SUSTAINABLE ENERGY TRANSITION ROADMAP
Executive Summary

USAID Energy Secure Philippines (ESP) Activity:
Enabling a Sustainable Energy Transition in Dumaguete City (ESETD)

ABOUT THE PROJECT

Increasing climate commitments worldwide have prompted transitions to low-carbon economies. In response to this, United States Agency for International Development Energy Secure Philippines Activity (USAID ESP) is supporting Manila Observatory's project entitled "Enabling a Sustainable Energy Transition in Dumaguete City". Through this project, the city government of Dumaguete will be able to better comply with Republic Act No. 11285 and the Government Energy Management Program (GEMP) through proper analysis, baselining, monitoring, and tracking, implementation, and communication.

The crux of the ESETD is the development of the Sustainable Energy Transition Roadmap. The roadmap was developed based on the Sustainable Energy Policy Blueprint and the Comprehensive Energy Audit, which are anchored on the implementation of the Republic Act No. 11285 and its Implementing Rules and Regulations, particularly the GEMP and Inter-Agency Energy Efficiency and Conservation Committee (IAEECC) Resolutions. This roadmap should serve as a starting point for Dumaguete City to further study these pathways and engage with its constituents for in-depth studies and consultations.

ACKNOWLEDGEMENTS

This report was developed under the guidance of John Altomonte (Manila Observatory) and authored by John Altomonte, Ruby Descalzo, Hannah Guinto, and Jaime Iñigo (Manila Observatory).

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List of Abbreviations

ACU	Air-conditioning unit
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BTO	Build-to-own
BPO	Business processing office
CCC	Climate Change Comission
CVRMSE	Coefficient of Variation of Root Mean Square Error
DER	Distributed energy resources
DSM	Demand-side management
ECM	Energy conservatin measure
EEC	Energy efficiency and conservation
EECO	Energy Efficiency and Conservation Office
ESCO	Energy service company
EV	Electrical vehicle
EVIDA	Electrical Vehicle Industry and Development Act
GEMP	Government Energy Management Program
GHG	Greenhouse gas
LCD	Liquid crystal display
LED	Light-emitting diode
LEECP	Local Energy Efficiency and Conservation Plan
LGU	Local government unit
LTO	Land Transportation Office
MCH	Motorcab-for-hire
NEECD	National Energy Efficiency and Conservation Database
NGCP	Natinal Grid Corporation of the Philippines
NORECO II	Negros Oriental II Electric Cooperative
NMBE	Normalized Mean Bias Error
PPP	Public-Private Partnership
PV	Photovoltaics
RE	Renewable energy
VRF	Variable refrigerant flow

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Overview

Most electricity is still generated by burning fossil fuels, making nearly 75% of present-day greenhouse gas emissions energy-related. At the same time, heavy reliance on fossil fuels generates economic vulnerabilities due to the climate impacts on the energy system such as disruptions to supply and transmission, system stress brought by higher demand for cooling, and others. This relationship positions energy at the center of the climate crisis.

Moreover, seventy percent of energy-related emissions come from cities, and with cities expanding and their economies growing, their population and energy consumption are expected to increase by 2050. This situation then puts cities in a significant role in the energy-climate crisis. With this, city governments play a key role in catalyzing large-scale sustainable transformations through the implementation of local policies and initiatives that can influence the energy management and sustainable development of the various sectors and communities in the city. These policies are often infrastructure and technology-driven, human and community-related policies, market-based policies, and command and control regulations.

Local governments in the Philippines are now increasingly pivotal in contributing to the energy transition by enacting and implementing renewable energy policies. We now see increased action from civil society and public institutions at the local level ranging from climate-related community projects to municipality mandates that aim to reduce the dependence on fossil fuels and shift to clean energy. Negros Oriental provides a case in point, with executive orders banning coal-fired plants, promoting the use of renewable energy, and increasing awareness about the benefits of clean energy. The region is also the first to enact a clean, renewable energy ordinance that not only institutionalizes renewable energy-oriented policymaking but also provides incentives and regulations for clean energy investors.

