



**Asia-Pacific
Economic Cooperation**

**Policy Review for APEC Low-Carbon
Model Town Phase 6
Mandaue City, Cebu Province
The Philippines**

Final Report

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APEC Low-Carbon Model Town (LCMT) Project - Phase 6

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ABBREVIATION AND ACRONYMS

Abbreviation

CO ₂	Carbon Dioxide
GWh	Gigawatt-Hour
km ²	Square Kilometre
KWh	Kilowatt-Hour
m ²	square metre
mm	millimetres

Acronyms

ATC	Area-wide Traffic Control
AGT-CML	Automatic Gateway Transit -Cebu-Mandaue-Lapu-Lapu
BERDE	Building for Ecological Responsive Design Excellence
BEMS	Building Energy Management System
BRT	Bus Rapid Transit
BAU	Business-as-Usual
BPO	Business Process Outsourcing
CPDO	City Planning and Development Office
CENRO	City Environment and Natural Resources Office
CSSEAZ	City South Special Economic Administrative Zone
CPC	Community Project Council
CLUP	Comprehensive Land Use Plan
DOE	Department of Energy
DENR-EMB	Department of Environment and Natural Resources–Environmental Management Bureau
DOTr	Department of Transportation
DCS	District Cooling System
DHC	District Heating and Cooling
EEV	Energy Efficient Vehicles
EMS	Energy Management System
ESCO	Energy Service Company
E-Trike	Electric Tricycle

EV	Electric Vehicle
FAR	Floor Area Ratio
GEMP	Government Energy Management Program
GGAs	Green Growth Areas
GHG	Greenhouse gas emissions
HUC	Highly Urbanised City
INDC	Intended Nationally Determined Contribution
IACC	Inter-agency Committee on Climate Change
LRT	Light Rail Transit
LGU	Local Government Unit
LCMT	Low-Carbon Model Town
MRT	Mass Rail Transit
MRF	Material Recovery Facilities
MOA	Memorandum of Agreement
MCAGB	Metro Cebu Airshed Governing Board
MCWD	Metro Cebu Water District
MDCDB	Metropolitan Cebu Development Coordinating Board
MEPS	Minimum Energy Performance Standards
NCCAP	National Climate Change Action Plan
NEECP	National Energy Efficiency and Conservation Program
NFSCC	National Framework Strategy on Climate Change
NREP	National Renewable Energy Program
NGO	Non-Government Organisation
NMT	Non-motorised Transport
PCU	Passenger Car Unit
PEP	Philippine Energy Plan
PhP	Philippine Peso
PHILGBC	Philippine Green Building Council
PSA	Philippine Statistic Office
PSSD	Philippine Strategy for Sustainable Development
PUDs	Planned Unit Developments
RGDP	Regional Gross Domestic Product
SLF	Sanitary Landfills

TOD	Transit-Oriented Development
UNFCCC	United Nations Framework Convention on Climate Change
VECO	Visayas Electric Company
WACS	Waste Analysis Characterisation Study
WTE	Waste-to-Energy
WD	Water District WD

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PREFACE

The APEC Low-Carbon Model Town (LCMT) project has been implemented as a response to the APEC Energy Ministers' directive. At the 9th APEC Energy Ministers Meeting held in Fukui, Japan in June 2010, the Energy Ministers discussed the low carbon paths in the context of energy security through cooperative solutions for energy-sustainable APEC region that would support the economic growth and development of member economies. To manage the growing energy consumption and the associated greenhouse gas emissions (GHG) in urban areas in the APEC region, the Energy Ministers recognised that low carbon technologies should be introduced in city planning to promote energy efficiency, as well as to reduce fossil energy use. Along this line, the Energy Ministers agreed to launch an 'APEC Low-Carbon Model Town Project (LMCT)' to demonstrate best practices and successful models in the implementation of advanced low-carbon technologies. The project is one of the priority initiatives under the APEC energy cooperation framework.

The key objectives of LCMT are:

- (1) To develop the 'Concept of the Low-Carbon Town', which will serve as a guidebook on the principles and implementation of low-carbon urban design;
- (2) To assist in the implementation of the concepts in selected Low-Carbon Model Towns by providing feasibility studies and policy reviews of these urban development projects; and,
- (3) To share the best practices and real-world experiences on low-carbon urban design with planners and policymakers throughout the APEC region.

Based on the concepts of LCMT, a Feasibility Study is carried out by an urban planning consultant as a form of assistance extended to chosen urban areas. Likewise, a Policy Review is undertaken (as presented in this report) to review existing and planned policies and regulations in relation to the development of low-carbon town.

APEC has already conducted six LCMT projects, which started in 2011. The Phase 1 project was held in Tianjin, China for Central Business District; the Phase 2 project in Samui Island, Thailand for Island Resort Area; the Phase 3 project in Da Nang, Vietnam for Redeveloping Mixed-Use Urban District; the Phase 4 project in San Borja, Peru for Residential Area; and the Phase 5 in Bitung, Indonesia for Industrial Area. For Phase 6 in Mandaue City, the focus LCMT is on Cooperation with Neighbouring Areas.

This report presents the findings of Policy Review for Mandaue City, Cebu Province, Philippines.

The reviewed economy and the Review Team share the accountability for the Policy Review. A team of six experts conducted the Policy Review in Mandaue City (see Appendix A). They visited Mandaue City from 06-07 December 2016.

During the visit, the Review Team held comprehensive discussions with representatives and experts from the City Government of Mandaue, officials from neighbouring cities and Metro Cebu, and other central government agencies such as the Department of Energy (see Appendix B).

The Review Team wishes to thank all the presenters and participants who spent time with the Review Team for discussions. We express our special thanks to the City Government of Mandaue and the Department of Energy for organising the LCMT Policy Review Team event.

EXECUTIVE SUMMARY

Mandaue City is one of the highly urbanised cities (HUCs) in Cebu province, which has started to embark on several programs related to low carbon strategies, some of which are in cooperation and close partnership with neighbouring cities and municipalities under the Metro Cebu Vision 2050, Roadmap. Among the projects identified in the Roadmap are the transport-oriented development like the Automatic Gateway Transit -Cebu-Mandaue-Lapu-Lapu (AGT-CML) along with the development of metro public transport system (LRT and MRT), and the Green Loop, a portion of which is located in Mandaue City.

The Mandaue Vision 2020 (Strategy Map) embodies the City's low carbon development framework with the overall mission of **'Creating an Environment for Sustainable Economic Growth and Liveable Society through Responsive Governance and Multi-Sectoral Involvement.'** The Vision 2020 promotes development strategies on sustainable urban land use, low-carbon building and energy efficiency, efficient transport and environmental management. It integrates the implementation of the City's new Comprehensive Land Use Plan, which covers the development of 'green growth areas;' and the Green Building Ordinance; the realization of the Green Loop and public transport system; watershed management of the Butuanon River, which is part of the Green Loop development; and, waste management.

The feasibility study conducted recognised that these low carbon-related projects could realise a significant reduction in GHG emission in the City once fully implemented. From this, Mandaue could develop its low carbon targets while improving the quality of life of its residents through collective leadership and effective governance as espoused in the Vision 2020.

Mandaue is the subject of the APEC Policy Review (Peer Review) led by the Asia Pacific Energy Research Centre to assist the City develop its plans on low carbon development and become a model town for others in the APEC region. Part I of the review contains background information on Mandaue City and provides the context to Part II, – which is produced by the Review Team. The findings and 52 recommendations for implementation in this policy review are grouped by topic: legal and institutional frameworks, sustainable urban planning, low-carbon buildings, area energy management systems, energy efficiency, renewable energy and untapped energy planning, transport, environmental planning and others. It should be noted that implementing these recommendations should take into account quantifiable issues (costs and timing), and less tangible considerations (leadership and stakeholder interest and support), as follows:

- Is the action cost effective? (e.g. a simple analysis of the unit cost of carbon emission mitigation).
- Is the action visible and engaging? (e.g. to what extent will the action educate residents and visitors about the importance of sustainability?).
- Does the action generate political and community support? (e.g. does strong leadership exist to promote the action?)
- Will community, businesses and other stakeholders engage to promote these changes?

The Review Team's recommendations are graded according to priority for implementation:

- Immediate action;
- Action needed in next two to three years; and,
- Action required in the long-term.

The prioritisation is intended to provide the policymakers a base to determine the timeframe for each recommendation contained in this report.

An 'integrated framework' explains the rationale for the prioritisation. Leadership and community support along with an integrated framework could make Mandaue become a leading and model Low-Carbon Town (LCT). Recommendations set forth under immediate action are the highest priority considering that they are both cost effective and likely to solicit strong and greater community support. The public can embrace the low-carbon path from the beginning and reap the benefits to having sustainable economic growth and better quality of life in the future.

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

RECOMMENDATIONS

LEGAL & INSTITUTIONAL FRAMEWORKS

Recommendations for immediate action★★★

- Rec. 1:** Maintain good cooperation among offices within the Mandaue City Government through the coordination of the City Planning and Development Office (CPDO), requiring immediate support at the local executive level (Mayor and Vice Mayor).
- Rec. 2:** Involve private business and local resident entities closely in low carbon development planning. To support this coordination, a Community Project Council (CPC) may be created for Planned Unit Developments (PUDs)/Green Growth Areas (GGAs) as recommended by the feasibility study in the early stage of the planning.
- Rec. 3:** Coordinate with the neighbouring cities and the central government through the Metro Cebu Development and Coordinating Board (MCDCB) mechanism. In order to consolidate this mechanism, the Houses of Congress are hoped to pass the bill to change MCDCB's legal status and allocate public fund for its operations, programs and projects.

Recommendations for action in the next 2-3 years★★

- Rec. 4:** Enact an Energy Efficiency Law by both Houses of Congress to institutionalise and mandate the energy efficiency program in all sectors and local government units

SUSTAINABLE URBAN PLANNING

Recommendations for immediate action★★★

- Rec. 5:** Make the most use of the PUDs/GGAs by introducing pilot low-carbon projects.

Recommendations for action in the next 2-3 years★★

- Rec. 6:** Promote decent housing options and attract diverse economic activities to transform Mandaue's inner city to a modern mixed-use urban center.
- Rec. 7:** Prepare for transit-oriented land use by discouraging individual car use.
- Rec. 8:** Maximise the use of vacant and/or underutilised land in strategic areas.
- Rec. 9:** Create an urban development agency to provide technical and financial support to accelerate inner city development.
- Rec. 10:** Replicate the leading initiatives in other LGUs in Metro Cebu by facilitating knowledge sharing.

LOW-CARBON BUILDINGS

Recommendations for immediate action★★★

- Rec. 11:** Build internal capacity for program oversight and for contractors and designers.
- Rec. 12:** Encourage development of multi-unit housing and mixed use commercial developments.

Recommendations for action in the next 2-3 years★★

- Rec. 13:** Strengthen the minimum performance standards.
- Rec. 14:** Provide more active role for utility companies (e.g. programs to facilitate replacement for higher energy efficient appliances).

Rec. 15: Encourage private sector financing through energy service contracts.

Recommendations for action in the longer term★

Rec. 16: Promote more energy efficient building design standards in a tropical climate, especially to builders of smaller residential and commercial buildings.

Rec. 17: Define the roles of the building board.

AREA ENERGY MANAGEMENT SYSTEMS

Recommendations for immediate action★★★

Rec. 18: Set a specific plan and program for the adoption and implementation of energy management system (EMS) in Mandaue.

Recommendations for action in the longer term★

Rec. 19: Incorporate EMS in the Green Building Code.

Rec. 20: Encourage all public buildings to be equipped with EMS.

ENERGY EFFICIENCY

Recommendations for immediate action★★★

Rec. 21: Promote (via financing and incentives) onsite renewable integration and LPG generating facilities for high energy users.

Rec. 22: Incorporate low carbon elements in the entire City, not only in GGAs.

Recommendations for action in the next 2-3 years★★

Rec. 23: Shift away from CFL lighting to LEDs as a part of the Minimum Energy Performance Standards and in government building program.

Rec. 24: Formalise data collection procedure for liquid fuels in the City in order to improve quality of carbon accounting.

Recommendations for action in the longer term★

Rec. 25: Emulate the central government program (Department of Energy) on offering subsidised building audits and coordination with energy service companies (ESCOs).

RENEWABLE ENERGY AND UNTAPPED ENERGY PLANNING

Recommendations for immediate action★★★

Rec. 26: Carry out an independent expert and peer review assessment on the viability of a waste-to-energy plant.

Rec. 27: Provide quality information and awareness on solar photovoltaic (PV).

Recommendations for action in the next 2-3 years★★

Rec. 28: Investigate and deploy opportunities for further utilisation of industry onsite waste as feedstock for energy.

Rec. 29: Investigate the use of municipal waste-derived and company-derived biogas.

Recommendations for action in the longer term★

- Rec. 30:** Deploy grid-supported solar charging stations, utilising roofs of covered transit areas as a component of e-trike and e-jeepney program.
- Rec. 31:** Investigate the feasibility of developing multi-utility energy centres.
- Rec. 32:** Maintain a watching brief on the opportunity for solar water heating and provide awareness through support of uptake if demand unfolds.

TRANSPORT

Recommendations for immediate action★★★

- Rec. 33:** Develop a coordinated, long-term transport development strategy and plan.
- Rec. 34:** Increase the effectiveness of existing road infrastructure to reduce traffic congestion and carbon emissions.
- Rec. 35:** Develop education and training programs to improve driver behavior (follow rules, eco-driving, etc.) and the environmental awareness for public citizen (★★★ and ★★).
- Rec. 36:** Coordinate efforts by different levels of governments and coordinate and integrate transport development strategy and urban planning (★★★ and ★★).
- Rec. 37:** Set up a strategy for a step-by-step movement toward public transit systems (bus ★★★, area-wide elevated light rail such as Automated Guideway Transit (AGT)-Cebu-Mandaue-Lapu Lapu (CML) Line ★★, Bus Rapid Transit (BRT) ★) to reduce traffic jams, starting in areas with heavy traffic congestion and transport demand.
- Rec. 38:** Promote the uptake of electric vehicles by encouraging the production and use of e-bikes, e-trikes and e-jeepneys in the near term. ★★★ In the longer term, Department of Energy should encourage the Philippine automotive industry to take steps to eventually manufacture electric vehicles. ★

Recommendations for action in the next 2-3 years★★

- Rec. 39:** Promote the shift to non-motorised transport (NMT) by making it easier (comfortable and safe) to walk and bike, including constructing covered walkways and paths for pedestrians and cyclists separate from motorised traffic (e.g., Green Loop project).
- Rec. 40:** Introduce higher fuel efficiency vehicle standards and high quality standards for gasoline and diesel (as part of the Philippine program).

Recommendations for action in the longer term★

- Rec. 41:** Reduce the use of automobiles on the road by controlling the number of automobiles (e.g., based on even/odd license numbers) during rush hours (6:00-7:00, and 17:00-18:00) to reduce traffic jams and environmental pollution. Congestion charges for certain roads or parts of roads with heavy traffic are recommended for the longer term.
- Rec. 42:** Build more road infrastructure and develop a transit infrastructure network that integrates rail, buses, walking and cycling.

ENVIRONMENTAL PLANNING

Recommendations for immediate action★★★

- Rec. 43:** Establish Low-Carbon Town Implementation and Coordination Unit in the City Government of Mandaue.
- Rec. 44:** Inculcate self-awareness and knowledge enhancement among the citizen, business and industry fraternity to support low-carbon town initiatives.
- Rec. 45:** Expand energy efficiency educational program.
- Rec. 46:** Incorporate carbon dioxide (CO₂) reduction in programs that address water quality from industrial operations.

Recommendations for action in the next 2-3 years★★

- Rec. 47:** Redefine the scope of low-carbon town to include a comprehensive green growth definition in order to encourage greater private sector involvement in the realisation of sustainable economic growth.
- Rec. 48:** Incorporate re-forestation into comprehensive stormwater management plan.

Recommendations for action in the longer term★

- Rec. 49:** Address the main culprit of carbon emission in Mandaue.
- Rec. 50:** Resolve pertinent issues of basic amenities and relocation/redevelopment of informal settlements area through integrated planning and win-win solution among the stakeholders.
- Rec. 51:** Optimise green building incentives.
- Rec. 52:** Encourage industry sector to participate in green growth initiatives, i.e. greening the industry through green manufacturing, remanufacturing and green/sustainable preferred products.

PART I: BACKGROUND INFORMATION

The City Government of Mandaue and the results of the Feasibility Study undertaken by ALMEC Corporation in October 2016 contributed to the background information contained in this report. This information provides some context to the Policy Review Team's recommendations.

1. OVERVIEW OF THE MANDAUE CITY

1.1 BRIEF HISTORY

Long before the Spaniards came to the Philippines, Mandaue was already inhabited with people. Mandaue was endowed with a fertile land where thick vine variety known as 'Mantawi' grew abundantly. The neighbouring areas associated the place with this vine where Mandaue got its name. Mandaue was already a trading center and dubbed as the 'merchant's paradise' of the region (Central Visayas) as it was once a busy port where merchants traded and held businesses.

During the Spanish time, Mandaue then was famous for its artistic carpentry and skilled carpenters. As early as 1575, the pieces of furniture mostly hand carved in hardwood by the Mandauehanons reached the households of prominent citizens in Spain. In the 1840's Mandaue also engaged in sugar production due to increasing demand for this commodity in foreign markets. It was favourably affected by the role of Cebu as an open port in the inter-island trade and a distribution center for a rapidly developing area of commercial sugar production. In the Middle of 19th Century, Cebu province was among the leading sugar producers in the Philippines.

Other early industries in Mandaue were salt making and fishponds, which provided income and employment for the people. Mandaue also developed its ceramics and bamboo crafts industries. In the late 1800's and early 1900's, rice and sugar production were expanded extensively.

Mandaue's industrialization gradually progressed during the time when it became a chartered city in August 1969 upon the promulgation of the Republic Act no. 5519, an 'Act Creating the City of Mandaue.' In 1991, Mandaue was considered as a highly urbanised city (HUC) (source: City Government of Mandaue).

1.2 GEOGRAPHY AND TOPOGRAPHY

Mandaue City is located in the Province of Cebu in Central Visayas (Region VII)¹ on Zone 51-P, Luzon, Philippines at Latitude 10.352834° and Longitude 123.960915° coordinates. (Figure 1). Mandaue City is on the central-eastern coastal region of Cebu and it is bordered on the north by the Municipality of Consolacion; on the south and west by Cebu City; and on the east by Lapu-Lapu City in Mactan Island. The City has a total land area of 32.85 square kilometres² (km²) (including the foreshore areas of 200.7 hectares), which represents 2.8% of the total area of Metro Cebu and less than 1.0% of the total land area of Cebu Province (ALMEC, 2016). The City forms part of the Cebu Metropolitan Area³ (Metropolitan Cebu or Metro Cebu) composed of seven cities and six municipalities, and it links the main island of Cebu and Mactan Island via two bridges – the Mactan-Mandaue Bridge and the Marcelo Fernan Bridge.

Generally, Cebu Province is characterised by hilly and mountainous terrain, and in like manner the Metro Cebu possesses the same land profile. Metro Cebu has relatively limited flat land with about 72% of its area having a slope of more than 18% gradient. Meanwhile, Mandaue City is located within the mainland Metro Cebu where the land elevation is less than 100 meters (330 feet). About 30% of the City is flat within the 2.0-5.0% slope category, 32% belonging to the 5.0-20% category, and the remaining areas have 20-30% slope. The City also

¹ Central Visayas is comprised of four provinces – Bohol, Cebu, Negros Oriental and Siquijor.

