instruments and financial mechanisms will generally be available, with many potentially being relevant for the LCMs under consideration. In many cases, given the complexity of a LCDS and the challenges and risks that it entails, a targeted combination of instruments will be necessary to enable the LCMT Financial Architecture to reach its full potential.

In order to gain an understanding of the best combination of instruments, an assessment of which of the available instruments are already being used for the deployment of ongoing budgetary (and extra-budgetary) expenditures should first be made. Knowing which instruments can be structured through the existing national budgetary process will help to determine:

a) what kind of financing will be needed to complete the LCMT Financial Architecture;
b) who could provide that additional financing;
c) under which instrument (or under which combination of instruments) could finance be channelled; and
d) which national and international institutions would be the most suitable for: (i) being responsible for the overall financial management of the LCDS; and (ii) overseeing, controlling, and providing fiduciary or guarantee roles, as necessary.

Following is a non-comprehensive list of some of the potentially available financial instruments/mechanisms that could be of relevance for the LCMT. The instruments listed below can be provided by a wide range of public and private, national and international (multilateral and bilateral) financing institutions, whether in the form of purely private financing (commercial banks), public financial institutions operating within the private sector for motives of profit (hybrid institutions), or public financing in the form of national or international development banks (UNDP, UNFCCC, UNEP Risø 2013).

4.2.5.2.1 Loans

Loans are traditional debt financing mechanisms on standard borrowing/lending terms (i.e. market rate and tenor). Loans are usually and mostly provided by banks, including development banks, but sometimes can be provided by pension funds or publicly-funded venture funds.

- Soft loans. These are a specific kind of loan that are provided on particularly favourable terms (usually, below market price and therefore with unusually low interest rates, long maturities and possible grace periods). A specific case of soft loans is mixed credits, which, according to OECD rules, must contain at least a 35% grant element (see below for grants). Usually, soft loans are offered by bilateral donors (through commercial banks), and by multilateral development banks under certain conditions of eligibility.

[205] Environmental effectiveness relates to the absolute GHG emission reduction potential; economical effectiveness (cost-effectiveness) to the potential in relation of the GHG achieved per USD.

4.2.5.2.2 Loan Facilities / Dedicated credit lines

Loan facilities and credit lines are yet another form of debt finance specifically designed for investing in projects that meet a number of specified criteria (in this case for example, these criteria could be related to GHG mitigation or SD benefit objectives). Loan facilities and credit lines are a way to provide debt financing for projects, either directly from a facility or via the banking sector. They are a relatively direct way to stimulate lending, substituting public funds for debt that would otherwise come from the market. With debt generally providing 70% of investment costs in the sector, they require significant funds to operate. The main purpose of credit lines is to address the lack of liquidity to meet medium to long-term financing requirements of clean energy or other climate projects. In markets where high interest rates are seen as a barrier, credit lines can be offered at concessional rates to induce borrowing and direct credit to target sectors and projects. And when the credit risk of such projects is high, credit lines can also be structured on a limited or non-recourse basis so that the development financial institution shares in the risk of the loans on-lent by other financial institutions. These provide debt finance but by-pass commercial financial lending institutions (Maclean et al. 2008). Credit lines are typically established by development banks or less commonly by public entities (government agencies) and channelled through a private sector bank or similar private financial institutions for the financing of private sector initiatives. Credit lines in the context of the LCMT should be created as a structured and streamlined financing window by multilateral and bilateral development banks.

Indonesian experience with loans facilities and credit lines
The Indonesian Investment Agency (Pusat Investasi Pemerintah – PIP) has experience with offering both a renewable energy loan facility and energy efficiency credit line in Indonesia. The first is a revolving debt fund of roughly US $25 – 30 million for mini-hydro projects. However, the risk profile of projects has so far not been acceptable to receive funding and collateral requirements remain high under this scheme (in excess of 100% of loan value) limiting eligible IPPs. The second is the Energy Efficiency Revolving Fund, a USD 45 million concessional credit line for local banks lending to energy conservation projects. This is in the process of being implemented. The French Development Agency (AFD) has provided USD full-recourse credit lines to banks in Indonesia, starting with a US $100 million credit line to Bank Mandiri for low-carbon investments. Three additional credit lines are planned. Anecdotal evidence suggests that lending to renewable energy projects through such a credit line remains challenging due to perceived risks and due diligence challenges of these projects. (Source: Mitigation Momentum, 2014: NAMA for small and medium scale renewable energy generation in Indonesia

4.2.5.2.3 Bonds

Bonds are another kind of financial instrument in which an investor loans money to an entity (that can be corporate or governmental, or a mix of both, such as in the case of a PPP). This entity (in this case the SEZ Management Agency, or the dedicated and approved Financial Manager on behalf of the SMA) will borrow the funds for a defined period of time, usually at a fixed and previously agreed interest rate. The bond (i.e. the debt) may be traded at an exchange and could be bought by anyone. A bond usually requires the collaboration of financial arrangers and specialists such as banks and credit institutions, large corporations, or governments.

4.2.5.2.4 Equity

An equity is an investment made directly to projects or operating assets by investors who assume a portion of ownership relative to their provision of capital. This kind of financial mechanism is usually led by private companies, wealthy individuals, venture funds (private), pension funds (public), and publicly-funded venture funds (public-private). Taking an equity stake in projects or providing subordinated debt (either from a direct facility or a credit line through a financial institution) can improve the ability of the project managers or operators (in this case, the SMA) to obtain bank financing as well as favourably impact their lending terms (for example with longer loan periods). The involvement of an equity/debt sponsor can also signal to financial institutions that a recognised organisation considers the project viable and has conducted its own due diligence.

4.2.5.2.5 First-loss/Subordinated debt

A first loss is a tranche of finance that, in the event of a default, takes the first loss before other tranches. It can also be called “mezzanine financing”, “subordinated debt”, or sometimes “junior debt”. The name refers to the order of or priority for repayment, as it is structured so that it is repaid from project revenues after all project operating costs and senior debt service has been paid. The senior lender gets paid first, and then the subordinated/junior/first-loss lender. Subordinated debt can substitute for and reduce the amount of senior debt in a project’s financial structure, thus addressing a possible debt-equity gap and reducing risk from the senior lender’s point of view. It can also substitute for and reduce project sponsor equity requirements set by senior lenders. It is typically in the range of 10-25 percent of a project’s sources of funds, and mostly intended to support smaller scale projects. In one sense, equity is the ‘most subordinated’ form of financing, as investors are the last to be paid, though a key difference is that they retain a stake in the project. This kind of finance could be regarded as a hybrid between investment (such as equities) and debt (such as loans, bonds, credit lines etc.). This kind of mechanism is usually offered by private companies, venture funds (private), and publicly-funded venture funds (public-private).

Indonesian experiences with equity and subordinated debt
PT Indonesia Infrastructure Finance (PT IIF) is a private non-banking financial institution under the Ministry of Finance, Regulation (PMK) No. 100/2009, with a focus on investing in commercially feasible infrastructure projects. IIF’s provides a project financing scheme to infrastructure projects, whereby IIF can offer term loan financing of up to 15 years. This is an area that banks in Indonesia have not yet been able to easily offer to their clients. In addition, IIF is able to provide mezzanine financing and equity investments to certain clients. PT IIF has been operating for four years and delivered its first financing agreement on September 2012, with long term finance for a toll road project in West Java. It now has investments in two gas fired power stations and one large hydro project, though the financing conditions for these involvements are not clear from publically available information (IIF, 2014). An initial concept for a biomass NAMA in Indonesia – to act as a catalyst for early demonstration projects that incorporate methane capture from biomass waste streams – also considers a form of equity provision, proposing a 10% grant in place of equity to projects (GoI 2013). (Source: Mitigation Momentum, 2014: NAMA for small and medium scale renewable energy generation in Indonesia).