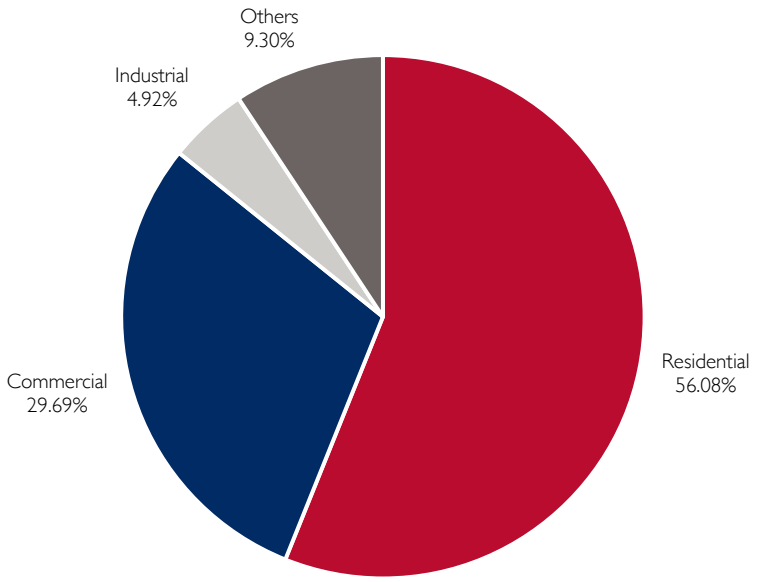
Dumaguete City

Dumaguete City is the capital of the province of Negros Oriental located in the Central Visayas Region. The city is divided into 30 barangays, all of which are urban, and is inhabited by a total of 134,103 people as of 2020. The city's economy relies on tourism, the academe (as a university city), retail industries, business process outsourcing companies (BPO), and information and technology firms. Data extrapolated from the Power Supply Procurement Plan of Negros Oriental II Electric Cooperative (NORECO II) indicate that Dumaguete City's energy demand occurs primarily from the residential sector, followed by commercial entities. Segmented datasets per municipality are not available, but NORECO II confirmed that demand ratios are relatively consistent across the franchise area.

Situated as the provincial capital of the renewable energy (RE) capital of the Philippines, Dumaguete is endowed with an abundance of resources and opportunities that can aid them in their transition towards a climate-resilient Smart City. With Dumaguete's growing economy, an increase in energy demand is inevitable. According to Oxfam Philippines (2022), Dumaguete City's current capacity would not be enough in the coming years. To accommodate the growing energy demand, the National Grid Corporation of the Philippines (NGCP) is already set to complete a new substation within Dumaguete City itself, which will be linked to the Amlan Substation via a 138 kV transmission line.

While resources are abundant and Negros Oriental energy policies are in place, there is much work that needs to be done for Dumaguete City to accommodate rising energy demand in light of a sustainable energy transition. As of this writing, there are no comprehensive climate and energy initiatives developed by Dumaguete City. This serves as an opportunity for the local government unit (LGU) to innovate and implement policies and mechanisms that foster the wide use of sustainable energy technologies in the city such as residential solar panel systems, demand-side management (DSM), retrofits, and vehicle electrification.

NORECO II Share of Energy Sales (2020)



Roadmap

The four key sectors that emerged in the development of the roadmap are energy, buildings, transportation, and waste.

The roadmap encompasses technological, infrastructural, financial, and human and community-related strategies, ensuring a holistic approach to the sustainable energy transition of Dumaguete City.

The strategies presented in this roadmap are designed with a Net-Zero emissions target by 2050. Given the complexity and institutional change needed to undergo an energy transition, it is impossible to immediately implement the entire suite of strategies. With this in mind, we can segment the Roadmap into two distinct phases: Near-Term and Long-Term.