² The Philippine Statistics Authority (PSA) reported 25.18 km² total land area of Mandaue City. Land area is based on cadastral survey from Land Management Bureau of the Department of Environment and Natural Resources

³ Metropolitan Cebu is composed of cities of Cebu, Danao, Mandaue, Lapu-Lapu, Talisay, Naga and Carcar, and the municipalities of Compostela, Liloan, Consolacion, Cordova, Minglanilla, and San Fernando.

has two major rivers – the Butuanon River traversing the northern section and the Mahiga Creek (Subangdaku River) traversing the southern portion (ALMEC, 2016)

Figure 1: Geographical Location of Mandaue City

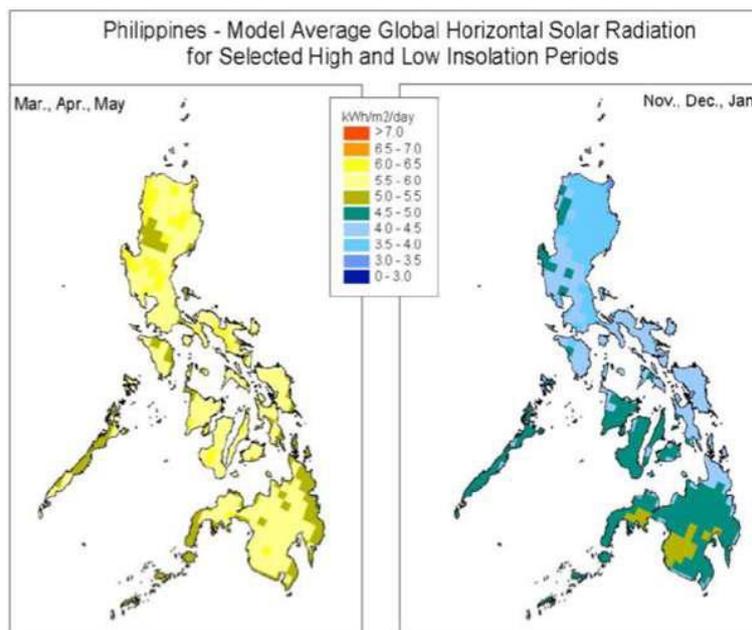


Source: Google Map, Maplandia 2016 and Wikipedia

1.3 CLIMATE

Just like the rest of the Philippine archipelago, Mandaue City has a tropical climate with an annual mean maximum temperature of 31.3°C and annual mean low of 24.8°C. Due to high temperature and the surrounding bodies of water, the City has a high average relative humidity of 81% (Mandaue, 2015a). Throughout the archipelago, the combination of warm temperature and high absolute humidity results in high sensible temperature. Thus, it is uncomfortable during the hot dry season (March to May) as the temperature and humidity reach the maximum levels (source: PAGASA).

Figure 2: Solar Radiation in the Philippines



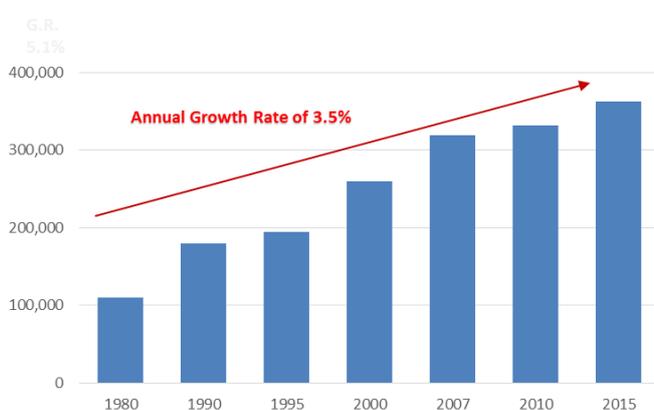
Source: The Roadmap Study for Sustainable Urban Development in Metro Cebu, JICA, 2015 and ALMEC, 2016

In terms of rainfall, the lowest level occur from February to April, and increases from May to July. The City has recorded an annual average rainfall of 1,564.5 millimetres (mm) with the greatest fall in one day is 493.7 mm and lowest fall is 276.1 mm. The mean annual rainfall in the Philippines ranges from 965 to 4,064 millimetres annually (source: PAGASA). The City’s average rainy days are 146 in a year, while the prevailing wind is the northeast with a speed of 3.0 meters per second (10.8 kilometres per hour). From 1982 to 2011, the City experienced 30 typhoons, 15 storms and 14 tropical depressions (Mandaue, 2015a). In some cases, super typhoons that hit the City caused damages to infrastructure and facilities like the suspension of operation of the first Mactan Bridge in 1990 due to Typhoon Ruping (international name Typhoon Mike) (ALMEC, 2016).

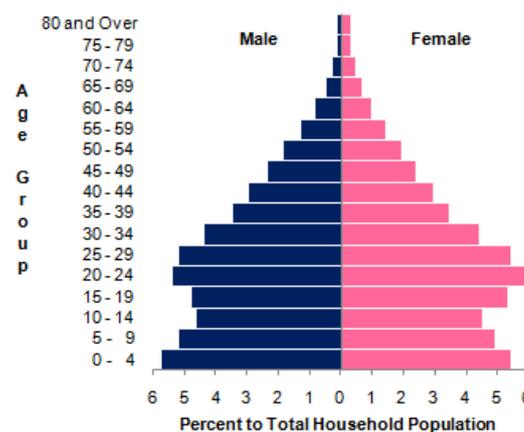
Cebu receives the highest solar radiation of 5.5-6.0 kWh/m²/day between March and May, which makes the entire province suitable for photovoltaic energy (Figure 2).

1.4 DEMOGRAPHY

Figure 3: Population and Population Composition



Source: Philippine Statistics Authority



Source: PSA, 2013 (based on 2010 Census)

Mandaue City is one of the 17 HUCs outside the National Capital Region (Metro Manila), and one of the three HUCs in Central Visayas (PSA, 2016b). Based on 2015 Census, Mandaue City’s population stood at 362 654, more than three-fold increase from 1980 level, translated to an annual average growth rate of 3.5% (Figure 3) (PSA, 2016a). From 2010 Census level, the City’s population grew by 9.5% (or an additional of more than 31 000 people (from 2010 to 2015). The City’s population is about 8.0% of the total population of Cebu province and 13% of the Metro Cebu population (source: PSA). In the same Census year, the City registered 94 547 total number of household, up by 21% from 2010 level. However, average household size was lower at 3.8 persons from 4.2 persons in 2010 (PSA, 2016b). The City’s household size is lower than the Cebu province household size of 4.4 (PSA, 2016b).

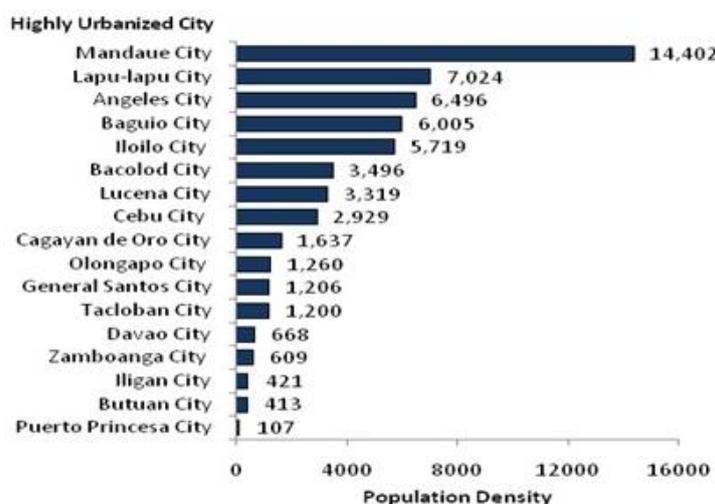
The 2010 Census revealed that Mandaue City’s population median age was 24.2 years, which means that about half of the population was below 24.2 years old. This level was higher than median age of 22.3 years recorded in 2000 Census. Female population accounted for 50.3% of total population, while male population comprised 49.7%, equivalent to a ratio of 99 males for every 100 females. The City’s overall dependency ratio was 50, indicating that for every 100 working-age population, there were 50 dependents. In the Philippines, the working population is 15 to 64 years old (PSA, 2013).

Although Mandaue City is the sixth smallest local government unit (LGU) in Cebu province in terms of land area (second smallest among the LGUs in Metro Cebu), it has the highest density, which was recorded at 14 402

persons per square kilometre (km²) in 2015⁴. The City’s population density increased by 33% from the 2010 level of (10 815 persons/ km²) (based on 2010 Census). Its population density is significantly higher than the other HUCs in Cebu province – Cebu City (with 2 929 persons per km²) and Lapu-Lapu City (with 7 024 persons per km²). The City is also the densest among the 17 HUCs outside the National Capital Region (PSA, 2016c) (Figure 4). The City’s high population density is indicative of the urbanisation and industrialization taking place that encourage in-migration of workers from others areas in Cebu province (even from other island provinces). Urbanization level of the City continuously increased in the past two decades: 95% in 1990; 96% in 2000; and 97% in 2010 (Mandaue, 2015b).

Based on the JICA Study, the City’s population will reach 445.4 thousand in 2030 and increase to 506.9 thousand in 2050, which more than doubles the 2010 level (JICA, 2015).

Figure 4: 2015 Population Density of HUCs (Outside the National Capital Region)



Source: PSA, 2016c

1.5 LAND USE

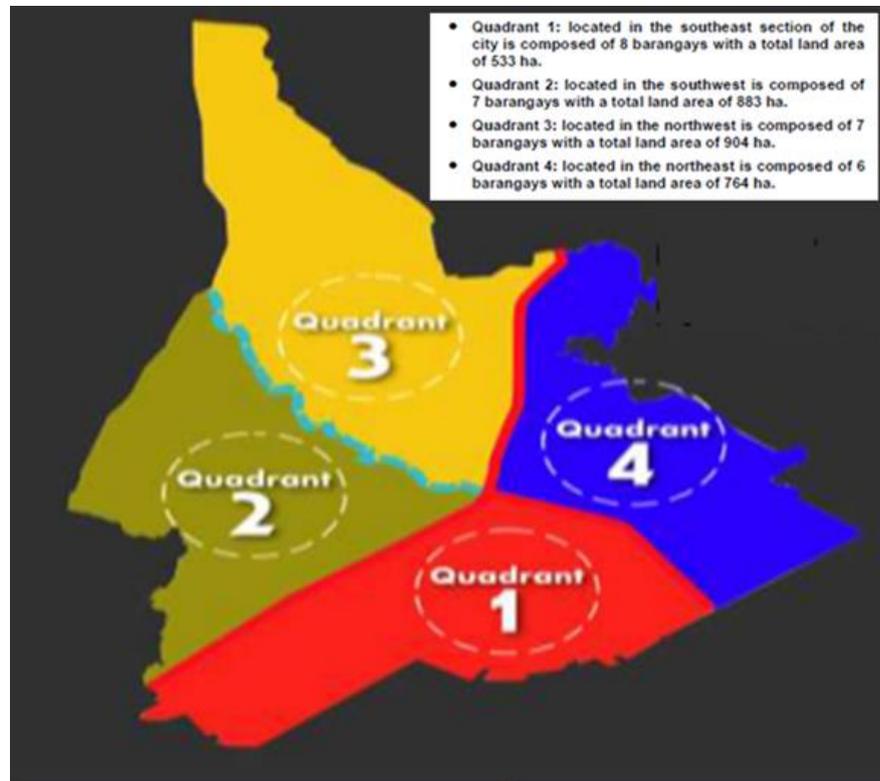
Mandaue City’s total land area, divided into 28 villages (barangays) including the City South Special Economic Administrative Zone (CSSEAZ), represents only 2.6% of the total land area of Metro Cebu and less than 1.0% of the total land area of the Province of Cebu. Around 30% of existing land use of the City is dedicated for industrial and commercial purposes. Historically, the City was an industrial town with 925 hectares devoted for industrial uses, representing about 60% of Metro Cebu’s industrial land. Industries and commercial establishments are spread along the City’s National Highway (M.C. Briones–Cebu North Road). Likewise, a number of industries are located within the seven kilometres stretch of the Butuanon River together with formal and informal settlers, thus some industrial and domestic wastes go to the river (ALMEC, 2016).

The City’s development pattern is characterised by economic activities that are dispersed and diversified. The City’s spatial growth is based on quadrant system consisting of four quadrants as follows: Quadrants 1 and 2 for multi-nodal growth pattern, which is strip/linear development, and Quadrants 3 and 4 for trend extension growth (Figure 5). It may be noted that the city’s urbanization development is a linear strip pattern, such that the development in city centre extends to major arterial roads, and thus leading to the growth in some villages (barangays) as periphery (or secondary) growth centres. Further, other interior villages also experienced

⁴ Based on 2015 Census by the Philippine Statistics Authority. The Feasibility Study on APEC Low-Carbon Model Town Phase 6 for Mandaue City conducted by ALMEC in 2016 reported a population density of 11 800 persons per square kilometre (118 persons/hectare).

significant developments. The City's 1979 Comprehensive Land Use Plan (CLUP) allocated a total of 2 513 hectares for various land uses (excluding roads, waterways and foreshore). Of the total, only 79% (or 1 995 hectares) is utilised and the remaining (518 hectares) is idle or vacant lands, and a portion is used for aquamarine purposes (ALMEC, 2016).

Figure 5: Quadrant Spatial Designation



Source: City Planning & Development Office of Mandaue

Strategic policies have been identified to manage the future growth of the City. The City will pursue trade promotion and commerce in Quadrants 1 and 2, while Quadrants 3 and 4 are designated areas for light and medium manufacturing activities. Manufacturing facilities located in all quadrants will be allowed to operate but are discouraged to expand and diversify their operation.

In the 1980's, the City also embarked on the Southpoint Reclamation Project covering 180 hectares where buildings have been constructed for commercial, business and logistics purposes. The City intends to develop the rest of the blocks within the reclamation project. Likewise, the City is developing the Mandaue Global City Project, a new reclamation project occupying a total land area of 131 hectares. The reclamation project was already awarded in 2013 to a private developer consortium. The new reclamation area will be a mixed-use land development featuring a waterfront commercial centre, an agro-industrial logistics park, Cansaga Bay Commercial and Residential Centre, and Mandaue Central Watersport and Leisure Park (Business World, 2013).

To address the issue of urban sprawling, a new zoning ordinance was promulgated in July 2015 amending the 1979 CLUP. It was revealed that around 47% of actual land uses do not conform to the 1979 zoning plan, and 20% of the land remains idle. The presence of shattered section in some built-up areas in city centre and in the southpoint reclamation area also pose a problem to the City.

The City identified three strategies in relation to the new CLUP, namely: Integrated Development, Sustainable Environment and Social Upliftment (Figure 6). The new CLUP establishes 19 base zones within the City to ensure

that the present and potential uses are maximise, as well as it regulates the land developments accordingly to the land use plan. Under the ordinance, regulations for each zone are set according to building density and guidelines (such as height and architectural design), and allowable uses (ALMEC, 2016).

Figure 6: Mandaue City's Vision based on the New Comprehensive Land Use Plan



Source: City Government of Mandaue

The CLUP's Integrated Development City establishes six Planned Unit Developments (PUDs) or the Green Growth Areas (GGAs), which are designed to bring in economic growth and development in a manner that is energy efficient and responsive to climate change. These PUD zones are intended for land development and redevelopment areas. In each PUD, the City requires to have a Master Development Plan and compulsory Green Building Certification with at least 3-Star BERDE rating⁵ in accordance with the City's Green Building Ordinance. BERDE or the **'Building for Ecological Responsive Design Excellence'** is a green building rating system development by the Philippine Green Building Council (PHILGBC) and supported by both the government and private sector (BERDE).

1.6 ECONOMIC

REGIONAL ECONOMY

In the past several years, the economy of Central Visayas region grew much faster than the total Philippine economy, exhibiting an annual average growth rate of 7.3% (from 2009 to 2015) (Table 1). However, in 2015, the regional gross domestic product (RGDP) of Central Visayas only increased at slower pace by 4.8%, the first time that the regional economy posted a lower growth rate compared with the total Philippine economy (5.9% growth rate). Contraction in the industry pulled down the regional economy. The regional economy still remains as the fourth largest regional economy, contributing about 6.0% to the total Philippine economy (Philstar, 2016). Among the sectors, the industry sector displayed the highest growth rate, an average of more than 8.0% annually and with an average share to RGDP of around 35%. However, the industry output fell in 2015 at -0.5% from

⁵ BERDE measures, verifies and monitors building performance beyond the existing mandatory regulations and environmental standards. BERDE assessment and certification are done through third party certification and process in conformity to international standards.

2014 level. The service sector followed next with 7.5% annual growth rate, and representing more than half of RGDP, while agriculture sector was only growing at less than 1.0% a year.

Table 1: Central Visayas' Gross Domestic Product (at Constant 2000 Price)

	2009	2010	2011	2012	2013	2014	2015
Central Visayas (in Billion P	301.9	339.5	366.4	397.7	427.3	460.7	483.0
Share (%)							
Agriculture	8.9	8.0	7.8	7.2	6.6	6.0	5.9
Industry	32.6	35.4	36.4	36.6	37.7	38.9	36.9
Services	58.5	56.6	55.8	56.2	55.7	55.1	57.2
Share to Total GDP (%)	5.7	6.0	6.2	6.3	6.3	6.4	6.4

Source: PSA, 2016d

PROVINCIAL ECONOMY

Metro Cebu has a significant contribution to the regional economy being one of the economic centres in Central Visayas, and the second largest metropolis in the economy with a population of about 2.90 million in 2015 (from 2.55 million in 2010). Metro Cebu's GDP is seen to rise at 8.3 annually until 2020, and 7.8% a year towards 2030 (from 2020), and then slows down to 5.8% a year from 2030 to 2050 (projection from JICA Study) (Business Mirror, 2015).

In April 2011, the Metropolitan Cebu Development Coordinating Board (MCDCCB) was created through a Memorandum of Agreement (MOA) signed by the local government heads of cities and municipalities within the Metro Cebu, heads of central agencies, and leaders of the private and civil society organizations. The MCDCCB is a consortium of the Province of Cebu with four focus area-based committees – Integrated Development & Planning, Environment and Public Safety, Human Resource, Assets and Partnerships, and ICT and Knowledge Management (MCDCCB, 2016). Its primary aim is to facilitate the formulation, coordination and monitoring of the integrated development strategies and developments of Metro Cebu, and to function as the platform for planning and implementing selected projects for the Metro-Cebu wide growth areas, such as: coordinated development planning (i.e., land use); transportation and traffic management; affordable housing; disaster risk reduction and environmental management (i.e., flooding, water resources and waste management); competitiveness; and public finance and project financing. A Bill has been filed in both Houses of Congress for the MCDCCB to have a legal status and mandate as a government institution overseeing the economic growth and development of Metro Cebu. Once the status of the MCDCCB is legislated, the central government will allocate funds for its operation and projects.

MANDAUE CITY

Mandaue City has a vibrant and a well-diversified economy, which comprises of manufacturing, trading and commercial activities. The City is a host to more than 13 000 commercial establishments and over 1 000 manufacturing establishments. Just like its neighbouring cities, new businesses are coming in such as the business process outsourcing (BPO), information technology and communication-related activities, and technology-intensive manufacturing activities.

The City's annual output in 2013 amounted to PhP 142 billion (current price), of which the commercial sector accounted for 65%, and the industry sector (manufacturing) contributed 35%. The agriculture sector output only amounted to PhP 278 million, less than 1.0% of the total output of the City. During the period 2009-2013, annual

gross sales and capital investments in commerce and trade sub-sectors rose at an average of 11% and 7.0%, respectively, with the number of establishments expanding at 2.0% annually, on the average. On the other hand, the manufacturing sub-sector recorded a 5.0% average increase in annual gross sales and 1.5% in capital investments for the same period.