4.2.5.2.6 Risk mitigation instruments and credit guarantees[206]

Risk mitigation instruments include a long list of instruments and financial mechanisms provided by either the public or the private sector to mitigate risk — whether real or perceived —, which is the single most important factor preventing low carbon projects from finding financial investors, or raising the returns that these investors demand. The use of guarantees is appropriate when financial institutions have adequate medium to long-term liquidity, yet are unwilling to provide financing to clean energy or other climate projects because of high perceived credit risk (i.e. repayment risk). The role of a guarantee is therefore to mobilise domestic lending for such projects by sharing in the credit risk of project loans that the financial institutions make with their own resources. Guarantees are generally only appropriate in financial markets where borrowing costs are at reasonable levels and where a good number of banks are interested in the targeted market segment. Typically guarantees are partial, that is they cover a portion of the outstanding loan principal with 50-80 percent being common. This ensures that the financial institutions remain at risk for a certain portion of their portfolio to ensure prudent lending (Maclean et al. 2008). Risk can be political, policy/regulatory, social, technical, physical, market/commercial, or linked to the outcome. Risk mitigation instruments can include bilateral contracts, credit enhancement instruments, insurances, revenue support policies, direct concessional investments, indirect political/institutional support, etc. While governments will typically provide political guarantees and government agencies may help to insure such guarantees, private sector entities will in turn provide a risk cover (which is usually paid pretty much like an insurance policy). Risk covers and

[206] See CPI (2013) for a very comprehensive analysis of the risks and their related mitigation instruments.

guarantees can be provided by export credit agencies, insurance companies, banks, governments, and technology suppliers.

Indonesian experiences with credit guarantees
Kredit Usaha Rakyat (KUR) is a micro credit guarantee programme in Indonesia. KUR is part of the Jaminan Kredit Indonesia (JAMKRINDO) credit guarantee scheme and is 100% government-owned. KUR offers guarantees for loans given to micro-SMEs and therefore decreases the normally high interest rates for these loans. A key difference would be that the size of these KUR guarantees is modest compared to those required for the renewable energy sector, while the number of guarantees is immense. For example, a total of RP 29.2 trillion (approx. US $2.6 billion) was guaranteed in 2011 across more than 6,000,000 customers (JAMKRINDO 2012). The Indonesian Infrastructure Guarantee Fund (IIGF), which offers government guarantees to large PPP infrastructure projects against political risks, is often referred to in this context, but should be noted as being distinct from a credit guarantee. This type of political guarantee provides coverage against specifically defined political (or sovereign) risks, i.e. risks related primarily to government, as opposed to risks related to IPPs or relatively new fields of lending. (Source: Mitigation Momentum, 2014: NAMA for small and medium scale renewable energy generation in Indonesia).

4.2.5.2.7 Project Finance

Project finance is a financing mechanism structured around a given project's own operating cash flow and assets, without requiring additional financial guarantees by the project sponsors. Loans in a project finance structure are also called "non-recourse" lending. Project finance will essentially be built around and depend on the structuring of the risk through the use of the risk-cover instruments mentioned above. As project finance is an instrument that relies on risk-cover instruments, it can be offered by the same financial institutions mentioned above.

4.2.5.2.8 Fiscal Incentive Programmes (FIPs)

FIPs are usually financial instruments aimed at fostering and facilitating investment in a country. They provide legal and fiscal advantages for existing and future investors. They can include tax holidays (periods granted to an investor during which it will not need to pay taxes for the activities produced in the country) and duty exemptions (free of import duty, revenue replacement duty) that make it more attractive for a particular investor to invest in a particular initiative (in this case, the LCMs or the overall LCDS).

4.2.5.2.9 Grants

The grants are provisions of funds without expectation of repayment (i.e. money that doesn't need to be given back). They are usually provided using government budget allocations and/or International Financial Institution (IFIs) or other donor funds (such as bilateral donors, philanthropic funds, and objective-specific funds). They are usually funds provided to cover for activities that will not generate direct returns (such as Technical Assistance, MRV set-up and capacity building activities), but that are a prerequisite to the functioning of the LCDS or LCM; or, alternatively, they can be used to pay up-front costs of measures and projects.

4.2.5.2.10 Blending mechanisms

Blending facilities use grant funds to create a blend of debt and guarantee instruments from a number of financial institutions in order to provide a package of finance with attractive terms to meet project finance needs. Given the complex nature of the LCMT and the number of stakeholders involved, blending mechanisms will be probably required in many cases, as sources will also be a combination of financial sources (mixing public and private, domestic and international) and available support (as we will see in the following pages).

Indonesian experiences with Blending Mechanisms: Energy Efficiency Financing Scheme (EEFS)
The Centre for Climate Change Financing and Multilateral Policy (PKPPIM) in the Fiscal Policy Agency of the Ministry of Finance (MoF) is currently developing an Energy Efficiency Revolving Fund (EEFS – Dana Bergulir Efisiensi Energi) in cooperation with PIP and the MEMR. The EEFS will be developed to encourage energy efficiency financing by Local Financing Institutions (LFI's) to support the implementation of Energy Efficiency investments in Indonesia. The EEFS process involves the Ministry of Finance that, via the National Investment Agency (PIP), will invite banks (commercial and public) to participate. Participating banks can refinance themselves from PIP on attractive terms (suggested Bank of Indonesia – rate minus 3% p.a) and will be allowed to take a margin of 5-5.5% to on-lend to energy efficiency projects at a rate of 2-2.5% p.a. below Bank of Indonesia rate. The government will also provide training and technical assistance to socialise the banks and clients with the programme and to promote the EEFS and energy efficiency. With that concept the EEFS will be able to offer below market rates for energy efficiency investments and to educate and socialise banks and clients in order to make energy efficiency investments happen. Ultimately, the aim of the programme is that, through initial seed support, the Indonesian Banking Industry will identify that the promotion of investments in energy efficiency will create additional demand for credit and hence boost their lending business further, besides having the effect that the government will save subsidies as the consumption of energy will be reduced. Funding for the EEFS is expected to be included in the 2015 national budget. Source: Low Carbon Support Program (LCSP) to the Ministry of Finance, Indonesia, "Preliminary Design of an Energy Efficiency Financing Scheme", Final Discussion Paper (March 2015).

4.2.5.2.11 Purposes of each financial instrument

The type of finance and the specific financial instruments for the LCDS and for each LCM will depend on the types of activities and actions to be implemented.

Public financing is likely to be used to support LCDS development, mechanisms for engagement of the private sector, establishing an enabling institutional environment (e.g. deregulation), developing an adequate policy/regulatory framework, financing feasibility studies by private companies, and implementing and financing demonstration projects, etc.