With Mandaue's strategic location and better business environment, many investors and entrepreneurs decided to locate in the City, such as export oriented and quality food/beverage processing, furniture and fashion jewelry makers, metal works, packaging materials and other finished and intermediate goods. The City is dubbed as the 'Furniture Capital of the Philippines,' as it accounts for about 75% of the economy's total furniture exports (Mandaue, 2016). Most business activities are concentrated along the arterial roads linking the City centre to the other barangays (ALMEC, 2016). The clustering of many types of industries and service activities attracts more skilled and semi-skilled workers in the City, as well as different industries that support each other's needs. Its business friendly policies and lower business taxes make it more profitable for new industries to locate in the City (CDN, 2012).

In the Competitiveness Index⁶ of the National Competitiveness Council of the Philippines, Mandaue ranked 44th (overall) from more than 140 cities in the Philippines in 2015. The City ranked 16th in the economic dynamism category.

1.7 TRANSPORT

Mandaue City has a total road network of about 139.3 kilometres with six major arterial roads as entry and exit points from and to the neighbouring areas of Cebu City, Lapu-Lapu City and Cordova in Mactan Island, and the northern part of Metro Cebu. The City is a public transportation hub (inter-city public transport) as it houses the North Bus and jeepney terminals serving the commuters in Metro Cebu and the northern towns of Cebu province. It also provides access to the Mactan International Airport and to the Cebu international and domestic ports. As the City is in the midst of Metro Cebu, it has the most densely road network, about 3.4 kilometres per square kilometre (km/km²) road density, among the cities and municipalities within the Metro Cebu. With this, the City faces large amount of traffic volume coming from different origins and destinations outside its boundaries. The most congested boundary is between Cebu City and Mandaue City, around 910 thousand passengers per day recorded in 2014, and the next congestion is between Mandaue City and Lapu-Lapu City with 323 thousand passengers per day (Figure 7). The volume of traffic traversing Mandaue alone is 438 thousand per day. Further, largest number of trips were registered in the cities of Cebu, Mandaue and Talisay. Based on the Screen Line Survey of 2014⁷ on vehicle traffic volumes, sharp peaks in traffic volume occurred in the morning between 6:00 to 7:00, and in the evening between 17:00 to 18:00 (ALMEC, 2016). The City Government of Mandaue also operates the '*Traffic Control Centre*,' which monitors 21 major intersections and if necessary adjusts the traffic signals depending on the traffic conditions.

The City's intra-city transport is made up of tricycles⁸ (and pedicab) plying around its road network and villages (barangays). There are about 1 585 registered tricycles in the City (Mandaue, 2015b).

As Mandaue's local economy keeps on growing with more industrial and commercial establishments continue to locate in the City, residential neighbours are also increasing with the influx of residential subdivisions,

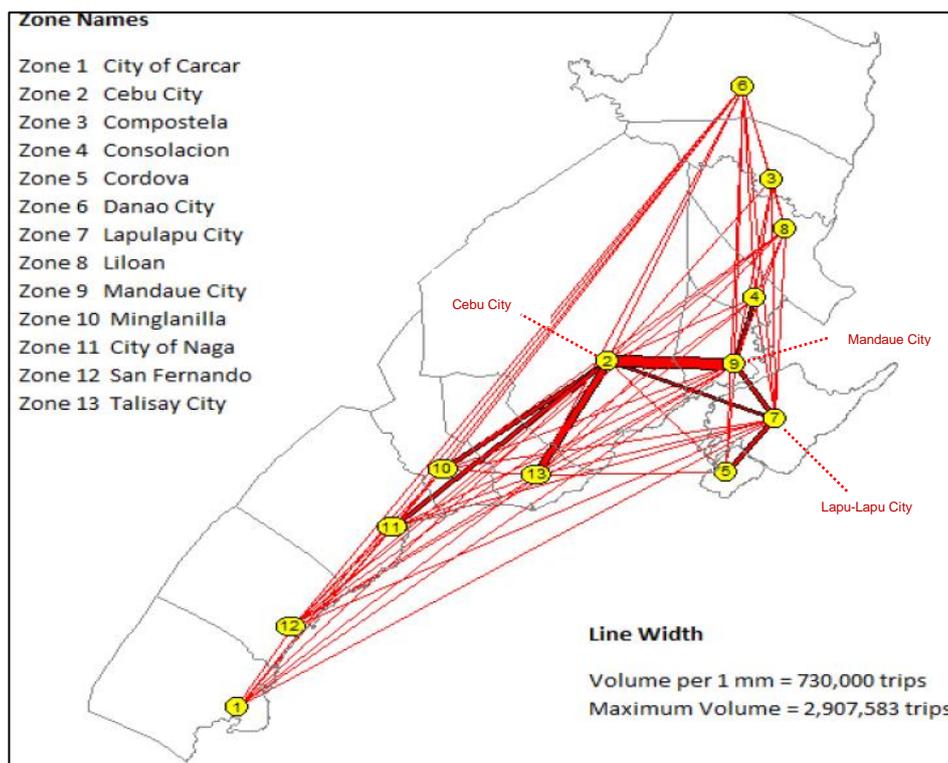
⁶ The Cities and Municipalities Competitiveness Index is an annual ranking of Philippine cities and municipalities developed by the National Competitiveness Council through the Regional Competitiveness Committees (RCCs) with the assistance from the USAID (NCC, 2016).

⁷ The Screen Line Survey was as part of the Roadmap Study for Sustainable Urban Development in Metro Cebu conducted by JICA in 2015.

⁸ Tricycle is a motorcycle with a sidecar making it as a three-wheeled public vehicle in the Philippines, specifically in villages (barangays). The pedicab is a bicycle with a sidecar and also used as a public vehicle just like tricycle.

townhouses and condominiums. The City’s urban growth and development could put more pressure on the transportation system, as well as the traffic flow in its road network with foreseen increase in the number of private cars and the limited road capacity, not to mention other issues on public transport system (Mandaue, 2015b)

Figure 7: Transportation and Traffic



Source: JICA, 2015 and ALMEC

1.8 ELECTRICITY SUPPLY

The Visayas Electric Company (VECO), a privately-owned electric distribution utility, provides the electricity supply in some cities and municipalities in Metro Cebu, specifically for the cities of Cebu, Mandaue, Talisay and Naga, and the municipalities of Consolacion, Liloan, Minglanilla and San Fernando. VECO is the second largest electric distribution utility in the Philippines.

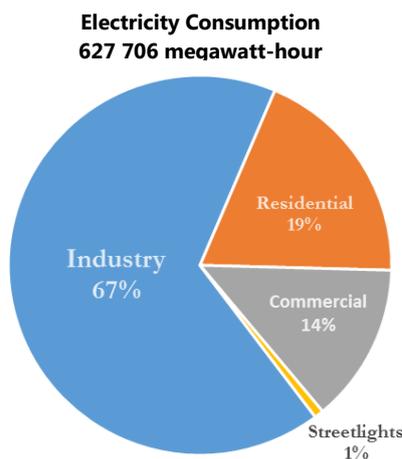
Table 2: Cebu Sub-Grid Generation by Plant Type (Gigawatt-Hour)

Cebu	2010	2011	2012	2013	2014	2015	GR (%)
Coal	1 499	3 249	3 674	3 652	3 354	3 868	17.0
Oil	930	395	477	532	448	281	-18.0
Natural	0	0	0	8	4	0	0
Hydro	5	6	7	5	4	4	-3.7
Total	2 434	3 651	4 158	4 196	3 811	4 151	9.3

Source: Power Statistics, Department of Energy

Due to growing economic activity, electricity demand of Cebu province grew annually at 9.0% during the last six years (2010-2016) (Table 2). The province (an island grid) is highly dependent on coal for power generation, providing about 90% of total electricity supply. Electricity generation from coal increased annually at 17%, while generation from other sources (oil, natural gas and hydro) declined (DOE, 2015). In 2015, electricity demand of Cebu accounted for more than 30% of the entire Visayas Island demand, and 5.0% of total electricity demand of the Philippines (DOE, 2015a).

Figure 8: Mandaue City Electricity Consumption, 2015



Source: VECO and ALMEC

Mandaue City’s electricity consumption reached 628 gigawatt-hour (GWh) in 2015, about 15% of total Cebu electricity demand (Figure 8). For the same year, the industry sector required around two-thirds of the City’s electricity consumption, followed by residential (20%) and commercial (14%). Peak demand hours happen from 10:00 to 12:00 noon, 13:00 to 15:00 and 17:00 to 20:00 (source: VECO). From the Home Interview Survey⁹ done in 2014, 58% of the surveyed households had an average monthly electricity consumption of 50 kilowatt-hour (KWh) and below, and 24% with 51 KWh to 100 KWh and the rest with more than 100 KWh (ALMEC, 2016). All households in the City are energised (with access to electricity).

1.9 WATER SUPPLY AND QUALITY

Water supply in Metro Cebu is provided either by the Water District (WD) with a franchise over the area or the local government units. The Metro Cebu Water District (MCWD) serves eight of the 13 local government units within the Metro Cebu – the cities of Cebu, Mandaue, Lapu-Lapu, Talisay, and the municipalities of Compostela, Liloan, Consolacion and Cordova. The water supply in the five remaining (two cities and three municipalities) is managed by water districts or waterworks of their local governments supported by a private water supply company (Table 3). The MCWD’s water source is mainly groundwater, constituting 98% of its total water supply. Surface water only accounts for 2.0% of water supply (JICA, 2015). For Mandaue City, the MCWD is the primary source of tap water. However, a significant portion of the City’s water supply is deep wells.

⁹ The Home Interview Survey was as part of the Roadmap Study for Sustainable Urban Development in Metro Cebu conducted by JICA in 2015

The Metro Cebu water system is beset with several issues, among which are salinity intrusion, peripheral urbanization of the watershed areas, active faults in Cebu, and difficulty or limited access to water of some households (JICA, 2015).

Table 3: Water Sources and Supply in Metro Cebu, 2013

Sources	Water Supply (m ³ /day)	Share (%)
a) MCWD	209 252	92.0
Ground water	173 183	76.1
Surface water	3 080	1.4
Bulk supply (Private supplier)	28 108	12.4
Desalination (Mactan Rocks)	4 881	2.1
b) Non-MCWD Service Area	18 273	8.0
Danao	5 541	2.4
Minglanilla (MIWASCO)	2 690	1.2
Naga (ABEJO)	1 200	0.5
San Fernando (LGU)	1 271	0.6
Carcar (Water District)	7 571	3.3
Total	227 525	100.0

Source: JICA, 2015

1.10 WASTE MANAGEMENT

Metro Cebu generates an estimated volume of 652 tons per day of solid waste sent to final disposal sites and dumpsites (representing 60% of total waste produced). Of the total volume, 486 tons (or 44% of total waste) is disposed in sanitary landfills (SLFs) and the remaining 122 tons (or 11% of total waste) is placed in various dumpsites. About 4.0% of the solid waste ends up in illegal dumpsites. As not all wastes brought to the material recovery facilities (MRF) are being subject for recycling, roughly 858 tons/day (or 77% of the total wastes) are for final disposal. Table 4 shows the total solid waste produced in Metro Cebu.

The City's solid waste is classified into household and non-household¹⁰. From the average 240 tons of garbage generated daily in 2016 (from 180 tons/daily in JICA study in 2015), household waste accounts for 86% of the total. Non-household wastes generate a combined waste equivalent to 14% of the total (source: City Government of Mandaue).

The City Government of Mandaue closed the SLF located at Barangay (village) Umapad in 2009 to undergo rehabilitation with the inclusion of MRF. However, the SLF was reopened on a temporary basis to accommodate and process the City's generated waste. The City is also looking at other alternatives such as the development of new SLF site (ALMEC, 2016).

From the 2016 data collected from the Department of General Services (DGS), an average of 1 132 kilograms (1.13 tons) of municipal solid waste daily was disposed at Umapad dumpsite. Based on the Waste Analysis Characterisation Study (WACS) conducted by the City Environment and Natural Resources Office (CENRO) with the help of the Department of Environment and Natural Resources–Environmental Management Bureau (DENR-EMB), the waste characterisation for households is as follows:

¹⁰ Non-household waste is comprised of wastes from commercial, industrial, agricultural and institutions, such as hospitals, health centers and school

- Biodegradable - 28%
- Recyclable - 34%
- Residual - 35%
- Special - 3%

Table 4: Solid Waste Generation

Cities/Municipalities (Metro Cebu)	Solid Waste Generated	
	Generation (tons/day)	For Final Disposal (tons/day)
Cebu City	423	390
Lapu-Lapu	175	50
Mandaue	180	175
Talisay	80	60
Danao	45	16
Carcar	30	25
Naga	21	18
Compostela	15	10
Consolacion	35	30
Cordova	20	10
Liloan	34	25
Minglanilla	45	40
San Fernando	9	9
Total	1 112	858

*Note: Solid waste generation is estimated based on 2010 population
Source: JICA, 2015*

2. LOW-CARBON FRAMEWORK

2.1 LOW-CARBON POLICIES AND FRAMEWORK

CENTRAL GOVERNMENT LEVEL

At the central government level, the 1987 Philippine Constitution clearly declares the policy of the state **'to protect and advance the right of the Filipino people to a balanced and healthful ecology in accord with the rhythm and harmony of nature.'** This provision in the Constitution mandates the protection of the environment and the promotion of sustainable developments.

A Philippine Strategy for Sustainable Development (PSSD) was formulated in 1991 along with the creation of an Inter-agency Committee on Climate Change (IACC) to coordinate various climate related activities and proposed policies. The Philippines was one of the first economies to establish a central committee to coordinate various climate change related activities, propose climate change policies and prepare positions to the United Nations Framework Convention on Climate Change (UNFCCC). The PSSD was clearly elaborated in the Philippine Agenda 21 after the 1992 Rio Earth Summit (United Nations Conference on Environment and Development). The Philippine Agenda 21 was formally adopted in 1996. The Philippines likewise signed a number of international treaties on environment and climate change such as the UNFCCC signed in 1992, and the Kyoto Protocol in 1998, which was ratified in November 2003.

Among the notable laws on environment and climate enacted by the Philippines was the Clean Air Act (Republic Act 8749) in 1999 as a measure to reduce air pollution and incorporate environmental protection into development plans (DENR). A Climate Change Commission was also created (which replaced the IACCC and the Presidential Task Force on Climate Change¹¹) by virtue of the Philippine Climate Change Act of 2009 (Republic Act 9729) as a policy-making body under the Office of the President. The Commission is tasked to monitor and evaluate programs and action plans relating to climate change, as well as mainstream climate change in disaster risk reduction and in central and local development plans in the Philippines (CCC). The Climate Change Commission came out with the National Framework Strategy on Climate Change (NFSCC) in 2010 as guiding principles, and the National Climate Change Action Plan (NCCAP) in 2011 which outlines the specific programs and strategies for adaption and mitigation for the period 2011-2028 (CCC).

On energy, the Philippines passed the Biofuels Act of 2006 (Republic Act 9367) mandating biofuels blend in gasoline and diesel. Currently, the government enforces 2.0% biodiesel blend (for diesel) and 10% bioethanol blend (for gasoline). The Renewable Energy Act of 2008 (Republic Act 9513) was enacted to accelerate the exploration and development of renewable energy resources to reduce dependency on fossil fuels and expand the share of clean energy in the primary energy supply mix. The National Renewable Energy Program (NREP) was formulated in June 2011 to institutionalise a comprehensive approach to address the challenges and gaps that prevent wider application of renewable technologies in a sustainable manner and the necessary action plans to facilitate and encourage greater private sector investments in renewable energy development (DOE, 2011). The National Energy Efficiency and Conservation Program (NEECP) was introduced by the Philippine government in 2004 as umbrella and banner program on the various initiatives on energy efficiency and conservation such as:

¹¹ The Presidential Task Force on Climate Change was created in February 2007. One of its mandates was to conduct rapid assessment on the impact of climate change to the Philippine setting, especially on the most vulnerable sectors/areas, like water, agriculture, coastal areas, as well as on the terrestrial and marine ecosystems, among others (Office Gazette, 2007).

- Government Energy Management Program (GEMP) which requires all government offices to reduce their monthly consumption of electricity and petroleum products (transport) by at least 10%; and the
- Energy Efficiency Standards and Labelling Program for selected household appliances helps consumers to choose the appliance model that provides the same amount of performance at lower electricity consumption.

The government has drafted an economy-wide Energy Efficiency and Conservation Roadmap with a goal to reducing the economy's energy intensity by 40% in 2030 based on 2010 level (DOE, 2015b).

PROVINCIAL LEVEL

Mandaue, as a highly urbanised city, is not under the jurisdiction of the Provincial Government of Cebu, and thus not covered by provincial ordinances. However, the City is still connected (being one of the cities in Metro Cebu) with its participation and involvement in the province-wide initiatives and programs like the Roadmap for Sustainable Urban Development in Metro Cebu. Therefore, the City's low carbon development program is linked with the province's policy and institutional framework.

The province implements a Green and Disaster-Resilient Building Program to contribute to the overall reduction of greenhouse gas emissions (GHG), and minimise the public expenditures associated with natural disasters (e.g., flooding and strong typhoon) through increased energy efficiency in buildings, water conservation and waste reduction, among others. The Program is mandatory for buildings and public works projects, and only voluntary for private projects (Cebu, 2014).

The province has Environment Code as guiding principles for various sectors (such as, land use, energy, coastal and marine, and water resources) for promoting and adopting sustainable approaches in development planning and environmental protection. Meanwhile, the Sustainable Cebu Program is geared towards building sustainable cities and municipalities in the province and encourage the local government units and private sector to engage and implement sustainable development initiatives (Cebu, 2013).

The province created the Metro Cebu Airshed Governing Board (MCAGB) in 2002 to conduct air quality management and develop action plans to address air pollutants. Members of the Board are the local government units of Metro Cebu, central government agency (Department of Environment and Natural Resources), private sector and the academe.

The establishment of the MCDGB in 2011 is a clear manifestation of the local government units in close partnership with the private stakeholders to lead and plan for the future growth Cebu. The MCDGB formulated the Mega Cebu Vision 2050 in 2013 in cooperation with JICA and Yokohama City. The Mega Cebu Vision 2050 serves as the blueprint for sustainable economic development. It comprises of four strategic pillars, namely: Competitiveness, Mobility, Liveability and Metropolitan Management, which further translate into 15 development directions as shown in Figure 9. A follow-up study was done in 2015 to formulate the Mega Cebu Roadmap containing action plans to realise the Vision 2050. From this study, seven Sub-Roadmaps were crafted and integrated in the four strategies as follows:

- Metropolitan Competiveness Enhancement;
- Urban Structure and Land Use;
- Urban Transport and Highway Network;
- Water Supply and Waste Management;
- Solid Waste Management;

- Smart South Road Properties (SRP) Development; and,
- Metropolitan Governance (JICA, 2015). MC

Figure 9: MEGA Cebu Vision 2050 Strategies and Directions



Source: JICA, 2015

The Roadmap Study prescribes several recommendations that promote low carbon in Metro Cebu, as follows:

Land Use

- Compact urbanization in a polycentric urban structure.
- Green loop encompassing Cebu City, Mandaue, Lapu-Lapu and Cordova.
- Promotion of Transit-Oriented Development (TOD).

Transport

- Mass transit network consisting of Bus Rapid Transit (BRT), Light Rail Transit (LRT) (which includes the Automatic Gateway Transit or AGT), and the Mass Rail Transit (MRT).
- Area-wide Traffic Control (ATC).
- Mactan Link & bypass roads.

Other Urban Services

- Material Recovery Facilities and Sanitary Landfills.
- River improvement and flood control.
- Septage services and sewerage.

MANDAUE CITY

Mandaue’s Low Carbon Development Framework is embodied in its Vision 2020 as a ‘**Home of High Value Manufacturing Serving the Global Market**’ (Figure 10).