On the other side, LCMs that have reasonably safe cash flows and acceptable risk/return ratios are likely to be funded through equity from private sector and/or loans from International Financial Institutions. In these cases, though the primary source of investment will be private sector, public funds could play a role in providing competitive risk/return profile for investments in low carbon options.

International public finance, finally, will be required to cover the incremental cost[207] of the LCMs, or to reduce/remove non-financial barriers to investment for those LCMs that may be profitable but that will require international technical assistance to create a conducive policy and regulatory environment, and/or the appropriate institutional structures to address risks in adopting those options.

[207] "Incremental cost" is a concept defined mostly by the Global Environmental Fund (GEF) and in the context of NAMAs refers to the additional costs that might be required to adopt a lower GHG emission option for meeting the national development and environmental goals, compared to a BAU option. Thus, the incremental costs are additional and beyond the costs that the country would have invested without financial support (i.e., the "nationally appropriate" costs). The incremental costs can be considered as a grant component to finance the climate change SD benefits associated with national actions. See GEF Report on Incremental Costs for further details on incremental costs.
http://www.thegef.org/gef/sites/thegef.org/files/documents/gef_c14_5.pdf

The following picture briefly summarises which instrument is more adequate to which purpose and type of finance:

Barriers to mitigation actions	Type of financing	Public Finance Mechanisms
Low (or no) return on investment	Contribution to investment and operational costs	Up-front grant (e.g. direct subsidies, investment tax breaks, grant component of concessional loans) Funding during operation (e.g. feed-in remuneration, carbon markets)
High up-front costs and lacking access to capital	Facilitating access to finance	Provision of debt, e.g. through loans or credit lines Provision of equity Incentivizing existing financing system*
High risk	Provision of risk coverage	Risk guarantees / insurance schemes
High transaction costs		Standardization and aggregation *
Non-financial barriers (e.g. regulatory barriers, lack of information and capacity)	(Financing) technical assistance	Mostly in the form of grants

Figure 55: Financial Barriers, Types and Mechanisms

Source: ECN/Ecofys Mitigation Partnership, 2014

4.2.5.3 Options of Available Support for Low Carbon Development in Indonesia

With regards to determining the necessary level of support for LCDS and LCMs, it is important to note that in many cases it can be difficult to determine the incremental costs of LCMs in a standardised and unambiguous manner. The cost calculations provided above are based on various assumptions and are only indicative, so they should be revised and updated carefully as more information becomes available and the LCDS implementation (and generally, the SEZ Bitung development) advances. Additionally, at least in the short to medium term, the level of support is likely to be subject to case-by-case negotiation and agreement. This could be partly based on a consideration of incremental costs (where applicable), but also on other factors such as the scale of available support, potential co-funding commitments by the host government and other aspects determining how to implement a certain mitigation action effectively and efficiently.

With respect to the cost effectiveness of the measures (and indicators such as Net Present Value, Cost/Benefit Ration and similar), it is crucial that, although the level of support provided may be subject to case-by-case agreements, there is confidence by potential donors and sources of finance that international support is spent wisely and produces results. This implies a need to measure accountability and to compare the impact achievement with the level of investment required, and is the reason why specific KPIs have been proposed for each LCM to monitor performance, track implementation progress, and check CIP.

Finally, potential funders may also consider performance-based approaches or result-based finance (RBF) for supporting the LCDS or specific LCMs for the SEZ Bitung. While there is limited experience with performance-based international support for mitigation actions (apart from the CDM), various approaches are possible for integrating performance-based elements into different types of support. Emerging lessons from performance-based climate support, as well as lessons from other sectors (especially health, where more experience with results-based financing is available) should also be taken into account and considered for inclusion in the Financial Architecture.

The real challenge is that private investors, who can and should provide the lion's share of global climate finance - as asset owners (project developers) and end-users (households, corporate manufacturers) of renewable technologies - only invest their money when the returns on offer outweigh the costs. Public policies, resources, and money will be required to seed-fund the most promising initiatives, as private capital will flow into climate investments only when public incentives and money make them commercially attractive by mitigating risk and reducing incremental costs. While many countries have policy frameworks that provide such incentives, significant capacity and incentive gaps remain (CPI 2003b).

In the specific context of available support for Low Carbon Cities, the first financial support for implementation is finally becoming available.

4.2.5.3.1 Public Domestic

Substantial domestic public support is finally being made available through the GoI's recent initiatives and policies that can reduce fossil fuel subsidies and diversify energy supply; for example PT SMI's contribution to the IIF, the anticipated support to the PIP energy efficiency revolving fund, the establishment of the Geothermal Fund, and others. Furthermore, there is the expectation within government that public financial contributions towards the achievement of the RAN-GRK and RAD-GRK will need to increase. In the 2012 budget, central government expenditure on RAN-GRK actions amounted to IDR 7.7 trillion, which is four times the level in 2009, but still accounts for less than 1% of total public expenditure. Internal estimates of costs required to meet the national target of a 26% reduction in GHG emissions by 2020 versus BAU (equivalent to approximately 767 MtCO2-eq) suggest that the current level of RAN-GRK support will only achieve 15% of the GHG target (i.e. 116 MtCO2-eq) (Ministry of Finance, 2012). The support needs for this LCMT project implementation and an expectation of GoI and Provincial support for implementation are, therefore, broadly in line with current approaches to public support and the anticipated additional expenditures and actions, keeping in mind that the focus of this LCDS is on leveraging private sector investments keeping with this need to minimise public contributions.

4.2.5.3.2 Public International

The volume and form of international support for the LCMT includes the possible role of the GoI in funding the financial mechanism, potentially in cooperation with a development partner or other source of international support. In the short term, international support will be sought for a comprehensive Technical Assistance Programme to carry out the necessary Enabling Activities (Policy, Regulatory, Technical, Financial and Institutional) and increase the capacity and the resources of the SEZ Management Agency and SEZ Council so they can be ready for implementation.

To date, Indonesia has been successful in securing support from the limited earmarked funds available for the implementation of Low Carbon Measures. An example is with the funding of NAMAs, namely through the NAMA Facility, jointly established by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Department of Energy and Climate Change (DECC) of the United Kingdom. The NAMA Facility awarded the Indonesian Sustainable Urban Transport Initiative (SUTRI) NAMA 15 million of grant support in November 2013 for the initial phases of implementation (GoI, 2013b). In addition to dedicated sources of support such as the NAMA Facility, this LCMT Financial Architecture is considering additional potential sources, as can be seen in the table below:

Topic-Sector	Financial Sources in Indonesia
Low Carbon Cities (i.e. multisector)	APEC, AFD, WB, ADB, EU, GCF
Energy Generation (Renewable Energy)	WB, ADB, USAID, JICA, AFD, UNDP-GEF, GCF, private
Energy End-Use (Energy Efficiency)	WB, ADB, USAID, JICA, GCF, private
Transport	WB, ADB, IDB, AusAID, JICA, AFD, GCF
Waste	WB, ADB, GCF
AFOLU	WB, ADB, GEF, USAID, GCF

Figure 56: Summary of LCMT potential sources of finance

Source: South Pole elaboration, 2014

A non-comprehensive list of some of the available support for Low Carbon Development and Finance[208] is presented below.

- The Asia Pacific Economic Commission (APEC)[209] is funding a number of Low Carbon Model Towns, the fifth being this current project. It would be the first option to go to request additional funding so this LCDS and related LCMs can be implemented.
- The French Development Agency (*Agence Française de Développement*, AFD[210]) is also funding a number of Low Carbon Action Plans for cities such as Bogor, as well as renewable energy and energy efficiency projects in Indonesia.
- The Asian Development Bank (ADB[211]) is also one of the strongest development partners in Indonesia, funding Low Carbon and Sustainable Development projects in renewable energy, energy efficiency, waste, transportation and AFOLU projects.
- The United States Agency for International Development (USAID[212]) also has a big low carbon and sustainable development portfolio in Indonesia, especially in energy and AFOLU.
- The Japanese International Cooperation Agency (JICA[213]) also has a very comprehensive support programme in Indonesia, currently funding low carbon energy (generation and end-use) and transportation projects.
- The Green Climate Fund (GCF)[214] is the intended main channel of multinational support as per the UNFCCC agreements. The GCF is not yet in operation, and has been slow to get started (which is why some developing countries have been hesitant to enter proposals and have instead sought bilateral support), but is now finally moving into pilot financing, and is expected to start full-fledged financing activities as soon as early 2015.
- The United Nations Development Programme (UNDP) is developing Low Carbon Strategies and proposals in a number of countries (including in Latin America) through its Low Emission Capacity Building (LECB)[215] and its Millennium Development Goal (MDG) Carbon[216] initiatives, and

[208] This list is not a comprehensive one but is based on the author's best professional knowledge at the time of the report. An official UNFCCC list of available NAMA support, which is not as detailed as this one, can be found at http://www4.unfccc.int/sites/nama/SitePages/InformationOnSupport.aspx. Another very comprehensive list of sources of climate finance (beyond NAMAs and Mitigation) can be accessed at the WB and UNDP Climate Finance Options (CFO) at http://www.climatefinanceoptions.org/.
However, please note that some of the institutions and initiatives listed here will fund only NAMA design activities (and related Technical Assistance), others will focus on NAMA Implementation (i.e. required investment for full-scale operation), while others could be used for both. Each of them have their specific requirements and procedures. Going in detail through all of them is beyond the scope of this analysis; however, more information is available in the provided websites and references, and South Pole has already advised a number of governments and NAMA developers on the possibilities of accessing such NAMA finance, so it could provide such assistance if required.
[209] http://www.apec.org/Press/Features/2014/0529_town.aspx
[210] http://www.afd.fr/lang/en/home/pays/asie/geo-asie/indonesia.org
[211] http://www.adb.org/countries/indonesia.org
[212] https://www.usaid.gov/indonesia.org
[213] http://www.jica.go.jp/english/index.html
[214] http://www.gcfund.org/home.html
[215] http://www.lowemissiondevelopment.org/
[216] http://www.mdgcarbonfacility.org/

preparing funding proposals mainly to be funded by the Global Environmental Facility (GEF).

- The GEF[217] itself has been financing mitigation activities and Low Carbon funding proposals that can be submitted directly without going through other multilateral organisations. The GEF is focussing on funding enabling and capacity building activities, namely in the fields of: (i) MRV, in particular the linkage of the LCM's MRV with the MRV needed for National Communications (NCs) and Biannual Update Reports (BURs); (ii) LCDS Design and Detailed Design/Piloting; and (iii) other Technical Assistance, such as Technology Need Assessments and National Action Plans (often in coordination with UNEP).
- The World Bank (WB), through a number of initiatives such as the Clean Technology Fund (CTF)[218], which include a number of funds that could be relevant for LCDS and LCM development; the Partnership for Market Readiness (PMR), which promotes preparation activities for the next global carbon markets; the Public-Private Infrastructure Facility (PPIAF), which could be used to co-finance a Public-Private Partnership (PPP); or the Carbon Finance Unit (CFU).
- The European Union provides Technical Assistance to partner countries through the Global Climate Change Alliance (GCCA)[219]; and the European Commission, that provides LCDS implementation support in the energy and transportation sectors.

The landscape of potential donors (the list above being intended as a non-comprehensive introductory list) is evolving constantly, as are their requirements and their understanding of their role in leveraging private sector funding (in the direction of the considerations made above). For example, both the GCF and the NAMA Facility have signalled their intent to provide a wide variety of financial instruments, in the realisation that only through the use of complex blending mechanisms will they be able to achieve their objectives of leveraging the private sector finance that is needed to implement low carbon initiatives successfully.

Besides the list above, some of the most active bilateral agencies are providing support for LCDS and LCM preparation activities. These include: the German Federal Ministry for Economic Cooperation and Development (BMZ), the German's International Climate Initiative (IKI), the German Development Banlk (Kreditanstalt für Wiederaufbau, KfW), the UK Department for Energy and Climate Change (DECC) through the UK's bilateral development agency (DFID).

4.2.5.4 Summary

In summary, the most recent developments and updates in relation to Financial Architecture for low carbon developments suggests that for this LCMT Financial Architecture to be successful, a targeted combination of sources of finance and financial mechanisms will need to be deployed. While a large number of donors is becoming progressively available, potential financiers should be engaged at the earliest stage, after the first outline of a financing model has been created. Identifying a central financial institution that can provide advice on the structuring of finance will be essential for achieving this. This central institution may play the role of a financial manager that can aggregate the different sources of finance and channel it through the different financial mechanisms based on its understanding of the functions of various financial instruments. The aggregator acts as a neutral financial adviser or "financial engineer" with the aim of eventually becoming involved in the implementation of the LCDS or LCMs at hand.

The following figure describes a general, indicative LCMT Financial Architecture and the inter-relations between the SEZ Management Agency (this is, the manager of the SEZ Bitung Implementation and the underlying LCDS and LCMs), the Financial Manager or "aggregator", and the LCDS/LCM beneficiaries (i.e. recipients of funds).

[217] http://www.thegef.org/
[218] https://www.climateinvestmentfunds.org/cif
[219] http://www.gcca.eu/