Figure 10: Mandaue Strategy Map (Mandaue Vision 2020)



Source: City Government of Mandaue

The Vision 2020's mission is 'to create an environment for sustainable economic growth and liveable society through responsive governance and multi-sectoral involvement', which promotes development strategies for the current and proposed initiatives on the following:

- Implementation of the new Comprehensive Land Use Plan, which incorporates the integrated development of 'green growth areas;'
- Implementation of Green Building Program;
- Implementation of Traffic Control Centre;
- Realization of the Green Loop and Metro Public Transport System;
- Watershed management of the Butuanon River; and,
- Waste management through sanitary landfill and MRF at Barangay Umamad dumpsite (ALMEC, 2016).

2.2 FUTURE DEVELOPMENTS

Mandaue needs the cooperation of neighbouring cities and municipalities to jointly resolve some of its urban management and development issues. In the same manner, the neighbouring cities/municipalities would also necessitate the cooperation of Mandaue in providing solutions to their own urban development issues. Cooperation agenda may include land use, transport and other urban services like solid waste management.

The Mega Cebu Roadmap identifies projects and programs, as well as the implementation of modalities for each of the seven Sub-Roadmaps. The Sub-Roadmap for Urban Structure and Land Use includes the Green Loop Plan and the Mega Cebu Spatial Plan. The **Green Loop** is a compact urbanization development with amenity space for non-vehicle road users. The designated road space is the Metro Cebu's core areas – Cebu City, Mandaue City and Lapu-Lapu City – and the Municipality of Cordova. The road space will include other non-vehicle road users - pedestrian (walking) and bicycle lanes (Figure 11). The Green Loop is proposed to be carried out and completed from 2021 to 2030. On the other hand, the Mega Cebu Spatial Plan serves as a guide to all

public and private investments in urban development and infrastructure projects. The Spatial Plan should be utilised in various administrative services in relation to infrastructure and land use zoning, developing effective land use control guidelines and in urban greening measures (JICA, 2015).

Figure 11: Green Loop Concept



Source: JICA, 2015 and ALMEC

The Sub-Roadmap on Urban Transport and Highway Network intends to address traffic congestion and mitigate traffic bottlenecks within Metro Cebu. The construction of a third bridge is proposed as an addition to the existing two bridges serving inter-island traffic between Cebu and Mactan. The first bridge has already reached its capacity, while the second bridge has also experiencing congestion. This Sub-Roadmap recommends to develop a suitable public transport system for Metro Cebu, a combination of road and rail transport modes. The Automated Gateway Transit – Cebu-Mandaue-Lapu-Lapu (AGT-CML) is planned to be constructed from 2018-2021, which will be linked to the BRT project in Cebu City. The LRT system will be introduced by early 2020s and the MRT, a large capacity transport system, from 2020s up to 2050. The LRT will have a capacity of less than 20 thousand passengers/hour/direction, while the MRT can carry a large volume of people, 20-50 thousand passengers/hour/direction. The MRT is envisioned to have several lines within Metro Cebu with a route length of 96.6 kilometres (JICA, 2015).

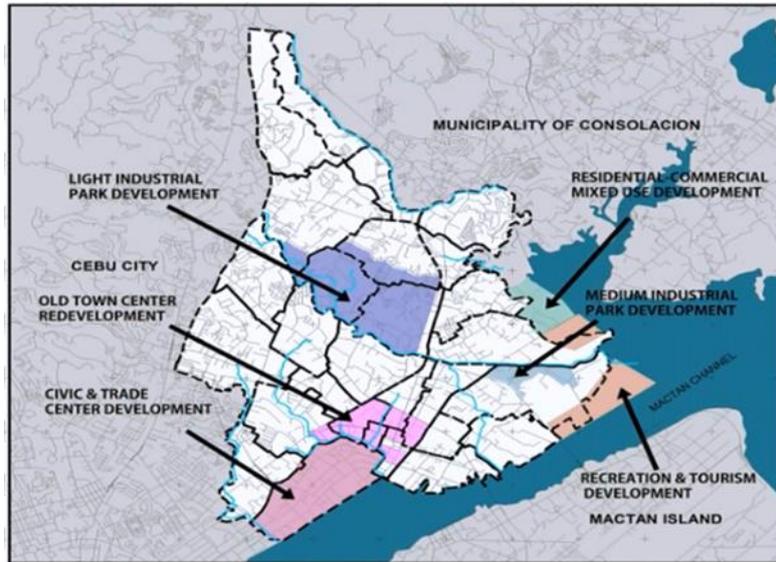
As for the Sub-Roadmap for Solid Waste Management, the development of area- and city-wide sanitary landfill and the construction and upgrading of operation of MRF are among the proposed projects. The Sub-Roadmap will likewise look at the appropriate technologies for waste-to-energy (WTE) facilities to reduce the increasing volume of solid waste within the Metro Cebu. Meanwhile, the Sub-Roadmap for Wastewater Management addresses the major problem on waste water in Metro Cebu, which has not been treated. Among the projects to be implemented are the construction of proper waste water treatment facility for development areas, septage treatment plant and centralised sewerage system (JICA, 2015).

LOW CARBON DEVELOPMENTS IN MANDAUE CITY

LAND USE

Mandaue' new Comprehensive Land Use Plan has identified six PUDs or GGAs designed for specific land development and redevelopment and each must have a Master Development Plan and compulsory Green Building Certificates (BERDE rating). The total land area for PUDs/GGAs is 848 hectares, or about 26% of the City's land area.¹²

Figure 12: Planned Units of Developments or Green Growth Areas



Source: ALMEC

These PUDs/GGAs (Figure 12) are:

- PUD-Zone Block 1 (GGA1) is reserved for **Civic and Trade Centre Development Zone** and will be the Central Business District characterised by high density commercial, institutional and residential buildings and with accompanying support uses. The maximum allowable floor area ratio (FAR)¹³ is 8.
- PUD-Zone Block 2 (GGA3) is dedicated for **Light Industrial Park Development** with some consolidation of properties among lot owners of light intensity industry that co-exist with residential areas. All industrial uses in this area should provide a 5-meter buffer or for tree and greenery lining. For this area, it is assumed that future developments will have a FAR of 2.
- PUD-Zone Block 3 (GGA6) is the **Residential-Commercial Mixed-use Development** area, specifically for the development of high-end residential condominiums and commercial establishments with structures that are terrain compatible, which consider disaster risk reduction management and climate change adaptations being a coastal area. Some reclamation will be undertaken to expand the area.
- PUD-Zone Block 4 (GGA4) is devoted for **Recreation and Tourism Development** area, which is proposed to be a reclamation area projected called as '**Mandaue's Global City.**' Allowable uses are those for recreation and tourism such as 5-star resort hotels, condominiums, theme parks, promenades, shops, and banks.

¹² Based on 32.85 square kilometres land area of the City.

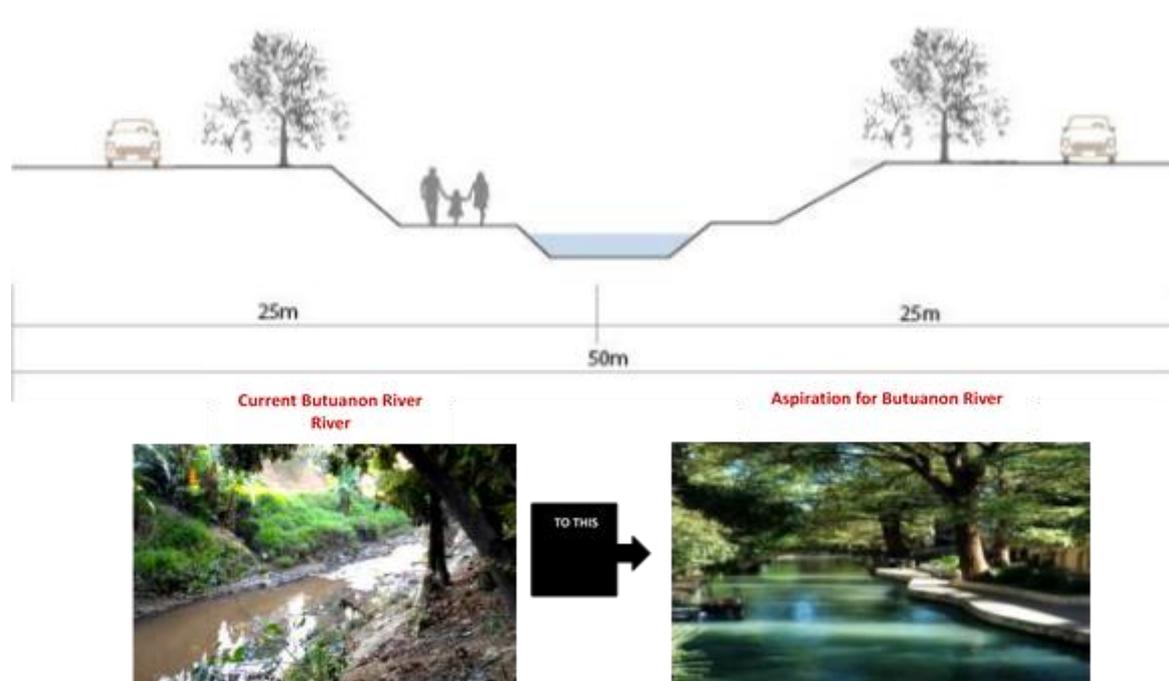
¹³ FAR is the measurement of a building's floor area in relation to the size of the lot/parcel that the building is located, which can be derived by dividing the total area of the building by the total area of the parcel (building area ÷ lot area).

- PUD-Z Block 5 (GGA5) is the **Medium Industrial Park Development** areas identified solely for medium- to high-intensity industrial development with priority to high-value manufacturing activities. FAR could be around 5 for building area of 40%.
- HR-Zone (Historic Zone) (GGA2) is the **Old Town Centre Redevelopment Area** containing the existing historical/heritage sites and landmarks in the inner urban core, which will be preserved. Along the historical strip from St. Joseph Shrine to the 'Bantayan sa Hari' and the 'poblacion' area, facade design of establishments should conform to the historical period. Building heights should be limited to nine meters equivalent to two storeys.

Green Loop

The Green Loop Project has been adopted through ordinances from the four core local government units of Metro Cebu (Cebu City, Mandaue City, Lapu-Lapu City and the Municipality of Cordova). The Green Loop is seen to enhance connectivity and liveability within Metro Cebu. It is predominately pedestrian and bicycle transit-oriented corridor around the four local government units, and will be linked to the key nodes of the proposed public mass transportation.

Figure 13: Green Loop Design Section Along the Butuanon River



Source: ALMEC

Mandaue City, being the Gateway of Cebu, has considered the Green Loop project in its new Comprehensive Land Use Plan. The City calls the portion of the Green Loop within its boundaries as the Green Corridor, which is about nine kilometres long divided into the stretch along Hernan Cortes Street and the stretch along the banks of the Butuanon River. The Green Corridor establishes a 50-meter no build zone from the centre line, 25 meters on either side of the Butuanon River. Likewise, it will provide access roads, pocket parks, land escaping, as well as mini-dams. Segments two and three of the Green Loop is within the City with some PUDs or GGAs with be connected, such as the GGA3 and GGA5. The City government has included in its Annual Investment

Plan (AIP) a budget for the Butuanon River Rehabilitation Project. This project (included in the Green Loop) intends to restore about 1.5 kilometres stretch of the Butuanon River. The Green Loop-Butuanon River Rehabilitation Project started with the clearing of informal settlers along danger zones in the Butuanon River Area in 2014. The project also aims to restore the riverbed gradient through riprapping, dredging, beautification and greening (Figure 13).

A component of the Green Loop is the proposed construction of a third bridge connecting Cebu and Mactan Islands. The new bridge is expected to reduce by 40% the volume of public and private vehicles passing through existing bridges (Marcelo Fernan and Mandaue-Mactan Bridges) (Mandaue, 2015a).

Green Building Program

The City's Green Building program is crafted to ensure a balance between economic growth and environmental sustainability. As part of the Program, the City's Green Building Ordinance was enacted in November 2015 as a policy to improve the resource efficiency of buildings, which could contribute to the central and global initiative to reducing GHG emissions. Said Ordinance applies to all public building and new private buildings to be located in the PUDs/GGAs. BERDE rating system is adopted as a tool to assess the environmental performance and energy efficiency of building projects beyond and above the environmental and building law, regulations and mandatory standards (Mandaue, 2015a). BERDE Certification will be incorporated in the process of securing building permits. Building developers and owners must secure first the BERDE Certification before the issuance of building permit. Likewise, developers of new buildings are required to prepare a green building design. New buildings located within the PUDs or GGAs will be mandated to undergo a BERDE rating of at least 3-Star. Compliance to the Ordinance for private buildings outside the PUDs/GGAs is voluntary. For the public buildings, the minimum rating is only 1-Star BERDE Certification. Below is the BERDE Certification per type of buildings:

- Both Public and Private Buildings
 - Mandatory for public buildings with a required minimum 1-Star BERDE Certification.
 - Voluntary for existing private buildings, unless otherwise indicated specific zones (PUD/GGA)
- New Buildings
 - Mandatory in PUD/GGA areas with a required minimum 3-Star BERDE Certification.
 - Voluntary in other areas outside the PUD/GGA.
- Heritage or cultural buildings and post-disaster shelters and structures are exempted from the Ordinance (ALMEC, 2016).

Under the BERDE Program, green buildings should be: (a) energy and water efficient; (b) cheaper to operate and maintain; (c) lesser in negative impacts to the environment; (d) creating healthy environment for the users; (e) providing improved productivity of users; and, (f) improve the quality of life. The BERDE rating scheme has three categories, namely: (1) new construction, (2) retrofitting and renovations, and (3) operations, covering commercial buildings, clustered or vertical residential development, and educational institutions (ALMEC, 2016). The City government offers incentives for greener buildings to encourage developers adopt green designs and in operation processes. Among the incentives are:

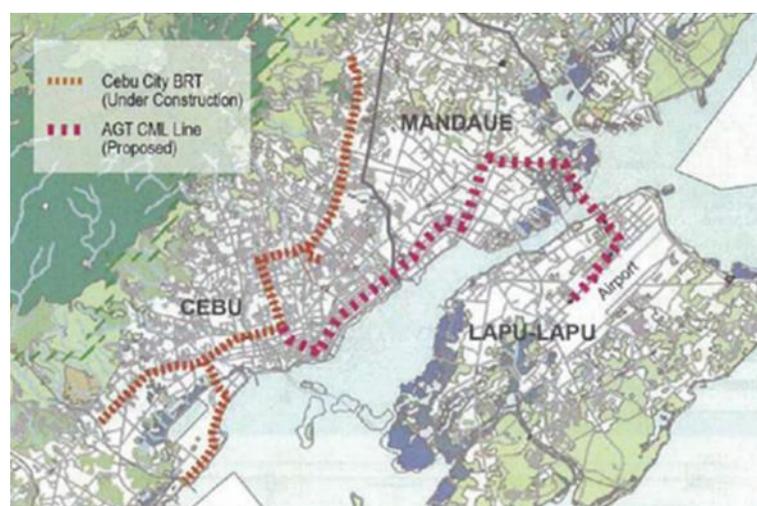
- Marketing support and public recognition;
- Density bonuses or floor-to-area ratio incentives;
- Real property tax incentives; and,
- Professional fees and tax incentives.

To cover the incentives for compliance, the City's Investment Code has also been enhanced (Mandaue, 2016).

TRANSPORT

The Transit-Oriented Development (TOD) is a transit ridership development that maximises public access to transport facility. In TOD, transit station will be made available within walking distance in the middle of residential and commercial areas.

Figure 14: AGT-CML Line Alignment



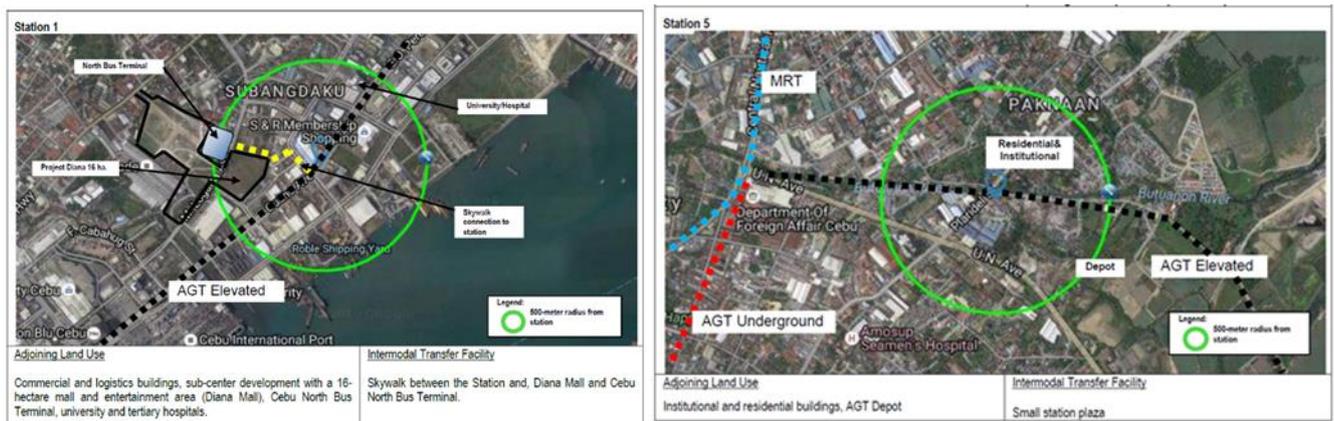
Source: JICA, 2015 and ALMEC

The proposed development of mass transport system within Metro Cebu as espoused in the Mega Cebu Roadmap complements the low carbon measures of Mandaue, specifically the Green Loop and the PUDs/GGAs. The planned 19.2 kilometres long AGT-CML mass transport system connects the Cebu City Central Business District, the Mandaue's growth areas, and the Lapu-Lapu City towards the Mactan Cebu International Airport (Figure 14). The AGT-CML will serve the heaviest inter-city traffic corridor (Cebu-Mandaue) and the second heaviest (Mandaue-Lapu-Lapu). The AGT-CML is expected to be operational by 2022. The AGT is one of the category systems of LRT. As AGT is powered by electricity, it generates less air pollution compared with jeepneys¹⁴ and buses, and less noise and vibration than ordinary rail due to its rubber tires.

Mandaue's portion of the AGT-CML has six stations with a rail length of 9.3 kilometres, which is adjoining the City's land use plan and with intermodal transfer facility (Figure 15). It will serve the City's four PUDs/GGAs (1, 2, 4 and 5). Thus, the AGT will not only address the road traffic congestion, but will also promote the City's urban structure and green growth areas. A depot, a prerequisite for the project, is proposed to be put up near the GGA5. The AGT-CML is expected to carry around 200,000 passengers a day during its initial operation in the early 2020s, and 222,000 passengers in 2030, which will significantly reduce road traffic volume by 11% in 2030 (ALMEC, 2016). The planned LRT and MRT from Mega Cebu Roadmap will also be linked to the AGT-CML. The Department of Transportation (DOTr) of the Philippines (a central government agency) is the implementing agency of the AGT-CML project. As of 2016, the project has not been approved yet by the DOTr.

¹⁴ Jeepney is a public utility plying the routes from the central business district to the suburbs passing along the major thoroughfares. After the war, surplus army jeeps were converted into the famous 'jeepney' with seating capacity of about 12 to 15 passengers on longitudinal benches behind the driver's partition.

Figure 15: TOD Plan for Stations 1 and 5



Source: ALMEC

WASTE MANAGEMENT

Most cities and municipalities in Metro Cebu are still operating open dumpsites, except in the Municipality of Consolacion where there is a private sanitary landfill. Although landfills in Cebu City and Mandaue City were constructed as SLF, these did not function as SLF, but rather as uncontrolled open dumpsites (Figure 16). With this, the DENR-EMB, a central government agency, ordered the closure of the dumpsites in accordance the provisions of the Ecological Solid Wastes Management Act. The City's Umapad landfill was closed in June 2009. The Umapad landfill has a total land area of nine hectares with only five hectares are being utilised, which also house the material recovery facility.