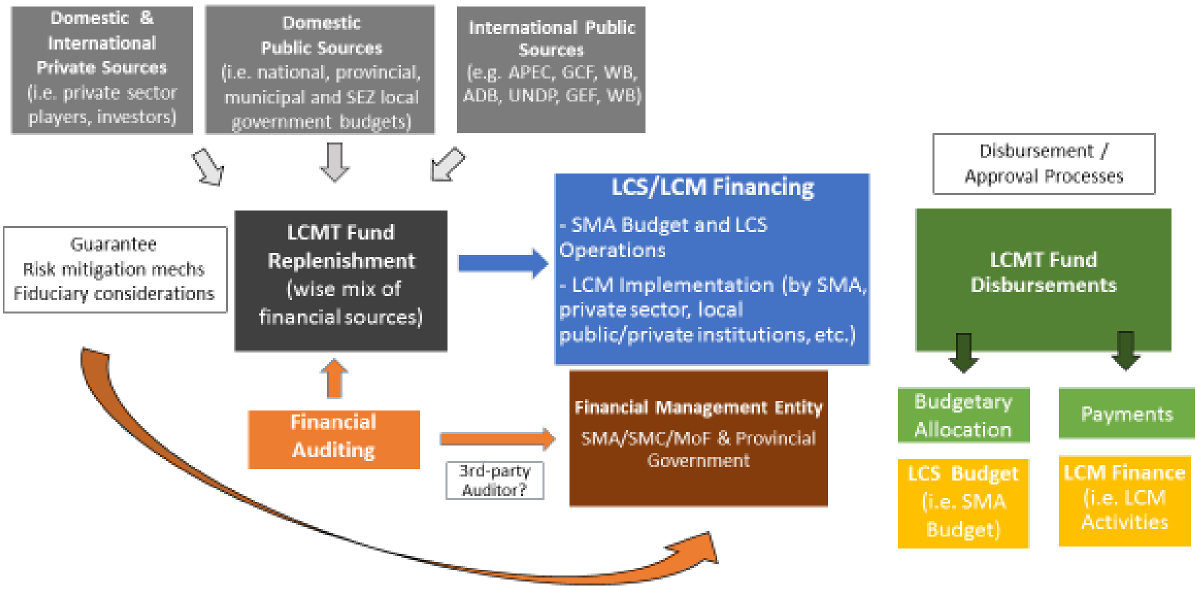


Figure 57: Suggested LCMT Financial Architecture

Source: South Pole, 2015

4.3 Summary of overall LCMT Impacts and Capital Investment Required

The following table summarises the total impacts of the low carbon model town project for the SEZ Bitung. Impacts are divided in terms of (i) overall contribution to the national policy objectives, (ii) overall GHG ER, and (iii) overall SD impacts.

In addition, the total estimated investment requirements for the implementation of the developed low carbon strategy for SEZ Bitung, i.e. technical implementation of all 10 selected low carbon measures and the creation of an enabling implementation environment, are presented.

Table 170: Summary of overall LCMT Impacts and Investment Requirements

Overall LCMT Contribution to National Policy Objectives	
Sector	**Contribution**
Energy	Contribution to Indonesia's National and Provincial Action Plan to reduce GHG Emissions (INDC & RAN/RAD-GRK)
	Contribution to the National Energy Strategy (KEN)'s objective to increase the share of RE in the national energy mix
	Contribution to the National Energy Conservation Development Plan (RIKEN)'s objective to achieve Indonesia's energy saving potential and reduced energy elasticity through energy efficiency and conservation measures.
Transportation	Contribution to the national sustainable transport and urban mobility objectives as per SISTRANAS, RENSTRA Transport and RPJBM
AFOLU	Contribution to the national objective of achieving a green and sustainable city environment
Waste	Contribution to the National Waste Management Strategy
Overall LCMT GHG ER Impact	
BAU Scenario (tCO_2e)	2,962,413
Total LCMT GHG ER (tCO_2e)	648,504
Mitigation Scenario (tCO_2e)	2,313,910
GHG ER Ratio (compared to BAU)	**21.9%**
Overall LCMT SD Impacts	
Impact Domain	**Specific Impact**
Environment	Reduction in Air, Water and Soil Pollution
	Noise Reduction
Social	Livelihood
	Health
	Time Savings
Growth & Development	Access to Clean and Sustainable Energy
	Capacity Enhancement
	Energy Security
	Education
Economic	Income Generation
	Expenditure Reduction
	Job Creation

Total LCMT Investment Requirements	
Capital Investment for LCM implementation	~ $33,400,000
Operation & Management costs for LCDS & LCM implementation	~ $13,800,000
Enabling activities (Technical Assistance costs) for LCDS & LCM implementation	~ $2,500,000
Total	**~ $49,740,000**

Source: Own elaboration

5 References

Asian Development Bank (ADB). (2014). *Handbook for rooftop solar development in Asia.*

Asia-Pacific Economic Cooperation (APEC). (2014). *The Concept of the Low-Carbon Town in the APEC region, Fourth Edition.*

B. Sudia, A. R. (2011). *The Assessment of Solar Radiation Intensity in Southeast Sulawesi Based on the Relative Position of the Sun.*

Bank Indonesia (BI). (n.d.). Retrieved 2015, from http://www.bi.go.id/id/perbankan/suku-bunga-dasar/Documents/SBDK%20Web%20Okt'11-%20Juli'15.xls

BAPPEDA (Bitung City) (RPJMD). (2011). *Bitung City Development Strategy.* Bitung: Government of Bitung City.

BAPPEDA (North Sulawesi). (2012). *North Sulawesi Province Action Plan for GHG Emissions Reduction (RAD-GRK).* Manado: Government of North Sulawesi.

BAPPEDA (North Sulawesi). (2010). *North Sulawesi Province Development Strategy (RPJMD).* Manado: Government of North Sulawesi.

BAPPEDA (North Sulawesi). (2010). *North Sulawesi Provincial Spatial Planning (RTRWP).* Manado: Government of North Sulawesi.

BAPPENAS. (2005). *Indonesia's Long-Term Development Strategy (RPJPN).* Jakarta: Government of Indonesia.

BAPPENAS. (2015). *Indonesia's Medium-Term Development Plan (RPJMN).* Jakarta: Government of Indonesia.

BAPPENAS. (2008). *National Action Plan on Greenhouse Gas Emission Reduction (RAN-GRK).* Jakarta: Government of Indonesia.

Bio Energy Consult. (n.d.). Retrieved 2015, from http://www.bioenergyconsult.com/coconut-biomass/

Centre for Research on Energy Policy. (2015). *End-use Model for Indonesia Low Carbon Development Pathways in Energy sector.*

China Communication Construction Company Limited (CCCC). (-). *Feasibility Study on SEZ Bitung Expansion.* Bitung: - .

Climate and Development Knowledge Network (CDKN). (2014). *Policy Brief, Small-scale IPPs in Indonesia.*

Climate Policy Initiative (CPI). (n.d.). Retrieved 2015, from http://climatepolicyinitiative.org/wp-content/uploads/2015/03/Sarulla_CPI_Randy_20150227.pdf

Dedinec, A. (2014). *Economic and environmental evaluation of climate change mitigation measures in the waste sector of developing countries.*

Dewan Energy Nasional. (2014). *Outlook Energy Indonesia 2014.* Jakarta.

Energy Sector Management Assistent Program (ESMAP). (2013). *Scaling-up renewable geothermal energy in Indonesia.*

German Development Agency (GIZ). (n.d.). Retrieved 2015, from http://www.greenchillers-indonesia.org/

German Development Agency (GIZ). (2010). *Beyond the Fossil City: Towards low Carbon Transport and Green Growth.*

German Development Agency (GIZ). (2013). *MRV Tool: How to Set Up National MRV Systems.*

German Development Agency (GIZ). (2014). *Waste Management V-NAMA in Indonesia .*

Gold Standard. (2011). Retrieved 2015, from thttp://www.goldstandard.org/wp-content/uploads/2011/10/Annex_I.pdf

Government of Bitung City. (2011). *City Government Work Plan (RKPD).* Bitung: Government of Bitung City.

Green Climate Fund (GCF). (n.d.). Retrieved 2015, from http://www.gcfund.org/home.html

ICLEI, WRI, C40. (2014). *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC).*

Indonesia Solid Waste Association (InSWA). (2015). *Waste to energy in Indonesia, Challenges and Opportunities, Indonesia Solid Waste Association.*

Institute for Transportation and Development Policy (ITDP). (2007). *Bus Rapid Transit, Planning Guide.*

International Institute for Sustainable Development (IISD). (n.d.). Retrieved 2015, from http://www.iisd.org/sites/default/files/publications/impact-fossil-fuel-subsidies-renewable-electricity-generation.pdf

IPCC. (2006). *IPCC Guidelines for National Greenhouse Gas Inventories.*

Japan International Cooperation Agency (JICA). (n.d.). Retrieved 2015, from http://www.jica.go.jp/english/index.html

Kompas. (n.d.). *www.kompas.com*. Retrieved 2015, from http://www.kompasiana.com/mulyady1688/10-peringkat-indonesia-di-dunia_54f934b0a333112c048b4a1a

Korea Land and Housing Corporation. (2015). *Inception Report: Study on the Revision of the SEZ Bitung Masterplan.* Bitung: Ministry of Land, Infrastructure and Transport of the Republic of Korea.

Local Governments for Sustainability (ICLEI). (n.d.). Retrieved 2015, from http://seas.iclei.org/logos/indonesian-cities-low-emissions-development.html

MEMR. (2014). *National Energ Policy (KEN).* Ministry of Energy and Mineral Resources. Jakarta: Government of Indonesia.

Ministry of Energy and Mineral Resources. (n.d.). Retrieved 2015, from http://kiosk.djk.esdm.go.id/index.php/view/19/rencana-kapasitas-pembangkit

Ministry of Energy and Mineral Resources. (2014). *MEMR Regulation No. 17 - Geothermal ceiling prices from year 2024 onwards.*

Ministry of Energy and Mineral Resources. (2014). *National Energy Conservation Development Plan (RIKEN).* Government of Indonesia.

Ministry of Energy and Mineral Resources. (2010). *National Energy Management Blueprint (PEN).* Jakarta: Government of Indonesia.

Ministry of Energy and Mineral Resources. (2014). *National Energy Master Plan (RUEN).* Jakarta: Government of Indonesia.

Ministry of Finance. (2014). *Low Carbon Support Programme; Design of an Energy Efficiency Financing Scheme.* Jakarta.

Ministry of Industry. (2008). *Master Plan Pengembangan Kawasan Industry Bitung.* Jakarta: Government of Indonesia.

Ministry of Industry. (2014). *Study on SEZ Bitung Expansion.* Jakarta: Government of Indonesia.

Office for Spatial Planning. (2011). *Bitung City Detailed Planning (RDTR).* Bitung: Government of Bitung City.

Outhred, H. (2014). *Insights from the Experience with Solar Photovoltaic Systems in Australia and Indonesia.*

Perusahaan Listrik Negara (PLN). (2015). Retrieved from http://www.pln.co.id/eng/

Perusahaan Listrik Negara (PLN). (2015). *Centralized photovoltaic development policy in Indonesia.*

Perusahaan Listrik Negara (PLN). (2015). *http://www.pln.co.id/wp-content/uploads/2015/05/Tariff-Adjusment-Juni-2015.pdf*. Retrieved 2015

Reducing United Nations - Emissions from Deforestation and Forest Degradation (UN-REDD). (n.d.). Retrieved 2015, from http://www.redd-indonesia.org/.

South Pole Group. (2015). *NAMA Design Document for Rural electrification with Renewable Energy in the Gambia.* United Nations Development Programme (UNDP).

South Pole Group. (2014). *UNDP NAMA SD Tool.* UNDP.

Sustainable Development Solutions Network. (2014). *Indicators and a monitoring framework for Sustainable Development Goals.*

United Nations (UN). (n.d.). Retrieved 2015, from http://www.un.org/sustainabledevelopment/sustainable-development-goals/

United Nations Development Programme (UNDP). (n.d.). Retrieved 2015, from http://www.id.undp.org/content/indonesia/en/home/presscenter/articles/2015/07/22/the-state-of-indonesia-s-renewable-energy.html

United Nations Framework Convention on Climate Change (UNFCCC). (2015). Retrieved from https://cdm.unfccc.int/methodologies/DB/EY2CL7RTEHRC9V6YQHLAR6MJ6VEU83

Walkability Asia. (n.d.). Retrieved 2015, from http://walkabilityasia.org: http://walkabilityasia.org/2012/06/29/enhancing-walkability-in-the-city-of-yogyakarta-indonesia/

World Health Organisation (WHO). (n.d.). Retrieved 2015, from http://www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/1528/1187

World Resources Institute (WRI); World Business Council on Sustainable Development (WBCSD). (2015). Retrieved from http://www.ghgprotocol.org/city-accounting

www.jakartaglobe.com. (n.d.). *www.jakartaglobe.com;* Retrieved 2015, from http://thejakartaglobe.beritasatu.com/business/electricity-hike-knock-seen-indonesia/

Annexes

Annex I: LCDS - Policy Recommendations

The table below represent a list of policy recommendations for the city, provincial and national level, aiming to create a holistic regulatory and policy framework for the implementation of the LCDS of the SEZ Bitung. The recommendations and policy objectives are targeted to specific LCMs in order to achieve a significant and relevant policy impact. In addition, the governmental institutions responsible for the development of the respective policy/regulation are indicated for each recommendation.

Table 171: List of Policy Recommendations for LCDS Implementation

Type of policy, approach	Policy required at Regional / Local level	Policy required at National level
LCM-1		
Project development and financial analysis	Policy / recommendation for PLN North Sulawesi region to purchase all generated power from renewable energy sources, and selling to industrial, commercial, residential electricity consumers (local grid operation and management) → *Bappeda, Sekertaris Daerah (Kota Bitung, dan Provinsi Sulawesi Utara)*	Policy / regulation on accelerating Renewable Energy development → Ministry of Energy and Mineral Resources (MEMR) *[existing regulation]* Law[220] 30 year 2009 Government Regulation[221] 14 year 2012 jo. 23 year 2014 Ministry of Energy Mineral Resource (MEMR) Regulation[222] 35 year 2013
Operational standard	Policy / instruction for SEZ Management Board to design and operate local electricity grid, with sufficient operational personnel and system maintenance → *Dinas Cipta Karya (PU), Dinas Energi (ESDM)*	*[existing regulation]* Ministry of Energy Mineral Resource (MEMR) Regulation[223] 19 year 2013
LCM-2		
Operational standard	Policy / recommendation for minimum 60 % flat-roof-area to be covered with solar PV panels → *Dinas Cipta Karya, Dinas Tata Ruang (PU)*	Not required further
LCM-3 and LCM-10		
Co-financing	Policy / instruction for MSW treatment development at city level, with optional scheme (PPP, public private partnership) → *Bappeda, Sekertaris Daerah (Kota Bitung, dan Provinsi Sulawesi Utara)*	Currently unidentified
Operational standard	Policy / instruction for SEZ Management Board to design and operate local electricity grid, with sufficient operational personnel and system maintenance. → *Bappeda, Sekertaris Daerah (Kota Bitung, dan Provinsi Sulawesi Utara)*	*[existing regulation]* Ministry of Energy Mineral Resource (MEMR) Regulation 19 year 2013

220 http://prokum.esdm.go.id/uu/2009/UU%2030%202009.pdf
221 http://www.re-guidelines.info/uploads/documents/pp_23_2014.pdf
222 http://prokum.esdm.go.id/permen/2013/Permen%20ESDM%2035%202013
223 http://prokum.esdm.go.id/permen/2013/Permen%20ESDM%2019%202013