The Umapad Landfill has been reopened and undergoing rehabilitation. Ongoing improvements are undertaken on access road and circulation networks, mining of garbage in the old dumpsite, excavation for landfill cells, tree planting and landscaping, and upgrading of facilities (i.e., MRF facility). However, the rehabilitation works have yet to cover those that could address GHG emissions due to the absence of methane capture technology (ALMEC, 2016).

Figure 16: Umapad Landfill Site



Source: APERC

The Umapad Landfill is a best location to host a waste-to-energy (WTE) facility as it is strategically situated to serve even the neighbouring cities and localities in Metro Cebu. As the Landfill is close to GGA4 and GGA5, the

energy to be generated from the WTE could supply energy to tourism, commercial and residential buildings that are planned to be built in these growth areas (ALMEC, 2016).

3. MANDAUE CITY FEASIBILITY STUDY

The feasibility study of Low-Carbon Model Town (LCMT) Phase 6 was aimed at providing the government officials at the central and local levels and stakeholders in Mandaue City and its neighbouring cities with implementable measures on low carbon urban development. The study focused on Mandaue City's low carbon initiatives and identified some Metropolitan Cebu-wide solutions which could be more effective in advancing low carbon development (than just a single undertaking by a City). Thus, the concept of LCMT for Mandaue is **'Sustainable Urban Life and Economic Activities in Cooperation with Neighbouring Cities.'**

The study covered four strategic sectors, specifically land use, transportation, building and urban services, that are anchored on the location of the PUDs/GGAs. On land use planning, the City's urban structure must be an environmental sustainable with support from the Metro Cebu flagship projects – the Green Loop and the AGT-CML Line which promotes Transit-Oriented Development. The Green Loop is expected to reduce GHG emission from improved quality of the river and transport modal shift to non-motorised trips as it allocates an area for pedestrian and cycling lanes. On the other hand, the ACT-CML encourages compact urban development with easy access to stations (with pedestrian facilities) and modal transfer, resulting in GHG emission reduction from increased walking trips to and from the stations.

For transport, the largest source of GHG emission in the City, the study proposed a smart corridor concept by installing LED streetlights with solar panels and wifi connections along a corridor. Using LED lamps would significantly decrease electricity consumption and thus GHG emissions. The availability of wifi would enable motorists to have real-time road traffic information from the City's Traffic Control Centre for better traffic management. The electric tricycle (e-trike) is recommended by the study to replace the current conventional tricycle. At present, the local manufacturer of e-trike has put 15 units in the City as part of its demonstration project. Mass procurement is suggested to take advantage of the economies of scale leading to reduction in capital investment. As the number of e-trike increases, the greater amount of GHG emission is avoided. The AGT-CML is expected to considerably reduce traffic volume within the City by 2030.

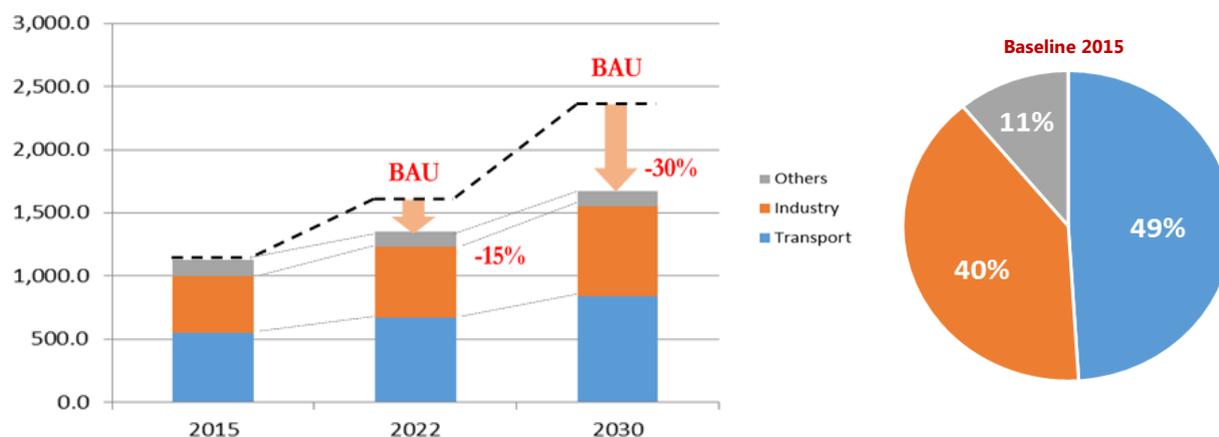
As for the other urban services, the study came up with some proposed measures that are more attractive to be adopted in PUDs/GGAs, such as the use of renewable energy and untapped energy. With Cebu's high solar radiation of around 5.0-5.5 KWh/m²/day, rooftop solar photovoltaics (PV) is seen as a potential energy option for the buildings in PUDs/GGAs. The study suggested that 25% of all the buildings in PUDs/GGAs must install rooftop solar PV. VECO, the electric distribution utility servicing a number of cities and municipalities in Metro Cebu, has been promoting the use of rooftop solar PV. Building owners can consume the electricity produced from solar for their requirements, and the excess can be sold to VECO.

The study also saw the opportunity in the reopening of the Umapad Landfill to utilise a WTE facility. A district energy system, which could be a District Heating and Cooling (DHC) or District Cooling System (DCS), is recommended to be put up in GGA 4 and GGA5 that are designed as new development areas. DHC/DCS is more energy efficient compared with individual building energy supply, and thus generates huge energy savings.

The City's Green Building Program will significantly contribute to lessening GHG emissions. Under the Green Building Ordinance, the study endorsed the adoption of low-carbon building measures for all new buildings in PUDs/GGAs, such as the energy efficient building envelope, Building Energy Management System (BEMS), natural day lighting, solar PV and solar water heating. A practical implementing rules must be formulated for the effective adoption of the BERDE rating.

POTENTIAL GHG EMISSION REDUCTION

Figure 17: Mandaue City GHG Emission Projections and Targets (thousand tons CO₂)



Source: ALMEC

The successful implementation of low carbon measures by Mandaue City in close partnership with its neighbouring cities could avoid an estimated 0.78 million tons of GHG emissions in 2030 compared with the business-as-usual (BAU)¹⁵, or equivalent to 32% lower than BAU scenario. The implementation of these measures necessitate an aggregate capital investment of USD 1.42 billion up to 2030.

Table 5: Baseline GHG Emission Estimates by Sector (tons CO₂)

Year/Sector	Transport	Industry	Commercial	Residential	Total
2015	552 447	446 261	53 625	74 124	1 126 456
2020	714 287	597 197	71 762	99 194	1 403 132
2022	791 725	664 696	79 709	110 406	1 646 700
2025	923 984	780 513	93 790	129 643	1 927 931
2030	1 195 835	1 020 099	122 580	169 438	2 507 953
Share (%)	47.7	4.9	6.8	40.7	100.0

Source: ALMEC

The study estimated the City's 2015 GHG emission level (as baseline) at 1.13 million ton CO₂. Among the sector, the transport accounted for nearly half of the GHG emission (0.55 million ton CO₂), followed by industry with 40% (0.45 million ton CO₂) and the remaining was generated by the other sectors (commercial and residential sectors). Projected GHG emission in 2030 for the BAU scenario will reach 2.51 million ton CO₂, up by 223% from 2015 level. The increase in GHG emission from 2015 baseline is forecasted corresponding to the annual growth rate of gross regional domestic product per capita of Metro Cebu. Emission will grow by 52% in 2020 (from 2015 level) or 1.48 million ton CO₂, and 11% growth from 2020 to 2022 (1.65 million ton CO₂), and finally 52% increase

¹⁵ BAU assumes no efforts to reduce GHG emission.

from 2022 to 2030. The study set a target emission reduction at 15% by 2022 and 30% by 2030 compared with the BAU scenario (Figure 17 and Table 5).

To achieve the target reduction in 2022, low carbon measures will focus on institutional development and the flagship projects – the AGT-CML Line and the Green Loop along Butuanon River. The target reduction in 2030 will be attained through intensive implementation of low carbon measures on the transport and buildings. The study assumed that beyond 2030, the low carbon development from the PUDs/GGAs will be expanded to other areas in the City.

Table 6: GHG Emission Estimates by Measure, 2030

Low Carbon Measure	GHG Emission Reduction Projections (2030) tCO ₂	Share to Total GHG Emission (%)	Estimated Capital Cost
Green Loop	97 526	12.5	PhP 2,200 million
TOD	2 560	0.33	PhP 1.8 million (only for design)
Smart Corridor	5 423	0.70	PhP 1,020 million
E-Trikes	1 244	0.16	USD 34.5 million
AGT-CML Line	124 515	16.0	USD 818.6 million
Renewable Energy	63 337	8.1	USD 356 million
Waste-to-Energy	130 255	16.7	USD 25 million
DHC/DCS	44 687	5.7	USD 32.8 million
Green Building	310 322	39.8	USD 86.6 million
TOTAL	779 869	100.0	USD 1 424 million

Note: PhP stands for Philippine Peso
Source: ALMEC

From the low carbon measures identified in the study, the Green Building will offer significant reduction in GHG emission, 40% of the total reduction in 2030 (Table 6). As the Green Building Program is perceived to decrease energy consumption through energy efficiency, renewable energy and passive energy design strategies, the City could generate huge amount of GHG emission reduction. The application of passive energy design and improvement in energy efficiency measures are highly appropriate for the construction of new buildings in the PUDs/GGAs. A case in point mentioned in the study is the low carbon building measures being implemented in Japan such as the Comprehensive Assessment System for Building Environment Efficiency (CASBEE) as an assessment system for environmental performance of buildings. The Building Energy-Efficiency Labelling System (BELS) was likewise established by Japan in 2014 to evaluate the energy efficiency and conservation performance non-residential buildings.

The proposed WTE in Umapad Landfill, using waste heat from garbage incinerated plant, is a measure for the utilization of untapped energy. The generated electricity from this facility will replace grid electricity, which is

predominately coming from coal, thereby realising GHG emission reduction from electricity consumed. Further, there is also avoided methane emission from landfill. Contribution from WTE is 16.7% of the total GHG emission reduction.

The AGT-CML will result in low GHG emission in transport from decreased road traffic as it can accommodate large number of passengers daily, and will eventually lead to reducing driving time. The modal shift from road vehicular traffic to AGT-CML could result in road volume traffic reduction by 357 000 passenger car unit (pcu) x kilometre. This low carbon measure could contribute around 16% to total GHG emission avoidance.

The components of the Green Loop to improve the drainage way, increase the quality the water quality of the Butuanon River, the greening of the river banks and the designated lanes for pedestrian and bicycle, and even the introduction of AGT-CML would have substantial reduction in GHG due to shift from motorised trips to non-motorised trips and the elimination of pollutants in the river (including methane). The impact of AGT-CML will be limited only to those for TOD (like reduction in trip distance). About 12.5% of GHG reduction will come from Green Loop initiative.

PART II: POLICY REVIEW TEAM REPORT

This part of the report presents the Policy Review Team's conclusions and recommendations for low-carbon town development in Mandaue City, Cebu Province, the Philippines.

The Policy Review Team evaluated the recommendations using an 'integrated framework' to help determine the priority recommendations.

The Feasibility Study on Mandaue City, however the findings and recommendations could have wider application to neighbouring cities developing low-carbon policies and programs.

1. LEGAL & INSTITUTIONAL FRAMEWORKS

FINDINGS

Although Mandaue City has established land use plan since 1979 and amended it in 2015 through a new CLUP, urban planning in the City is still in early stage. The City has to establish 'civil minimum' for a liveable city including housing, water supply, waste disposal, sewage treatment, community road, among others. Along with the urban planning for a liveable city, low-carbonisation should be pursued in parallel. In that sense, the City's low-carbon town development is much more challenging compared with the case towns in the previous Phases of APEC LCMT Project. However, if it is successful, the City will be a good model for low carbon town development in many cities/towns in APEC region which have similar living conditions.

Mandaue City is part of Cebu Metropolitan Area or 'Metro Cebu,' the second largest metropolitan area in the Philippines and one of the world famous marine resorts. Moreover, the City is the pathway between Cebu City and Lapu Lapu City, the site of Mactan Cebu International Airport. As such, urban development planning of the City should consider its impact to the neighbouring cities, which would require cooperation with neighbouring cities. The low carbon development plan in the City is not exceptional in terms of impact to and cooperation with neighbouring cities.

Within the City Government of Mandaue, the City Planning and Development Office (CPDO) and the City Environment and Natural Resources Office (CENRO) are mainly involved in the low carbon development plan. CPDO has a coordination role among offices within the City Government including CENRO.

In its low carbon development planning, cooperation with private sector such as Public-Private Partnership (PPP) should be pursued. Community involvement should also be strengthened through the institutionalisation of a process for cooperation and coordination with local residents in every aspect or stage of urban and low carbon development planning.

On metro-wide planning and development coordination, the MDCDCB was created in 2011 through a MOA signed by local government executives, heads of central government agencies and leaders of the private sector. While MDCDCB is on a voluntary basis at this moment, a bill to give such a body a solid legal status, and thus with public fund allocation from the central government, is now under consideration in both Houses of Congress.

An energy efficiency law must also be pursued by the central government to strengthen the energy efficiency and conservation program at the central level that would eventually support and advance the energy efficiency-related initiatives by local government units.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

- Rec. 1. Maintain good cooperation among offices within the City Government of Mandaue through the coordination of CPDO, requiring immediate support at the local executive level (Mayor and Vice Mayor). ★★★**
- Rec. 2. Involve private business and local resident entities closely in low carbon development planning. To support this coordination, a Community Project Council (CPC) may be created for PUDs/GGAs as recommended by the feasibility study in the early stage of the planning. ★★★**
- Rec. 3. Coordinate with the neighbouring cities and the central government through the MCDCB mechanism. In order to consolidate this mechanism, the Houses of Congress are hoped to pass the bill to change MCDCB's legal status and allocate public fund for its operation and implementation of programs and projects. ★★★**
- Rec. 4. Enact an Energy Efficiency Law by both Houses of Congress to institutionalise and mandate the energy efficiency program in all sectors and local government units. ★★**

2. SUSTAINABLE URBAN PLANNING

FINDINGS

Spatial Framework in Progress in Mandaue

In 2015, the spatial development framework in Mandaue City has taken a major step towards low carbon development: the City's new CLUP was revised for the first time since 1979. It was approved by the City Council, and currently in the process of ratification by the provincial and central governments. A CLUP is the most essential policy document for the spatial development framework in the Philippines. Every LGU is mandated by law to prepare a CLUP. The binding zoning ordinance for the CLUP was also approved.

Mandaue's new CLUP divides the city into four geographical categories and sets land use objectives in each quadrant: Quadrant 1 (the city centre) will be guided as commercial centre; Quadrant 2 will be mixed between commercial and residential; Quadrant 3 will be mixed between industrial and residential; and, Quadrant 4 will be industrial. It also proposes a green city as an overall vision and propose three key strategies. The first is social uplift, with tax incentives for private social housing. The second is environmental sustainability. Five geographic clusters are defined to improve disaster risk management and solid waste management. Land management, such as restoration of major waterways, ground water replenishment and mangrove parks, is also defined. The third strategy is integrated development. From these three strategies, the CLUP has introduced new instruments to advance the city's low carbon development: enhanced PUDs for integrated development; designation of six GGAs, which the zoning ordinance controls the types of industry to locate in the GGA; the Green Loop project, of which the area along Butuanon River is designated as a green corridor; and the promotion of TOD.

The CLUP is also integrated in the City's 2020 Vision. The City is envisioned to be the home of high value manufacturing serving the global market, represented by food and beverage, metal works, furniture and home furnishings. It also presents integrated development of GGAs and Butuanon River as a showcase of sustainability efforts of the City.

The CLUP has also linked the new Green Building Ordinance of the City, another innovative initiative introduced in 2015 to advance the City's low carbon development. It requires BERDE Grade I for all the new buildings in the City, and BERDE Grade III for all the new buildings within the PUDs/GGAs. In addition, the building ordinance provides incentives for buildings outside PUDs/Green Growth Areas, such as real property tax discounts, green building tax credit, FAR bonuses, among others, to promote green buildings. The City is one of the pioneers for Green Building Ordinance, and the only City that adopts the BERDE certification in granting building permits, the first of this kind in the Philippines.

Another big leap for the City's low carbon future is the emerging metropolitan planning framework. The Roadmap for Sustainable Urban Development in Metro Cebu, jointly formulated by MCDCEB and JICA in 2015, sets a spatial development framework for Metro Cebu. Although the Roadmap remains a voluntary planning document for the moment, it could function as a guiding principle for land use for all the 13 LGUs in Metro Cebu.

Remaining Challenges of Mandaue City and Metro Cebu for a Low-Carbon and Sustainable Future

Even though the new CLUP is a big step for the City to promote a low-carbon and sustainable future, the existing urban land patterns is posing persisting challenges, creating conditions leading to high-carbon spatial structure. In particular, the followings stand out as long-term challenges:

- The existing low density and inefficient land use in the inner city. Despite of its prime location in Metro Cebu, the lands are not used very efficiently, leaving much underutilised land in the urban centres. In addition, some high density areas of the inner city need to improve their living quality, as they do not have sufficient urban infrastructure, public space and housing.
- Attractiveness / liveability due to poor environmental quality. In particular, poor management of solid waste and drainage is an issue to be urgently addressed. Floods are another imperative concern for the City.
- Lack of land use strategies to avoid long commutes and traffic congestion. This is partly because such consideration will need coordination with other LGUs in Metro Cebu.

More fundamentally, it is important for local leaders in Mandaue (and all the other LGUs in Metro Cebu) to recognise that these urban challenges in the City must be tackled together by the 13 LGUs in Metro Cebu. Metropolitan wide planning and close coordination among the LGUs are very important. For example, while the arterial road structure proposed in Mandaue' CLUP tries to address traffic congestion within the City, the success of such strategy would depend on comprehensive transport planning across Metro Cebu. In this regard, a metropolitan wide land use policy in Metro Cebu will play a crucial role in advancing low-carbon urban development in the City.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 5. Make the most use of the PUDs/GGAs by introducing pilot low-carbon projects. ★★★

Designated in the latest CLUP of the city, the PUDs/GGAs have potential to function as test-beds of low-carbon measures. The City could use this potential more strategically by introducing more innovative low-carbon measures. For instance, in collaboration with the central government, the city could require the establishments in GGA3 to meet higher energy efficiency standards and more stringent environmental quality monitoring requirements. In residential PUDs/GGAs, the City could also add requirement for developers to provide affordable housing. To promote such pilot projects, the City could also introduce incentives, such as easing parking requirements and FAR bonuses.

Rec. 6. Promote decent housing options and attract diverse economic activities to transform Mandaue's inner city to a modern mixed-use urban center. ★★

The City has been, and will continue to be the economic hub of Metro Cebu. However, the land use of the inner city has been specialised in industries and small local commercial functions, and with low density. Given its strategic location, the City needs to utilise its inner city more efficiently. An untapped but urgent option is to promote mixed land use. Although the City has been an industrial hub, many workers are commuting from other LGUs in Metro Cebu, which creates long travel distance, traffic congestion and high carbon emission. The City will benefit considerably by providing decent housing options near jobs for the workers. Quality of life of citizens is getting more and more important and becoming the determinant of a city's attractiveness and long-term economic growth. In addition, the City centre has a potential to attract more diverse economic activities, such as commercial and service industries, which are currently concentrated in Cebu City.