Type of policy, approach	Policy required at Regional / Local level	Policy required at National level
LCM-5 and LCM-6		
Operation management	Policy / regulation enforcement for Energy Management implementation (technical staff assignment, critical recommendations) → *Dinas Energi (ESDM)*	Policy / instruction for more technical staff development on Energy Management and Energy Audit skills → *Kementerian ESDM, Perindustrian, Tenaga Kerja*
LCM-6		
Operation standards	Policy / standard for commercial building EUI (Energy Use Intensity) minimum 240 $kWh/m^2/year$ → *Dinas Cipta Karya, Dinas Tata Ruang (PU)*	
LCM-7		
Co-financing	Policy / instruction for transport infrastructure (Bus Rapid Transit) development, with optional scheme (PPP, public private partnership)	Currently unidentified
Traffic regulation inside Bitung SEZ	Policy / regulation enforcement for inter-area transport (inside Bitung SEZ), not-allowing private vehicles for personnel transport, and obligation for parking cars / motorcycles in parking area outside SEZ (with bus terminal transfer facility) → *Dinas Tata Ruang, Dinas Bina Marga (PU), Dinas Perhubungan*	Currently unidentified
Operation standards	Policy / standard for minimum bus capacity (at least 54 seated passengers, with optional 100 non-seat passengers extra) → *Dinas Perhubungan*	Currently unidentified
LCM-8		
Spatial planning indicators	Policy / recommendation for transport oriented development, more pilot activities (distribution of bicycle units, etc.) → *Bappeda, Dinas Tata Ruang, Dinas Bina Marga, Dinas Cipta Karya (PU)*	Policy / recommendation for transport oriented development, more pilot activities → *Kementerian Agraria dan Tata Ruang*
LCM-9		
Operation standards	Policy / regulation enforcement for Building Coverage Ratio (*Koefisien Dasar Bangunan, KDB*) on building construction → *Dinas Tata Ruang, Dinas Cipta Karya (PU), Dinas Kehutanan*	Policy / regulation enforcement for Building Coverage Ratio (*Koefisien Dasar Bangunan, KDB*) on building construction

Source: Own elaboration

Annex II: MRV Concept for LCDS Implementation at Provincial and City level

Regional Government GHG emissions reporting team (Tim RAD-GRK)

Implementation of the National Action Plan for GHG Emissions Reduction, or RAN-/RAD-GRK, at the Province Government level has been in place since 2013 / 2014, with the GHG emissions reporting team (Tim RAD-GRK) of North Sulawesi Province Government, under coordination of the Bappeda North Sulawesi. Covering 5 sectors (Agriculture, Forestry, Energy-Transport, Industrial-processes and Waste), the Team provided annual GHG reporting under the PEP-RAD-GRK scheme (*Pemantauan, Evaluasi, Pelaporan*) to the Bappenas office of 'Sekertariat RAN-GRK'.

Currently the Team (for GHG emissions reporting) operates in the Province Government level, and has no local-team at city level, such as in Bitung City Government. Monitored data for RAD-GRK reporting is compiled from the Province Government budget expenditure data, with little (or virtually none) check on the actual GHG mitigation project implementation. Opportunity for improvements to this procedure in coming years may comprise initiating the local MRV-team at each Regency / City Government level, capacity building and institutionalizing policy for GHG mitigation actions at local level, such as developing City Government Regulation, engagement to both public and private sector, as well as preparing technical infrastructure and standard to comply with the low carbon development strategy.

Reporting procedures for GHG mitigation actions by private entity

National GHG emission reporting from the Government of Indonesia is implemented through the National GHG Inventory Regulation 71 year 2011 (or *Inventarisasi Gas Rumah Kaca Nasional*). The Ministry of Environment Regulation 15 year 2013 on GHG mitigation MRV provides technical guidelines to the potential emissions reduction project, to be implemented by private entity (on top of GHG mitigation actions in the public sector). Implementation of the MoEF regulation for GHG emission reporting is under the responsibility of each GHG mitigation action (or *Penanggung Jawab Aksi Mitigasi*) management, either as a private entity, or a public office / unit. GHG reports would then be submitted to the Line Ministry for QA/QC procedure, possibly through local government offices (Province or Regency / City Government). Final reporting procedure is to be received by the MoEF, where Verification work might be completed by the Directorate General of Climate Change Control (Directorate of GHG Inventory and MRV). Upon completing the verification stage, each GHG Report data is to be fed into the National Registry System (SRN, *Sistem Registrasi Nasional*, Article 12 of MoEnv Regulation 15 / 2013), for the National GHG Inventory System and submission to the UNFCCC.

Figure 58: GHG emissions reporting, MoEF regulation and national GHG inventory

GHG reporting procedure for Bitung SEZ, coordinated by the Bitung City Government would need to be implemented through several stages. Specific GHG mitigation actions (or LCMs) would be constructed in Bitung SEZ in coming years, and not expected to be operational in the next 2 – 3 years. Therefore the GHG reporting might not become an immediate need for the Bitung SEZ Management Board, and the Bitung City Government. On the other hand, a series of Government policy would be important for the Bitung SEZ to provide guidance and direction for specific LCM to be implemented, or planned, and setting realistic priorities for both economic growth, project investment and climate sustainability.

Initiating the GHG reporting procedures at Bitung City and SEZ, prior to the LCM implementation and private entity GHG reporting, it would be important for the City Government to set up a local 'Tim RAD-GRK', for mainstreaming climate change mitigation actions in both public sector, community and private entity. Implementation states of the GHG reporting works are described in the following table.

The left column shows Government activities on the PEP-RAD-GRK (*Pemantauan, Evaluasi, Pelaporan*) for Bappenas GHG inventory system, to be implemented at Bitung City Government level (currently organized by Bappeda Province Government, North Sulawesi). The right column indicates steps to develop GHG reporting infrastructure to be required for Bitung SEZ investment, facilities construction and operations, starting from assessment of policy review, standards, guidelines for low carbon investment activities (LCMs), and thereafter performing monitoring and evaluation of such policy implementation (supervising GHG reporting procedures from Private entity activities).

Table 172: Timeline for GHG reporting activities, Bitung City Government and Bitung SEZ LCM

Stages	GHG Inventory activities (PEP-RAD-GRK, *Pemantauan Evaluasi Pelaporan*) for Public sector mitigation actions	GHG mitigation actions reporting (LCMs), for Private entity (industry, commercial, residential)
Initial stage *(current, 2015 – 2016)*	Implementation of low carbon activities / projects (RAD-GRK, Government initiatives), Needs assessment and Government personnel identification for local MRV-team at City Gov. units (Tim RAD-GRK)	Policy review, standards and guidelines Developing City Government Regulation on low carbon strategy for project investment (industrial, commercial, residential sector), e.g. in Bitung SEZ
Follow-up stage A *(2017 – 2018)*	GHG emissions reporting for Bitung City (PEP-RAD-GRK, *Pemantauan Evaluasi Pelaporan*) on sectors and sub-sectors: Agriculture, Forestry, Energy-Transport, Industrial-process, Waste-management	Implementation of City Government Regulation, policy monitoring and evaluation (during Bitung SEZ facilities construction)
Follow-up stage B.1 *(2018 – 2019)*	*(same as above)*	Operations and monitoring activities in Bitung SEZ (GHG reporting, to be submitted to Line Ministry, through Regional Government, City / Province)
Follow-up stage B.2 *(2018 – 2019)*	QA / QC of GHG emission reports, by Regional Government (Tim RAD-GRK) Verification of GHG reports, by MoEF (Directorate General of Climate Change)	QA / QC of GHG reports, by Line Ministry (supported by Regional Gov.) Verification of GHG reports, by MoEF (Directorate General of Climate Change)