To realise such a vision, the CLUP as well as the metropolitan-wide land use planning will play a crucial role. Although the CLUP is revisited/revised every nine years, it is recommended for the City to already consider possible amendments and start discussing how to incorporate such a vision in the current CLUP. Such amendments should strengthen the provisions in the CLUP (and the Zoning Ordinance) promoting smart/green growth areas not only in PUDs/GGAs but also in new developments in the built-up areas, which will also be covered in the City's Incentives Code. The additional provision must focus on retrofitting the built-up areas to transform the existing low-density, industry oriented land use into high-quality, commercial-oriented and, resident-friendly neighbourhoods, while respecting the value of industrial land use. Low-carbon urban development must be a backbone of this transformation.

Rec. 7. Prepare for transit-oriented land use by discouraging individual car use. ★★

Land use and transport policies need to work together to tackle the current traffic problem in the City and in Metro Cebu. Currently, investment in urban transport infrastructure is not strong enough in order to address the City's serious traffic problems, although most of which need to be considered at the metropolitan scale. In particular, investment in urban transport in the inner city (public transport systems, sidewalks for pedestrians, bicycle lanes, waterfront promenades) is lacking, which undermines long-term attractiveness of the City.

An option for the City is to address the increasing demand for individual cars by easing the parking requirement for developers and instead require them to provide other urban amenities like sidewalks for pedestrians, and bicycle lanes. This strategy should also be considered in the integrated land use and transport planning in the City.

Rec. 8. Maximise the use of vacant and/or underutilised land in strategic areas. ★★

Introducing fees for vacant and/or underutilised land in strategic areas in the inner city could be an interesting option for the City to encourage more intense land use particularly in the inner city. This measure has been introduced in many European cities (e.g. Freiburg in Germany) and proven to be effective. It also helps the City to raise its own revenue source for low-carbon urban development.

Rec. 9. Create an urban development agency to provide technical and financial support to accelerate inner city development. ★★

The City needs to increase its capacity, in terms of financial resource, as well as institutional arrangement, to promote low-carbon urban development led by the private sector. A critical policy lever could be the creation of a dedicated local **Urban Development Agency/Unit**, which provides technical and financial support to accelerate low-carbon urban development. This agency could be an important interface between the private sector and the City.

Rec. 10. Replicate the leading initiatives in other LGUs in Metro Cebu by facilitating knowledge sharing. ★★

Strengthen cooperation with neighbouring LGUs is critical, given the functional integration of Metro Cebu. The City's innovative low-carbon policy initiatives mentioned above (CLUP, PUDs/GGAs in the CLUP, green building ordinances, etc.) could be replicated in other LGUs in Metro Cebu. Sharing knowledge on low-carbon actions among the 13 LGUs will benefit all of them. The Cebu Province and the MDCDCB have critical roles in facilitating such interaction across the LGUs.

3. LOW-CARBON BUILDINGS

FINDINGS

As noted from visual observation during the site visits in December 2016, existing buildings in Mandaue City are generally of poor quality. Buildings are not designed to be highly resistant to the elements, such that natural ventilation is the primary method for cooling in the hot and humid climate. Buildings are also not built of quality materials and high construction standards. At present, with a low penetration of high energy using appliances and of mechanical air conditioning, these conditions have limited impact. However, if these buildings were to be retrofitted with higher energy uses in the future, they will perform very poorly due to the nature of their construction.

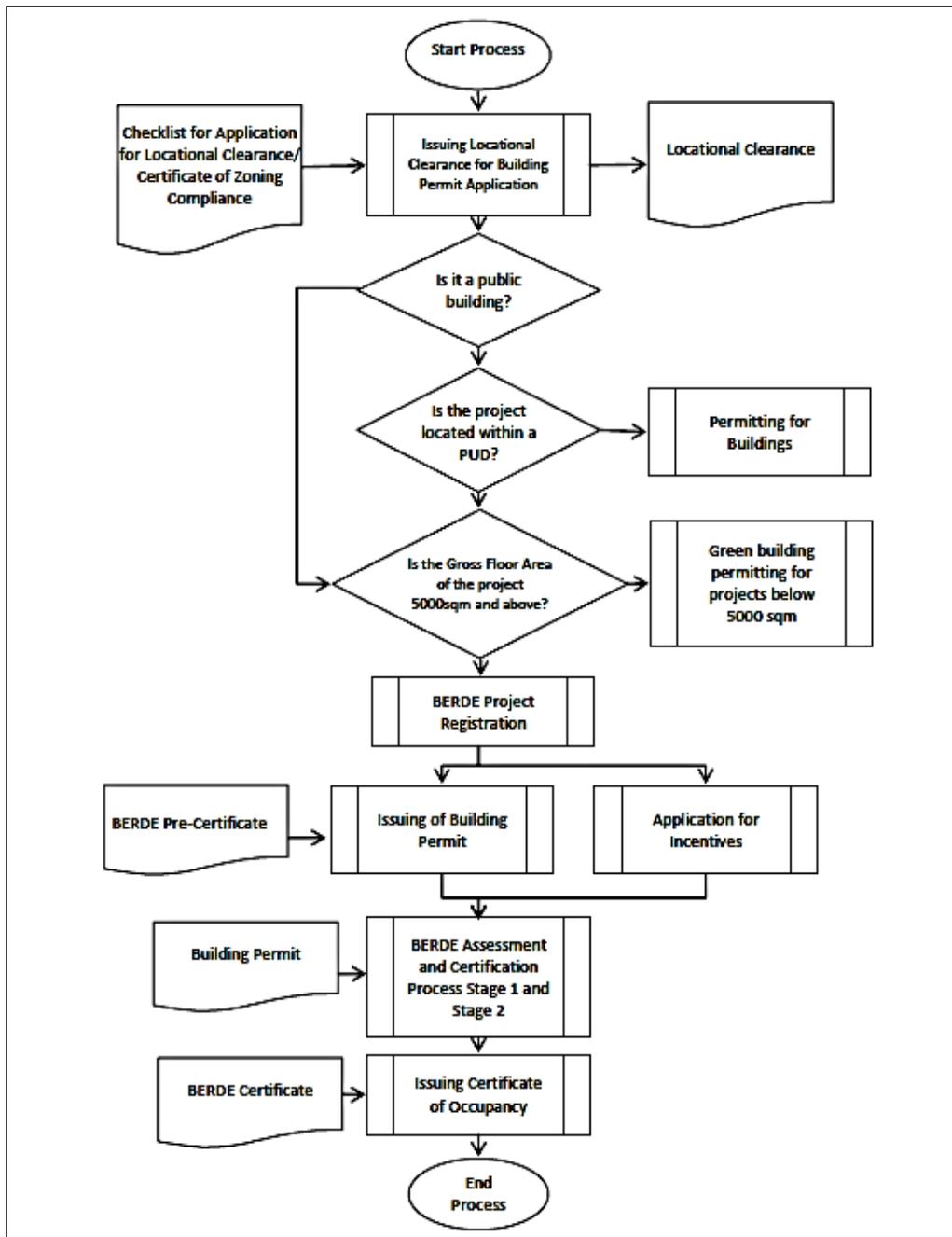
Cebu Province and the City have already established a legislative base for the promotion of low-carbon building. At the provincial level, two programs, the Green and Disaster-Resilient Building Program (Ordinance No. 2014-02) and Our Sustainable Cebu Program (Ordinance No. 2013-03) both support green building, though they approach the need from different angles (Cebu, 2014 and 2013). These programs stem from the Province of Cebu Environmental Code (Ordinance No. 2012-13), which mandates the province to promote and implement energy efficiency and resource conservation programs with the primary aim of:

- reducing energy consumption;
- reducing greenhouse gas emissions;
- preventing depletion of the province's water resources; and,
- controlling pollution, and maintain the public's health and well-being.

The Green and Disaster-Resilient Building Program regards the need for enhancing the structural quality and performance of buildings in the face of risk posed by environmental disasters, such as the Bohol earthquake and typhoon Yolanda, as well as the risk that poor building design poses to building occupants (i.e. indoor environmental quality) and the environment itself. The Our Sustainable Cebu Program, approaches this challenge by pushing for sustainability actions at the Local Government Unit level – as well as by private sector actors – by conferring awards, recognitions, and incentives. This program also considers sustainability holistically (i.e. spiritual, human, social, cultural, political, economic and ecological).

The Green Building Ordinance of Mandaue City builds from the Cebu Province Environmental Code. The Green Building Ordinance includes more stringent requirements than those at the central and provincial levels, such as requiring that all private-sector buildings in designated PUDs/GGAs meet the 3-Star BERDE standard. All public buildings in the City will also need to seek at least a 1-Star BERDE certification. The Green Building Ordinance calls for a reporting system for energy use in buildings larger than 5,000 square metres (m²) and the establishment of a Green Building Board. Figure 18 shows the flowchart for the issuance of building permit under the Green Building Ordinance. Finally, it is important to recognise that the Philippines has established minimum energy performance standards (MEPS) for air-conditioners, refrigerators and lighting at the central level. These standards – along with building energy codes – promote building energy conservation. Also at the central level, the Philippines Green Building Council or the PHILGBC has capacity building efforts to ensure that local contractors can build based on high efficiency standards.

Figure 18: Flowchart for the Issuance of Building Permit under the Green Building Ordinance



Source: Green Building Toolkit and ALMEC

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 11. Build internal capacity for program oversight and for contractors and designers. ★★★

The City should continue its cooperation with the Philippines Green Building Council to provide capacity building programming the implementation of its Green Building Ordinance. This training should extend to all levels of energy efficient building sector: builders, designers, auditors and other compliance personnel, and City officials responsible for administering the green building program. Builder training will impart critical skills for green building design, such as installation of insulation and air sealing of building envelopes. Small-scale developers are one of the most important groups to target, as they are typically responsible for both design and build decisions, and can influence client demand for green features.

Rec. 12. Encourage development of multi-unit housing and mixed use commercial developments. ★★★

The City is projecting a nearly 3.0% annual population growth rate. Likewise, the City, located adjacent to steep slope land, has nearly depleted its buildable area. As a consequence, accommodating this increasing population will necessitate increasing the density of new construction to replace older, less efficient structures. The City should prioritise the construction of multi-unit housing to meet the growing housing needs. The construction should have added benefit of being inherently more energy efficient. This efficiency comes from a greater ratio of floor area to exterior area. Building exteriors are the main contributors to heat gain and loss. Sound design practices can also ensure that sufficient natural lighting is available to tenants without large heat gains.

The City should also promote construction of mixed-use developments, in which a portion of the building – typically the bottom floors – is devoted to commercial use while other space is used for residential units. Mixed-use development helps to reduce overall urban transportation energy use by bringing commercial services within proximity of the population.

Rec. 13. Strengthen the minimum energy performance standards. ★★

The MEPS should be extended to other home appliances, such as clothes washers and dryers. Phase-out requirements should also be incorporated in the performance standards, so that older technology is removed from the marketplace and replaced by more efficient options.

This recommendation may need to be implemented at the central level or by the central government. However, it is also still prudent to encourage it at the local level (Mandaue City).

Rec. 14. Provide more active role for utility companies (e.g. programs to facilitate replacement for higher EE appliances). ★★

One of the biggest challenges in implementing a successful energy efficient building program is in overcoming the stigma of higher first cost spending on more efficient construction methods (e.g. wall insulation) and equipment (e.g. HVAC, solar water heaters, etc.). There are numerous ways to deal with this additional cost, one of which is to provide subsidies to reduce that cost. While these subsidies could come directly from the local government, it is difficult to justify this extra cost to tax payers. A popular alternative is to provide such incentives through the power utility (distribution utility), which would finance the spending through minor rate changes. Successful program reduces energy use and energy sales, which also relieves spending on expanding generation, transmission, and distribution capacity.

This recommendation needs cooperation with other cities and municipalities in Metro Cebu considering that Mandaue is within the franchise area of VECO.

Rec. 15. Encourage private sector financing through energy service contracts. ★★

Another powerful financing method is to encourage the involvement of the private sector through energy service contracts. Energy service companies (ESCOs) operate by first appraising the potential value of energy efficiency upgrades in a building and then funding this extra cost upfront and recuperating the expense through the monthly energy savings. After a pre-determined period, when the contract is fulfilled, all further energy savings go to the owner. This service has added benefit of sheltering a building owner from any risk of under-performance of energy efficiency upgrades, as contracts are typically written to guarantee the owner an energy savings.

Rec. 16. Promote more energy efficient building design standards in a tropical climate, especially to builders of smaller residential and commercial buildings. ★

Recognising the PPHILGBC's BERDE standard, it may be necessary to develop other tropical climate design standards. This recommendation considers the needs of smaller builders that often lack the capacity to comply with the standards such as BERDE. Providing easy-to-follow best practice standards that ensure that builders meet the critical elements of building energy codes and also ensure occupant comfort may lead to higher penetration of these practices in the City, especially outside of PUDs/GGAs.

Rec. 17. Define the roles of the building board. ★

The Green Building Ordinance designates the creation of a Green Building Board, though its role is relatively undefined. The Board should be in-charged with enforcement of the code and periodic evaluation and revision of provisions of the Green Building Ordinance. Penalties for non-compliance with the code should be stiffened.

4. AREA ENERGY MANAGEMENT SYSTEMS

FINDINGS

Implementation of LMCT recommendations could give synergetic effect not for only Mandaue City, but for neighbouring cities, provinces and regions as well. Although the low-carbon town program could be seen by others as ambitious, the tasks are feasible to implement but requiring political will from concerned authorities (both local and central governments) and the support and involvement of the private sector and the community. A number of ordinances on low-carbon related policies both at the provincial and City levels have been crafted, which are crucial to the realisation of reducing carbon footprints.

Aside from the Green Building program of the City, an energy management system (EMS) must also be incorporated to monitor and control a wide range of building services, which include air conditioning, ventilation and lighting, among others. The implementation of EMS in individual buildings can control the energy consumption, and thus achieve higher energy efficiency and energy savings. The benefits of EMS in energy-savings related management is that it provides energy analysis, management and control as it monitors energy consumptions in buildings in real time and adjust the air conditioning and lighting, etc., to eliminate energy losses, as well as giving information and advice on the savings from energy costs. The EMS also monitors the equipment status and environmental conditions. Further, such system would be of great importance as it plays a central role in the formation of a smart media. In addition to the above-mentioned energy savings functions, the EMS is noe equipped with a variety of additional 'smart' features to ensure safety.

The EMS varies depending on the purpose or destinations of the building: Building Energy Management System (BEMS), Home Energy Management System (HEMS), Mansion Energy Management System (MEMS) for energy management of apartment of buildings, Factory Energy Management System (FEMS), and the Area Energy Management System (AEMS), which combines all the energy management systems.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 18. Set a specific plan and program for the adoption and implementation of EMS for Mandaue ★★

The City must formulate a specific plan and program (medium- or long-term) for the gradual adoption and implementation of EMS. The plan or program should contain strategies (such as inclusion of EMS in the Green Building Code), timeframes and possible incentives for the eventual mainstreaming of EMS, which should be accessible to investors or building developers for them to understand the regulation that could have some impacts on their investment. The EMS' plan or program is also a way to communicate the commitment of the City to be a model for low-carbon town.

Rec. 19. Incorporate energy management system in the Green Building Code. ★

The Green Building Code already sets the platform for the adoption of EMS in all types of new buildings to be constructed even outside the PUDs/GGAs. Installation of EMS must be part of the requirement for BERDE certification in new buildings.

However, for existing buildings, the implementation of EMS may be initially voluntary with incentives to encourage adoption.

Rec. 20. Encourage all public buildings to be equipped with EMS. ★

Government leadership in incorporating EMS in all public buildings will encourage private sector to adopt the same in their new projects.

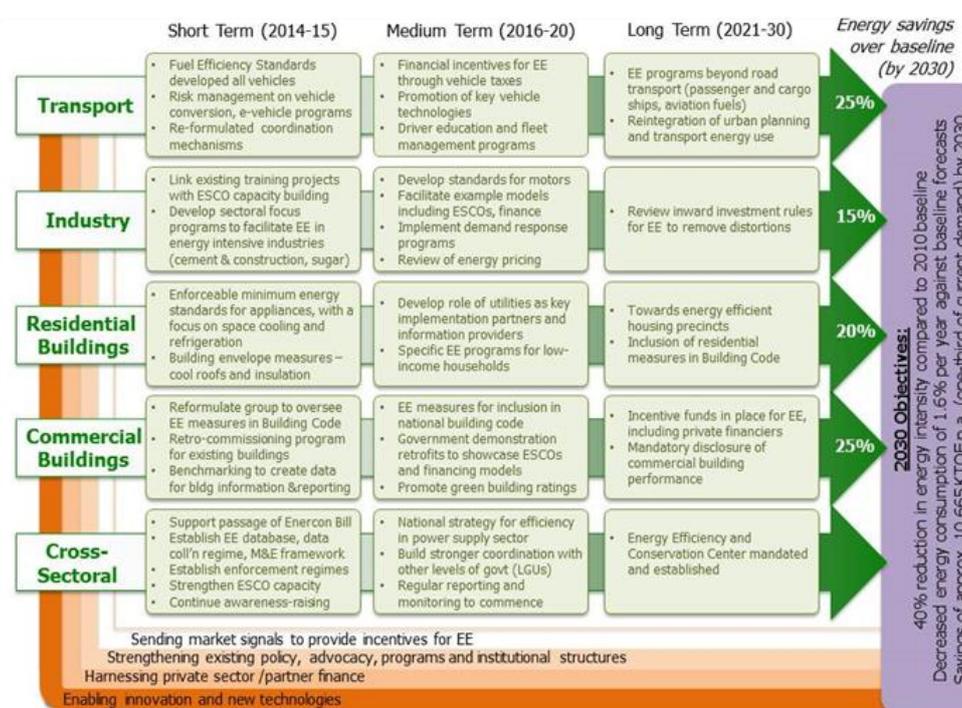
The Philippines Department of Energy should serve as the central authority in the implementation of EMS' plan and program in all public buildings. A bill on Energy Efficiency as an economy's policy must incorporate provisions on EMS adoption and implementation.

5. ENERGY EFFICIENCY

FINDINGS

The Philippines has a number of policies that support energy efficiency at the local level. However, they are not explicitly applied to the local level. The assistance from central government to guide local action is happening in an ad hoc manner through partnerships with the Philippines Department of Energy (DOE). The DOE has put in place several policies and programs on energy efficiency like mandating 10% reduction in electricity and fuel consumption of government offices, energy standards and labelling program of selected household appliances, energy audits and the ESCO program, among others (DOE, 2014).

Figure 19: Energy Efficiency Roadmap of the Philippines , 2014-2030



Source: Department of Energy

Further, the Philippines Intended Nationally Determined Contribution (INDC) submitted as part of the United Nations Framework Convention on Climate Change (UNFCCC) targets a 70% reduction in GHG by 2030 from 2000 levels relative to BAU scenario (UNFCCC, 2015). However, based on the discussions with DOE representatives during the Policy Review, the central government is currently reviewing this commitment level and may be considering a reduced target. The Philippine Energy Plan (PEP) 2012-2030 also advocates a low-carbon future for the Philippines as one of the policy thrusts of the government. The DOE has also formulated and approved the implementation of the Energy Efficiency and Conservation Roadmap in July 2014. Said Roadmap identifies short- to medium-term action plans and policy directions across key energy consuming sectors with a goal towards an energy-efficient economy by 2030. The overall aim of the Roadmap is to achieve 40% reduction in energy intensity by 2030 based on 2010 level (Figure 19).

From the feasibility study, the City could achieve a 30% reduction in GHG relative to the 2015-2030 BAU scenario. Unfortunately, the City lacks some important data to conduct accurate carbon accounting, such as fuel

consumption. Electricity is available from the power distribution utility company servicing the City and other areas in Metro Cebu. GHG projections predict strong growth of emissions in all sectors with the transportation and industrial sectors accounting for the vast majority of future emissions (47.7% and 40.7%, respectively). The remaining emissions are attributed to the residential and commercial building sectors, which are expected to see a large growth in the period to 2030 (ALMEC, 2016).