Source: Own elaboration

Needs assessment for for the local MRV-team (Tim RAD-GRK), Bitung City Government

Low Carbon Model Town LCMT development in Bitung SEZ would require quite significant amount of work on the GHG emissions reporting details, in compliance with the existing Government scheme for GHG inventory (President Regulation 61 and 71, year 2011) and GHG mitigation MRV (Ministry of Environment Regulation 15 year 2013). It is expected that quite a large number of periodic GHG reports would be submitted to the Government (with upcoming industrial and commercial activities in Bitung SEZ starting 2017), and the role of Regional Government would increase to manage some of the supervision and QA/QC procedures on such individual GHG reports.

At present, very little discussion and policy is happening at the City level, while such limited information might be available at the Province level, mainly within the Bappeda office, with some other Government staff assigned to the RAD-GRK team, North Sulawesi. Later on, the amount of activities would need to increase in both Province and City level, to ensure implementation of GHG mitigation measures (or LCMs), and measuring performance for continuous improvement.

Policy required for MRV activities at project level (the local-team, or Tim RAD-GRK)

Examples of policy development in coming years, for the local MRV-team is provided in table below.

Table 173: Policy required, Bitung City Government and Bitung SEZ LCM

Scope	Type of Policy	Descriptions
Resources and team development	Bitung City Mayor Decree	Assignment of City Government Unit (SKPD) for supporting the local MRV-team (Tim RAD-GRK, Bitung City); Assignment of staff for member of the team.
	North Sulawesi Governor Decree	Daily and weekly coordination of GHG reports (Tim RAD-GRK) at Province level and Regency / City level.
Policy implementation and private entity participation	Bitung City Mayor Regulation	Regulation for industry and commercial management (owners) to comply with the Ministry of Environment Regulation 15 year 2013 on MRV and periodic GHG reporting procedures, to the local MRV-team (Bitung City Government units); Regulation for industry and commercial facility management (owners) to comply with the Ministry of Energy Regulation 14 year 2012 on the Energy Management.
	North Sulawesi Governor Regulation	Regulation for industry and commercial management (owners) to comply with the Ministry of Environment Regulation 15 year 2013 on MRV and periodic GHG reporting procedures, to the local MRV-team (Bitung City Government units); Regulation for industry and commercial facility management (owners) to comply with the Ministry of Energy Regulation 14 year 2012 on the Energy Management.
Implementation guidelines	Bitung City Mayor Decree	Guidelines on the implementation of GHG mitigation activities and responsible entities; References for GHG emissions calculation and scope / description of mitigation activities (LCMs).
	Bitung SEZ Management Board Regulation	Implementation coordination and information center available (One Stop Services) for specific requirements at project level (LCMs); Provision of services and material handling activities, with regard to low carbon strategy in Bitung SEZ.
	Bitung SEZ Management Board Decree	Procedures for industry and commercial development, with regard to the low carbon strategy in Bitung SEZ; Procedures for residential and public services development, with regard to the low carbon strategy in Bitung SEZ and Bitung City; Other guidelines and standards for implementation of low carbon measures (LCMs) in Bitung SEZ and Bitung City.

Source: Own elaboration

Workplan development for local MRV-team

Examples of work plan development for the local MRV-team in the next years:

Table 174: MRV Workplan for Bitung City Government and SEZ Bitung

Scope	Activities	Descriptions
Low carbon measures LCM potentials identification	Follow-up of the revised Bitung SEZ Masterplan, Collaboration with Bitung SEZ Management Board.	Developing calculation procedure and MRV format for specific industry, with potential implementation in Bitung SEZ.
Capacity building	Workshop and discussion sessions on the revised PEP-RAD-GRK (Pemantauan Evaluasi Pelaporan), Bappenas scheme (RAN-GRK).	Understanding GHG baseline emissions at the sector and project level, with proper reference to the emissions calculation.
GHG reports QA/QC and Verification	Workshop and discussion sessions on the revised Ministry of Environment Regulation 15 year 2013 on Mitigation Action MRV, the National GHG Inventory scheme.	Understanding GHG reporting procedures, QA/QC and Verification for proper GHG inventory system (*Sistem Inventarisasi GRK Nasional, SIGN*)
Project Investment for industry and commercial activities	Low carbon project specific feasibility study, for industrial and commercial activities.	Detailed financial analysis for specific project investment (production volume, price, costs, tax, interest, etc.) with regard to the actual low carbon measures being implemented in private entity facilities.
Spatial planning and regional development	Low carbon project specific feasibility study, for urban planning and economic development activities (public sectors).	Detailed financial analysis for specific project investment (volume of services, willingness to pay, costs, tax, interest, etc.) with regard to the actual low carbon measures being implemented in public sector.
Public engagement and consensus building	Identification of potential issues and opportunities for low carbon measures (LCMs) to support low carbon economic development in Bitung SEZ and Bitung City.	Participatory consultation and tripartite meeting (Government, Public/Academics and Private Entities) to discuss low carbon economic development and setting priorities for specific project implementation, public services as well as private sector involvement in the regional development issues.
Consultative meeting with Ministry of Environment, Ministry of Energy	Discussion sessions on the revised Ministry of Environment Regulation 15 year 2013 on Mitigation Action MRV, the National GHG Inventory scheme and the APEC Energy Working Group-B.	Understanding GHG reporting procedures, QA/QC and Verification for proper GHG inventory system (*Sistem Inventarisasi GRK Nasional, SIGN*)

Source: Own elaboration

Role of each specific Bitung City Government Unit (SKPD) in the local MRV-team (*Tim RAD-GRK*) is described in the table below:

Table 175: Bitung City Government Unit (SKPD), potential roles in local-team (Tim RAD-GRK)

Bitung City Gov.Unit (SKPD)	Role
Bappeda Bitung	Coordinator of local MRV-team (*Tim RAD-GRK*)
Bitung Office of Industry (*Dinas Perindustrian*)	Supervision of low carbon measures in the industrial and commercial energy efficiency sector, QA/QC
Bitung Office of Transport (*Dinas Perhubungan*)	Supervision of low carbon measures in the transport sector, QA/QC
Bitung Office of Public Works (*Dinas PU*)	Supervision of low carbon measures in the street lighting sector, QA/QC
Bitung Office of Spatial Planning (*Dinas Tata Ruang*)	Supervision of low carbon measures in the forestry and urban green sector, QA/QC
Bitung City Environmental Agency (BLH)	Supervision of low carbon measures in the waste management sector, QA/QC

Source: Own elaboration

APEC Project: EWG 06/2014 A

Produced by
South Pole Carbon Asset Management Ltd.
Technoparkstrasse 1
8005 Zurich
Switzerland
Tel: +41 43 501 35 50
Email: info@thesouthpolegroup.com
Website: http://www.thesouthpolegroup.com

For
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

APEC#216-RE-01.2