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 21. Promote (via financing and incentives) onsite renewable integration and LPG generating facilities for high energy users. ★★★

The City is a home to large industrial buildings with expansive flat roof area. These roof areas are a prime location for siting photovoltaic panels for onsite generation. Further, if the infrastructure is in place to support the delivery of sufficient quantities of LPG, onsite generation using this fuel could replace the use of fuel oil, which currently dominates in the industrial sector. LPG could also be used to produce onsite power for industrial plants that are large electricity users, increasing reliability and improving the emissions of the consumed electricity.

Rec. 22. Incorporate low carbon elements in the entire City, not only in GGAs. ★★★

While much planning is underway to develop PUDs/GGAs with more conservative building code and built around mass transit hubs, the City should not concentrate all of its efforts in these areas alone. The City should implement strict building standards throughout the entire city. The City's long-term planning should include the development of a highly connected and well-distributed mass transit network with Bus Rapid Transit (BRT)/light rail backbone feeding to bus network, bike share, and other services. Likewise, the urban design principles should be incorporated to reduce car dependency and encourage live/work zones throughout the whole city.

Rec. 23. Shift away from CFL lighting to LEDs as a part of the Minimum Energy Performance Standards and in government building program. ★★

While this recommendation will yield a relatively smaller overall energy reduction for the City, it is still a best practice that should be encouraged. Current standards of the central government promote the use of compact fluorescent lamps. However, LEDs have become the international standard for lighting, and now being promoted for greater use. LEDs are more energy efficient, have longer operating durations, and do not contain mercury as CFLs do, therefore reducing their environmental impacts. Government programs to subsidise the purchase price of LEDs may be necessary to initiate the market for these lights that have a premium compared to traditional incandescent and CFL lights.

Rec. 24. Formalise data collection procedure for liquid fuels in the City in order to improve quality of carbon accounting. ★★

One notable challenge in the carbon emissions calculations performed by the LCMT Expert Group was the absence of data for the liquid fuel usage in Mandaue City. Consequently, the carbon emissions baseline relied upon data available in the adjacent Cebu City to provide proportional consumption figures, which introduces substantial errors, especially given that the two cities have very different economic drivers. Thus, it is recommended that a formal accounting standard be applied for liquid fuels in Mandaue. Following more stringent data collection, the 2015 baseline may need to be adjusted to more accurately reflect real usage.

Rec. 25. Emulate the central government program on offering subsidised building audits and coordination with energy service companies (ESCOs). ★

As noted in the findings, the DOE has a number of programs for energy efficiency and energy conservation. The recommendation is for the City to emulate, at the local level, programs such as promoting building audits as well as the coordination with energy service companies (ESCOs). Building energy audits can be incorporated into energy code and BERDE compliance certification. Audits also

serve to evaluate energy conservation retrofitting opportunities in existing buildings. Experienced ESCOs can overcome one of the largest barriers to implementing energy efficiency building projects, which is financing. ESCO contracts are typically structured so that all or most of the project is financed by the ESCO while project payment is derived from the consequent cost savings from reduced energy use.

6. RENEWABLE ENERGY AND UNTAPPED ENERGY PLANNING

FINDINGS

Photovoltaics (PVs)

Mandaue is well placed for PV uptake: the cost of PVs has dramatically decreased in the last few years; the existing electricity supply network is stressed, particularly during the day; peaks in electricity demand are during the day, when PV-generation is at the highest; there is PV panel and related electronics manufacture within the economy; and there is good industry capability to install and use PVs.

These characteristics align well with the electricity demand from the manufacturing sector, avoiding the need for batteries or other means to store and shift the time of use of the PV-generated electricity. Industries in this sector also often have reasonable roof space available for solar panels, and internal engineering staff capable of maintaining, and perhaps installing the equipment involved.

Upfront affordability and awareness are expected to be significant barriers to PV uptake in the short term. Consolidation of demand from industry has the potential to gain interest from domestic equipment manufacturers (whose focus is on export), potentially enabling a local and cheaper supply option (but noting the high, export, quality of the equipment involved).

Domestic or wider industry use of PVs may require battery storage as part of the solution. Although there is an emergence of the use of lithium-ion batteries for the storage, such is an expensive option and has questionable GHG emissions and other benefits compared with the (traditional) use of deep-cycle lead-acid batteries for this purpose. This situation is expected to change as lithium-ion battery technology improves, or is replaced itself with other technologies of superior performance. Care is therefore required to avoid too early entry into electricity storage.

One exception to this is the provision of basic amenities to poorer communities. For such situations, the overall electricity requirement is very low allowing the use of small and relatively low-cost lead-acid batteries. There also stands to be significant health benefits to be realised where replacing lighting otherwise generated from combustion. Low voltage, PV electricity systems may also offer simple, safe solutions for the supply of electricity to poorer communities where supply is currently through illegal and/or sub-standard wiring and safety systems.

Thermal Solar

There appears opportunity for the use of thermal solar water heating across a number of industries, in particular for food processing. Similar to PV, many industries with reasonable to significant demand for hot water also tend to have access to large roof areas where panels could be mounted.

The demand for hot water, and therefore for solar water heating, appears limited in the domestic market. This is at odds with other economies with similar climate. It is expected that the demand for domestic hot water will increase. Therefore, it is recommended that a watching brief is kept of the situation followed by awareness and easy access to solar water heating if the demand does unfold.

Waste-to-Energy

The City has a significant solids' waste issue and the current practice of dumping at a local landfill is unsustainable and may also result in significant costs for land and water remediation in the future. The City's move to hauling rubbish to other regions provides a short-term management option, but is not a sustainable

long-term solution. This scenario may be well served by a waste-to-energy plant, possibly also accepting waste from other cities and provinces in order to attain the scale required to make the project more economic.

In line with this, it is recommended that a thorough, credible and independent investigation should be undertaken on the suitability of a waste-to-energy plant for the City. An important component of such investigation would be a thorough review of the technologies available and their robustness in providing emissions surety over the lifetime of the plant's operation. The investigation would be expected to benefit from the learnings of the recently released report, the 'Feasibility Study of Appropriate Waste-to-Energy Technologies Covering 178 LGUs in the Manila Bay Region' (SMEC, January 2017).

Biogas

There is very little centralised wastewater management which is unsustainable, particularly considering the population and commerce growth expected in the area. The introduction and use of onsite biogas production for food processing industries and local communities has the potential to relieve some of the issues, at the same time partially displacing the use of carbon fuels that are bought and used for heat production.

Energy Crops

There are few opportunities for growing crops for energy production due to the priority required for the production of food. There is not much opportunity for the use of waste by-product from food crops either due to the relatively small scale and low quality of the fuels involved. That said, there may be opportunity for use of food crop by-product as feedstock for biogas production, but this is likely to be limited to more-rural applications because of the transport costs and emissions involved.

Industrial Energy Centres

The City's industrial sector appears well placed for the use of energy centres providing integrated utility services (electricity, heat, cooling, fresh water and wastewater) to industrial parks. Integrated utility provision across synergistic companies is expected to reduce base energy requirements of the companies involved and provide more economic solutions for managing discharges.

District Heating and Cooling

District heating and cooling outside of localised industrial parks or multi-storey, multi-complex dwelling arrangements does not appear feasible: the warm-to-moderate temperature climate lends itself to very low residential heat demand and there are practicability and efficiency losses associated with a wide-area heat and cooling distributed model.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 26. Carry out an independent expert and peer review assessment of the viability of a waste-to-energy plant. ★★★

The independent assessment would support the City's waste management plan with inputs from those responsible for managing air quality (within the City's air shed).

Rec. 27. Provide quality information and awareness on PVs. ★★★

This initiative should target promising industries, build into social housing designs, and investigate opportunity for aid-supported electricity supply for low voltage PV systems to poorer communities.

Rec. 28. Investigate and deploy opportunities for further utilisation of industry onsite waste as feedstock for energy. ★★

There are opportunities to use industry onsite wastes for useful purposes including through added processing of waste streams. The additional process has the opportunity to produce animal feed and manufacturing materials, in the case of food processing. Plant-based wastes also have the potential to be used for the generation of energy.

Rec. 29. Investigate the use of municipal waste-derived and company-derived biogas. ★★

Assessment of biogas potential in the City could provide an option for alternative fuels to reduce consumption of carbon fuels.

Rec. 30. Deploy grid-supported solar charging stations, utilising roofs of covered transit areas as a component of e-trike and e-jeepney program. ★

As the transport sector is the largest source of GHG emission, the program on e-trike and e-jeepney as among the modes of public transport (in the Philippines) will have significant impact to GHG emission reduction from this sector. Once this program develops, establishment and deployment of charging stations using solar should in parallel be developed.

Rec. 31. Investigate the feasibility of developing multi-utility energy centres. ★

The multi-utility energy centres would provide the synergistic utility requirements for industrial parks or industry clusters of companies.

Rec. 32. Maintain a watching brief on the opportunity for solar water heating and provide awareness through support of uptake if the demand unfolds. ★

With potential of solar water heating to provide lower cost and low carbon heating of water, promotion and preparation for its use must be encouraged as the demand for hot water increases. This includes preparation and support of the market through the provision of relevant information for the people to be aware and make informed choices.

7. TRANSPORT

FINDINGS

The transport sector is the largest contributor to CO₂ emissions, accounting for nearly half (49.0%) of total CO₂ emissions in Mandaue in 2015, which is very different from many developing cities in the world. Most CO₂ emissions are from road vehicles. In addition, based on the feasibility study, the estimated CO₂ emissions in the transport sector will continue to account for the largest among the four sectors (residential, commercial, industry, and transport) in 2022 and 2030.

The City has a very limited public bus system and there is no metro/light rail system. The jeepney currently provides an important passenger service across the City, but it is also a major emitter of both air pollutants and CO₂ (though far better than its diesel-fueled counterparts operating in Manila). Similarly, the gasoline-fed tricycle provides an important first-mile/last-mile service but is also a significant contributor to poor air quality, particularly when the tricycle is powered by two-stroke gasoline engine is concerned. The quality of these transport options requires improvement – to encourage wider use by upgrading the services provided, and by improving the specification of their motive component. As a first step, minimum specifications are required for the engines used. This would also incentivise the use of electric vehicles. Due to their relatively small capacity compared to public buses, a larger number of jeepneys and gasoline-trikes are required on roads to meet the demand for passenger service, which are major causes of traffic congestion.

Automobiles have increased rapidly and contribute significantly to both air pollution and CO₂ emissions. The Household Interview Survey (HIS) for Metro Cebu conducted in 2014 revealed that about two-thirds of the residents of Mandaue believe that the traffic situation is bad and that the increased use of automobiles (36%) and lack of discipline of drivers (24%) were two major causes of traffic congestion. Currently different transport modes converge on the same roadway, compromising the safety of bikers and pedestrians. Road design should encourage non-motorised transport (NMT) and include covered walkways and separate bike lanes. The provision of road space for bikers and pedestrians could provide higher flow of traffic along other corridors in the absence of low-speed traffic. Such win-win opportunities need to be identified and progressed.

As the City is located in the midst of Metro Cebu, it has a relatively well-developed road network (118 km long with a road density of 3.4km/km²) among the 13 member LGUs of Metro Cebu that connect Cebu City to other cities such as Consolacion and Lapu-Lapu. Therefore, the City has a large amount of through-traffic with different origins and destinations outside of the city. The city provides access to the Mactan Cebu International Airport and the Cebu International Port and the domestic port for inter-island ships. The port, airport and Cebu City are significant start and end destinations. Traffic from proposed new ports is likely to significantly increase through traffic demand. Each cross-road to these main arterials presents a barrier to free-flow traffic both along the arterials and within the immediate vicinity. With the City's traffic density, management tools such as phased lights are no longer sufficient, and underpasses, overpasses, and/or elevated roads will need to be considered. The construction of each will likely bring about significant disruption in itself, which will require both management and development and adoption of alternatives. The City will need to work closely with other LGUs to provide a coordinated transport solution.

The City's road transport is severely congested during 6:00-7:00 (going to work) and 17:00-18:00 (going to home) periods. The shoulder periods are becoming more extended indicating that the growth in infrastructure is not keeping pace with the increases in demand. And this situation will only get worse with projected growths

in population and industry as the City plans to focus on developing its industrial sector in the future. The slower speed and frequent stops of vehicles have worsened the emissions situation.

Global and local emissions could be improved from addressing traffic congestion. In the longer term, this will require a significant shift from private to public transport to increase the passenger movement density of the current road infrastructure. This will take a multi-step approach, including improving first the public transport services to encourage mode shift (public transport) from the currently more comfortable or convenient options. On the other hand, short-term relief from congestion could be obtained through control or management measures, or dis-incentivising travel at peak times. Some of the management methods may include:

- Restrictions on private vehicle use during times of expected peak traffic (including methods based on the vehicle's registration number);
- Congestion charging and variable tariff rates for public transport with a premium on fares during peak traffic periods; and,
- Adoption of different operation hours for industries with large workforce populations to avoid going to and from work at the same time period (flexible working hours) thus easing traffic congestion

The City has a waterway on its eastern boundary that currently appears underutilised. This waterway could provide for daily commuting and/or freight transport, and could offer an unobstructed link for passenger transport between the north and south of the region. It is recommended that this potential opportunity be investigated.

Because of the complexity of the transport sector, and the change required, it is vital to develop a long-term transport development strategy and plan. Such will require the close involvement of neighbouring LGUs and central government, using information from respective city visions for industry development, tourism, ecological development, land-use planning and zoning.

Elements of such a plan would need to include:

- Short-term targets. These might include improvements to existing infrastructure through the use of transit lanes, smart corridors, express jeepneys (reducing pull-ins), and others aimed to improve upon traffic flow;
- Intermediate targets. These might include development of an integrated and connected transport infrastructure that also considers the need for intermediate-term routes that will limit the likely disruption with construction of longer-term transport infrastructure solutions (in recognition that the City requires some form of mass public transport system and efficient freight transport system within 10 to 15 years); and,
- Long-term targets. This would include coordinated public transit systems (bus, area-wide metro/elevated light rail, AGT-CML Line, and BRT) to reduce vehicle numbers, starting in areas with heavy traffic. Development of expressway for through-traffic vehicles (for example, airport-related traffic and existing and future port related traffic).

If found feasible and economic, the use of the Mactan Channel as additional transport infrastructure could also be considered, both on and alongside the channel.

As an enabler to the uptake of modern engine technology (that is expected to provide fuel efficiency improvements) it is recommended that the City presses the central government for the development and introduction of higher quality standards for gasoline and diesel. This is also expected to provide air quality emissions improvements. However, it is recognised that the City's demand for automotive fuels is very small

compared to total Philippines. For this reason, it is more prudent for City government to approach other regions to provide a larger voice to the central government.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 33. Develop a coordinated, long-term transport development strategy and plan. ★★★

With neighbouring LGUs, develop a coordinated, long-term transport development strategy and plan to respond to current congestion and transport emissions issues, and to plan for further port-related activities and increased airport traffic with expected growths in population, industry and commerce.

The development strategy and plan should prioritise a transportation mode shift from private automobile usage to public transportation. The large category of public transportation should include existing and new transit options that can augment the road-based system.

Rec. 34. Increase the effectiveness of existing road infrastructure to reduce traffic congestion and carbon emissions. ★★★

Both the shortage of road infrastructure and the low efficiency of existing road infrastructure contribute to traffic congestion in the City. Some traffic management and land-use approaches can be employed to increase the effectiveness of existing road infrastructure, as follows:

- a. Coordinated operating hours (different work hours) for companies with large labor forces to reduce traffic jams;
- b. Implement Intelligent Transport Systems (ITS) and smart transport (smart corridor, Wi-Fi devices for traffic information, traffic control center). Traffic information can help vehicle drivers to avoid driving through congested areas, and thus reducing vehicle operation costs, shorten waiting time, alleviate traffic jams, and reduce pollution emissions. The City government can collaborate with the private sector to provide better traffic information;
- c. Introduce transit lanes during peak traffic periods to encourage ridesharing;
- d. Consider the locations of the industrial firms and where the workers live in making infrastructure investments; and
- e. Adopt a better management for tricycles/jeepneys to reduce their combined footprint on the road and in easing congestion. Two-stroke tricycle using gasoline in the city should be phased out gradually, and restrictions should be placed on the remainder during peak-traffic periods (when they pollute most).

Rec. 35. Develop education and training programs to improve driver behavior (follow rules, eco-driving, etc.) and the environmental awareness for public citizen ★★★ and ★★

Driving behaviour is a major factor that contributes to traffic congestion in Mandaue City. A series of education and training programs are necessary to help citizens and drivers to increase their awareness on air pollution and climate change, as well as their own contribution to those problems. These programs can be organised by the government, schools, and non-government organisations (NGOs). Education of all road users is necessary for them to respect and comply with traffic regulations and signals.

Meanwhile, eco-driving training can be conducted in driving schools and in communities. Eco-driving is a driving style that involves constant speeds, less 'fast-slow-fast-slow' driving and anticipation of driving flow, which can minimise fuel consumption and the emission of carbon dioxide. A driver safety program could be developed to help drivers learn to drive safely around pedestrians, cyclists, and motorcyclists.

Provision of quality, robust information and awareness at the development, planning and deployment stage for providing awareness of better options, which may include information on:

- Driving practices, fuel consumption-related vehicle maintenance;
- Changing time of travel to avoid congestion; and,
- Vehicle purchased choices.

Rec. 36. Coordinate efforts by different levels of governments and coordinate and integrate transport development strategy and urban planning. ★★★ and ★★

Many of the above recommendations cannot be implemented by the City alone. The City's low-carbon transport initiatives are closely linked not only with the central government but also with Cebu Province, Metro Cebu and neighbouring cities. A working group made up of representatives from Mandaue and neighboring LGUs, and the central government is essential for realising low carbon development of Mandaue by coordinating different low-carbon transport initiatives. Financial and knowledge support from the central government agencies, such as DOE, is also necessary to ensure the effective implementation of these initiatives (recommendations from policy review).

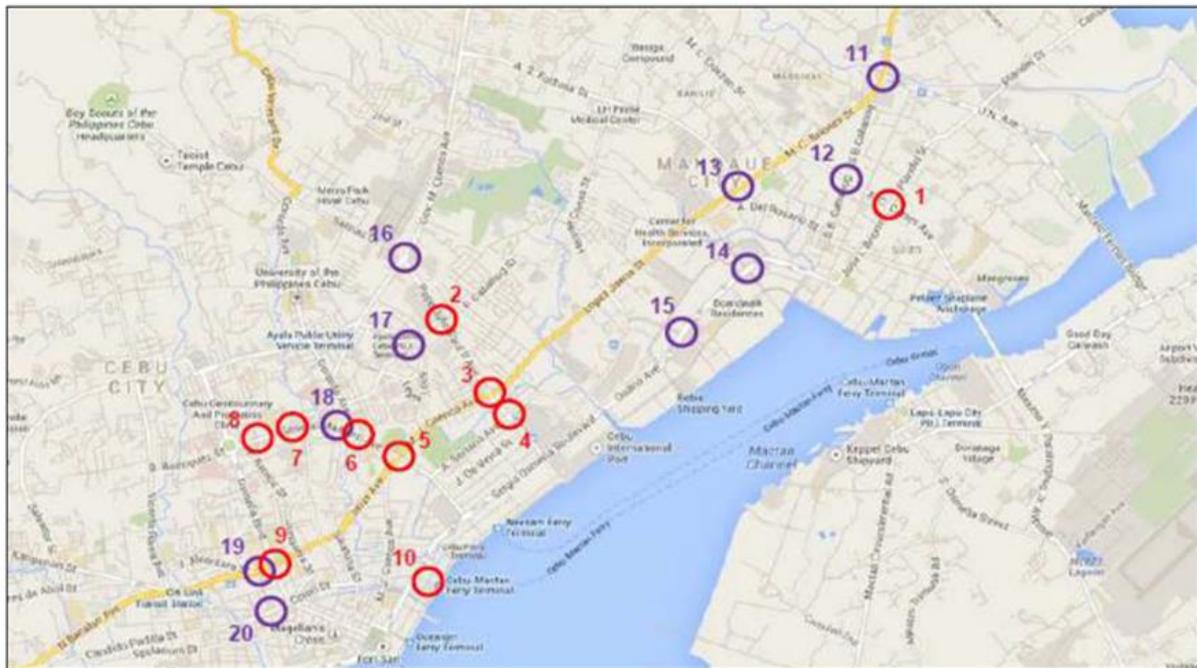
A long-term transport development strategy is necessary to reduce lock-in costs since most transport infrastructure involves tremendous investment and construction over a long period of time. This strategy should be combined with a vision for the City (e.g., tourism and ecological development), and other strategies for land-use planning.

Rec. 37. Set up a strategy for a step-by-step movement toward public transit systems (bus ★★★, area-wide elevated light rail such as AGT-CML line ★★, BRT ★) to reduce traffic jams, starting in areas with heavy traffic congestion and transport demand.

The City has a very limited public transit system, while jeepneys and private automobiles have been the major travel modes and the sources of traffic jams and emissions for both CO₂ and air pollution. There are barriers to developing public transit systems to replace jeepneys as they provide very convenient public service (flexible stops) and job opportunities, as well as local citizens are used to this travel mode. However, public transport systems can not only provide mobility, safety, and economic benefits to individuals and businesses, but also offer significant environmental advantages.

Due to its high capacity, public transport can replace many separate emissions-producing vehicles with fewer transit vehicles moving more people to their destinations. With this, fewer vehicles will be on the streets, thus alleviating traffic congestion, improving air quality, and reducing GHG emissions. International experience has demonstrated that public transportation produces significantly lower GHG per passenger mile than private vehicles. The establishment of public bus systems is recommended for immediate action. It can start in residential and commercial areas with heavy traffic congestion and high transport demand (red circle area for Mandaue City in Figure 20). The environmental departments and NGOs in the City can organise programs to educate the public about the environmental, economic, and health benefits of the public buses to change their habits and attitude towards public buses. The government also needs to provide subsidies to lower bus cost to attract public citizens to take buses and to train jeepney drivers to be bus drivers. It will be more beneficial to low-carbon city development if the City could leapfrog to battery buses in its transit to public bus systems.

Figure 20: Locations of Congested Intersections



Note: Red circle means first priority to be improved, while Blue circle is second priority. Intersections No. 1 and No. 11 to 15 are found in Mandaue City.

Source: ALMEC and Travel Speed Survey 2014 under the Roadmap Study for Metro Cebu.

The proposed mass transport system, the AGT-CML, can be a start-up project for the next 2-3 years. This project will connect the Cebu City Central Business District, the Mandaue high growth areas, and Lapu-Lapu City with the Mactan Cebu International Airport, one of the heaviest traffic corridors of Metro Cebu. This project will not only benefit Mandaue City but also neighbouring cities as well. The AGT uses electricity as its power and generates less air pollutants and CO₂ than jeepneys and buses using gasoline. AGT has an elevated structure and simple railcars and it is more resilient in strong winds and heavy rain, which is important for a coastal city such as Metro Cebu.

Public transportation can also support higher density land development and facilitate more compact development, which reduces the distance and time people need to travel to reach their destinations, and thus decreases emissions from transportation. Compact development also leaves more land for parks, wildlife preserves, forests, and other uses. The development of public transport systems can be integrated into urban land-use development. The TOD is a type of urban development that maximises the amount of residential, business, and leisure space within walking distance of public transport. It requires the building of transit stops or stations in the middle of high-density residential and commercial neighbourhoods. Therefore, the building of stations in the City that connect to the AGT-CML Line should be planned (see the Roadmap Study for Sustainable Urban Development in Metro Cebu). The compact development around those stations will be integrated with the land-use planning for Mandaue City.

Rec. 38. Promote the uptake of electric vehicles by encouraging the production and use of e-bikes, e-trikes and e-jeepneys in the near term. ★★★ In the longer term, DOE should encourage the Philippine automotive industry to take steps to eventually manufacture electric vehicles. ★

Use of electric vehicles has been increasing rapidly worldwide due to its contribution to improving urban air quality, reducing GHG and fuel dependency. In response to the economy-wide e-trike program in

the DOE's 'Philippine Energy Plan (2012-2030),' the City has started an e-trike demonstration project sponsored by a local manufacturer and featuring 15 e-trikes in operation. The promotion of e-trikes can not only help realise the city's low-carbon and low-pollution objectives, but also support increased manufacturing of e-trikes. Similarly, both e-bikes and e-jeepneys should be promoted as well. E-trikes/jeepneys offer a zero-tailpipe, lower cost solution if one considers the total cost of ownership over five or more years. They provide GHG savings despite the high proportion of coal-generated electricity in the grid. There are also large potential benefits to be realised from solar-based charging.

In order to commercialise e-trikes/jeepneys, three conditions have to be addressed: 1) more and convenient battery charging stations; 2) lower price of both e-trikes/jeepneys and batteries; and, 3) financial support from the government for the manufacturers and charging station construction. Without the government's support in the initial stage, it will be difficult to promote this program. Increased manufacturing of e-trikes/jeepneys also fits the development vision of the City to promote the industrial sector.

Further, the City can act as a leader in promoting the use of electric vehicles and low-emission vehicles, though much of the support for these shifts will have to come from the central government.

Rec. 39. Promote the shift to NMT by making it easier (comfortable and safe) to walk and bike, including by constructing covered walkways and paths for pedestrians and cyclists separate from motorised traffic (e.g., Green Loop project). ★★

The NMT, which includes walking, bicycling and other small-wheeled transport, can play a key role in clean urban transport. It can be a very attractive mode of transport for relatively short distances. It is highly cost-effective and brings about large health, economic, and social co-benefits. The promotion of NMT needs a policy package consisting of investments in facilities (improved sidewalks, crosswalks, and bicycle lanes), awareness campaigns, smart urban planning, and connected public transport.

The Green Loop Project is proposed to establish a green corridor prioritising non-motorised transport. The Loop traverses the Cebu mainland and Mactan Island and it connects Cebu City, Mandaue City, Lapu-Lapu City, and the Municipality of Cordova in Metro Cebu. Since this project involves many cities and different levels of governments, it may take some time for the approval of this project. The City can first initiate the project in areas within its boundaries. The Butuanon River is seriously polluted which affects the quality of life of people along the banks of the river. This project can also promote the cleaning of this river and thus requires coordination and collaboration among the departments in charge of the environment, urban planning, and transport.

Rec. 40. Introduce higher fuel efficiency vehicle standards and high quality standards for gasoline and diesel. ★★

Introducing more fuel-efficient automobiles is necessary to address urban environmental challenges caused by the growing number of automobiles in the City. The quality of both vehicles and fuel (to enable use of more modern and efficient engine types) needs to be improved in order to reduce the emission intensity of individual vehicles. Higher fuel efficiency standards for vehicles and quality standards for gasoline and diesel should be promoted and related feasibility studies should be conducted. This policy can be promoted at the economy-wide level (e.g., by DOE) to be more effective. A supporting information and awareness program can be introduced at the city level.

Rec. 41. Reduce the use of automobiles on the road by controlling the number of automobiles (e.g., based on even/odd license numbers) during rush hours (6:00-7:00, and 17:00-18:00) to reduce traffic jams and environmental pollution. Congestion charges for certain roads or parts of roads with heavy traffic are recommended for the longer term. ★

It is difficult to control the demand for owning more automobiles as the City develops economically, but the government can limit the use of automobiles using command and control regulations and market-based instruments. Both approaches have been used in many cities, e.g., Beijing and Mexico (license plate restrictions on driving on different days), and Singapore and London (congestion charges). The control of vehicle use should be implemented for an area greater than Mandaue City (Metro Cebu or Cebu Province) and be mandated by higher-level governments (Metro Cebu, Cebu Province) given that the City has a large amount of through-traffic. Congestion charges/pricing is a demand-side strategy to use the price mechanism to increase the costs to users of motor vehicles in certain areas. Its operation involves a lot of social and economic issues, related to determining the amount of the charges, the locations subject to charges, and how the charges are assessed. Feasibility studies for both approaches are required before the government can decide on the optimal approach to choose.

Rec. 42. Build more road infrastructure and develop a transit infrastructure network that integrates rail, buses, walking and cycling. ★

Existing road infrastructure cannot meet rising demands, so more road infrastructure is necessary for the City to continue to develop. An elevated expressway for through-traffic to the airport and ports is recommended for the long-term transport strategy. Such an expressway can reduce the driving time to airports and ports, as well as the flow of traffic through the City, thus alleviating the traffic jam problem. The building of an expressway will require huge investment, which can come from public (different levels of government) and private sources. A toll fee can be charged to raise funds to cover the high investment cost. A feasibility study for the expressway should be conducted in the near future.

A transit network infrastructure that can integrate rail, buses, and walking and cycling should be constructed. Planning such a system should be combined with land-use and urban development planning. Low-emission vehicle infrastructure such as parking facilities for e-trikes/jeepneys or electric vehicles could be built to encourage the use of these cleaner vehicles.

The City requires some form of a passenger transit system and some form of an efficient freight transport system within the next 10 to 15 years. Construction disruption carries the risk of crippling an already transport-stressed region. A plan is required to limit disruption and the passenger transit system should be part of a larger transport solution (including advanced traffic signaling and other measures).

8. ENVIRONMENTAL PLANNING

FINDINGS

Adequate policies and legal instruments for environmental protection and sustainability but need more active participation from the public and enforcement by the stakeholders

Based on inputs/feedbacks from various parties, there are sufficient policies and legal instruments that have been approved by the central/provincial government and LGUs to protect the environment and support the implementation of various low carbon initiatives at the central/province/city level. To change the mind-set of the people is not an easy task and require multiple strategies and engagement sessions.

Further engagement with the public (grass root level) is much needed to create awareness and to inculcate the importance of environmental protection and how this can affect their livelihood and future generation. The public active participation and strong support will assist all parties to work and cooperate to improve their living standard for the betterment of their community.

To effectively enforce the legislations/laws, constructive enforcement approach by the respective agencies will help the community and industry to understand the impact if they fail to comply with regulations and how they can play a big role in addressing environmental issues. They must be given the technical assistance, knowledge and ample time period for them to make the transformation.

Lack of compatible data to calculate and determine the GHG emission by Mandaue City

Using Cebu City's data as a proxy did not equally represent the GHG emission produced by Mandaue City. Further, the adoption of the ratio of electricity usage of Cebu City and the vehicle registration in Mandaue to determine the energy consumption of Mandaue city is questionable and may not reflect the total energy consumption in Mandaue.

Taking into consideration the specific nature of each city, the calculation of GHG emission must also consider the well diversified economic based (manufacturing, commercial and trading), utilisation pattern and the multiple uses of energy fuel within the City. Due to the absence of the consultants, the panel of experts was unable to further investigate, understand and verify the methodology and findings of the feasibility study.

Monitoring, data collection and evaluation mechanism are yet to be properly established

In guiding Mandaue towards low-carbon town, the stakeholders must establish a comprehensive data gathering mechanism to monitor how the City has progressed in recent year. Proper mechanism in data collection will ensure the continuity, consistency and validity of the data, which will help in providing the right inputs and reflection of what is happening on the ground.

The mechanism will enable the City Government to evaluate the effectiveness of the proposed action under LCMT study and address any pertinent issues that hinder the implementation of low-carbon town initiatives. The findings also will assist the policy makers in determining the main problem that contribute to GHG emission and provide the necessary interventions and actions to be implemented by various stakeholders.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 43. Establish a Low-Carbon Town Implementation and Coordination Unit in the Mandaue City Government. ★★★

The City government needs to take the lead in establishing the supporting mechanism in implementing low-carbon town initiatives. As the focal point, the creation of the Low-Carbon Town Implementation and Coordination Unit requires adequate resources and qualified manpower to support its operation.

The main task of the Unit is to oversee and monitor the implementation low carbon initiatives. This Special Unit will also be responsible in coordinating and administering the data collection, as well as prepare the progress report and evaluation for the City. Collaborative research and fact findings with research institutions will be good approach in finding innovative options for reducing GHG emissions.

Rec. 44. Inculcate self-awareness and knowledge enhancement among the citizen, business and industry fraternity to support low-carbon town. ★★★

Changing the mind-set of the citizen is crucial in supporting low carbon initiatives and this effort requires stakeholders' involvement and participation. Inputs from stakeholders are important to the City in implementing the awareness program, as well as finding the most suitable approach for each segment and cohort of the community.

The City can strengthen the existing collaborative society (purok system/barangays) that has been established or actively participated in to encourage public participation and raise public awareness on major and critical issues. Focus should be given in knowledge enhancement and capacity building to equip them with necessary skills and knowledge to promote effective governance.

Rec. 45. Expand energy efficiency educational program. ★★★

The low-carbon city program implementation cannot only contain documents or special bodies. Smart City should be in people's minds. This is the only way for success. There are only few educational programs pursued by VECO on energy efficiency. The authorities should involve all stakeholders in the discussion and to conduct mass training of people, starting with resource saving programs.

Rec. 46. Incorporate CO₂ reduction into programs that address water quality from industrial operations. ★★★

The City is experiencing severe environmental degradation as a result of poor treatment of industrial wastewater, along with the air quality impacts from emissions in energy generation facilities and industrial processes. Projects that can address these environmental impacts should be prioritised and these projects should allow for the reduction of CO₂, wherever possible. For example, industrial operations that generate large organic materials in their wastewater discharge may be able to incorporate a bio-digester into a new wastewater facility, which would produce methane for onsite generation.

Rec. 47. Redefine the scope of low-carbon town to include a comprehensive green growth definition in order to encourage greater private sector involvement in the realisation of sustainable economic growth. ★★

Creating the business opportunities and attracting new investment in sustainable-related industry within the City is pivotal to sustain its economic growth. In addressing the GHG emissions, the scope of low-carbon town must include prominent sectors – manufacturing and industry, power generation,

infrastructure and transportation. Besides focussing in green building certification, it is important to provide avenue and assistance to encourage the private sector to embark on green/clean technology-based industry. This will facilitate and assist local SMEs/Industry to explore business opportunity from green business.

Rec. 48. Incorporate re-forestation into comprehensive stormwater management plan. ★★

As a consequence of unplanned growth and disjointed urban stormwater management, the City experiences damaging flooding during heavy rain events. The City has cited intentions to develop a comprehensive stormwater management plan. Any such plan should incorporate 'greening' actions that will both help with stormwater and contribute to vegetative carbon capture. Applications include steep slope stabilisation, riparian buffers adjacent to waterways, urban green space with integrated stormwater management, and green roofs.

Rec. 49. Address the main culprit of carbon emission in Mandaue. ★

The proposed measures in addressing the source of GHG emission (i.e. e-trike and transportation planning, and Green Loop) have limited impact in reducing GHG emission in Mandaue city itself. It may reduce the traffic congestion within the city and provide an alternative transportation mode but unable to reduce the incoming vehicles into the City, which is the backbone that support the industry sectors. Other options should be given priority, such as the use of energy efficient vehicles (EEV), electric vehicles (EVs) and other type of low carbon mobility, which can contribute to minimising the impact on the environment in terms of reducing dependency on fossil fuels, fuels wastage as well as emission of harmful gases and black smoke should be given priority.

The introduction of Green Loop can be enhanced by improving the connectivity, linkage and coverage of green landscape/shades and covered walkways within the major interest stops/commercial centre as well as buildings. Unpredictable temperate climate and lack of shading discourage people from walking or cycling although only for short distance.

As an industrial hub of Cebu, further deliberation in energy mix for electricity generation, multiple uses of energy fuel, mode of transport, type of vehicle, fuel specification as well as traffic flow must be addressed holistically. Other measures include implementing the EURO 5 emission standard, increasing biodiesel blending requirement, and use of CNG can be considered.

Since the City is one of the maritime hubs for Cebu, focus should also be given to introduce green concept in the management of the port as well as to manage the logistic industry in a more sustainable approach.

The City may require effective intervention and cooperation from multiple stakeholders to ensure the stipulated targets can be achieved. Thus, the central government intervention and assistance are much needed to assist the City become a low-carbon town.

Rec. 50. Resolve pertinent issues of basic amenities and relocation/redevelopment of informal settlements area by integrated planning and win-win solution among the stakeholders. ★

As the City aims to be a low-carbon town by the year 2030, the City government must address the needs for basic amenities of the public (i.e., clean water supply, drainage system, solid waste management), as well as sewerage and sanitation system, and even flooding. Poor living conditions and inadequate basic infrastructures within the respective clusters have direct social, health and environment challenges, if not resolve urgently, would prevent others low carbon efforts to be realised. Inability to provide the

necessary public services will affect the livelihood and well-being of the citizens and may undermine long-term economic growth and low-carbon town targets.

The feasibility study mentioned that the City is expected to enjoy robust and a well-diversified economic growth, which would also contribute to the population growth in urban/suburban areas, including informal settlement areas. Thus, proper planning and effective implementation for relocation and redevelopment of the informal settlement areas are equally important to complement the low carbon initiatives.

Rec. 51. Optimise green building incentives. ★

The effort of the City government to provide green building incentives to encourage the industry/commercial sector to embrace and implement green building design is laudable. This will create interest from the industry/commercial sector to implement green building initiatives in their project/property, as well as add value to their property (i.e. in terms of market price). Since this incentive (i.e., increase of plot ratio to the developer is one-off approval) has an impact on the City's revenue, the City government must monitor and ensure that the green building certificate is renewed periodically by the developers/owners of the buildings or properties to optimise the benefits of green building throughout the property life span.

Rec. 52. Encourage industry sector to participate in green growth initiatives, i.e. greening the industry through green manufacturing, remanufacturing and green/sustainable preferred products. ★

The commitment to shift from the conventional and costly 'grow first and clean-up later' path to low-carbon town approach would ensure its socio-economic development is pursued in a more sustainable manner, protecting development gains, biodiversity and the City's resilience to climate change and disaster. In pursuing green growth for sustainability and liveability, there are plenty of business opportunities that could be created from green-related industries.

To harness business potential from green/clean technology as new emerging industries, the stakeholders must strengthen the enabling environment to facilitate a shift in the economy, especially the private sector, towards a more sustainable pattern of consumption and production. This includes policy and regulatory framework, human capital, green/clean technology investment, financial instruments and greening the industries.

The transformation will spur green growth and sustainability development in the City by ensuring the sustainability of the resources, minimise pollution and waste, and strengthen energy and water security. By creating green business opportunity, the City can become more competitive providing new dimension that would attract new investments that contribute to its economic growth.

9. OTHERS

FINDINGS

For Mandaue, it is also critical to consider addressing air quality, water/land pollution and contamination, wastewater management/treatment, access to fresh water, solid waste management, climate change-related resilience, and socio-ecological resilience. However, in addressing these issues, there are many considerations that need to be taken into account, such as: regional growth aspirations; population increase/shift; land use change and establishment of new land; quality of life; involvement of several LGUs and private sector; effective Central Government-LGU liaison, and inertia of current practices or difficulty to bring about change. In consideration of all these issues, the City's immediate priority could be to **'build a liveable city with strong support from community-conscious companies.'** The City's priority should not redound to reducing the importance of working towards being a low-carbon model town, which is also significant. Rather, all projects must integrate measures to reduce carbon footprint, but should not necessarily be the lead activity.

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