In the near-term, the City of Dumaguete can begin implementing key strategies that are no cost or low-cost and that support the successful implementation of further strategies in the long-term. The near-term strategies aim to be accomplished by 2030, resulting in a 0-5% emissions reduction.

Long-term strategies constitute the bulk of large investments and institutional shifts towards sustainability. While the implementation of these strategies is not expected to occur before 2030, these studies and analyses can be accomplished in the near-term.

Ultimately, this Roadmap is designed to be a strong starting point for Dumaguete City and is expected to change and adapt as further studies are conducted, through more stakeholder input, and as different technologies and markets mature.

Below are national and local energy policies that are relevant to the city's energy transition, with respective areas that Dumaguete City can focus on:

1. Republic Act No. 11285 (Energy Efficiency and Conservation or EEC Act) – energy audits, Energy Effciency and Conservation Office (EECO), Local Energy Efficiency and Conservation Plan (LEECP), National Energy Efficiency and Conservation Database (NEECD)
2. Republic Act No. 9513 (RE Act) – Green Energy Option Program, renewable protfolio standards, waste-to-energy (WtE)
3. Republic Act No. 11697 (Electric Vehicle Industry Development Act or EVIDA) – green routes, mandatory electricle vehicle (EV) share
4. Republic Act No. 8749 (Clean Air Act)
5. Republic Act No. 9003 (Ecological Solid Waste Management Act)
6. RE Code of Negros Oriental
7. City Ordinance No. 231, Series of 2011
8. City Ordinance No. 45, Series of 2022

Energy

Set a local renewable energy target

Dumaguete City can formally adopt energy targets through legislation, adding certainty for investors, developers, and local constituents. A target for Dumaguete City should cover short, medium, and long-term targets and be integrated into any local development plans, particularly the vision to become a smart city.

Create a transdisciplinary local energy council

Dumaguete City's transdisciplinary local energy council shall include city government officials and advisors and members from different sectors, e.g. academe, commercial sector. This will also ensure more holistic and informed decision-making on matters relating to sustainable energy. The council can also participate in the development of a technical working group between Negros Oriental and Negros Occidental to collaborate on a framework of energy laws for the transition.

Implement a climate and energy data management system

Dumaguete City can start developing a local digital repository of climate and energy information to make it more accessible to the LGU, especially with complying with Republic Act No. 11285, particularly on the NEECD. Conducting a city-wide greenhouse gas (GHG) inventory will help establish climate goals and targets.

Support and promote city-wide adoption of distributed energy resources

Dumaguete is in a unique location in terms of renewable energy: the region of Negros Island is the renewable energy capital of the Philippines, with many generation assets producing solar, geothermal, hydropower, and biomass energy. Dumaguete can look into community energy and virtual power plants.

Support and promote city-wide smart distribution infrastructure upgrades

Smart energy metering is one popular solution that makes it easier for individual users to track energy consumption and make decisions on energy usage. Similarly, bi-directional meters allow for ease of net-metering programs, allowing end-users to leverage excess generation from distributed energy resources (DER) to feed into local grids.

Increase direct and indirect investments in large-scale sustainable energy projects

Dumaguete City can explore these mechanisms at the city level for smaller-scale RE systems such as for households, neighborhoods, and universities. In 2022, a BPO company celebrated the inauguration of its solar facility, making it the first BPO company in Dumaguete City and Negros Oriental to use solar energy to power its operations. The first subdivision in Dumaguete City that includes a 1 kW solar system in every rooftop also recently opened in 2023. In terms of funding, Dumaguete can consider implementing a Municipality Utility Development Tax to fund renewable energy initiatives. Other funding mechanisms include the People's Survival Fund under the Climate Change Commission (CCC), a special fund intended to finance climate change adaptation programs and projects that will better equip LGUs to deal with the impacts of climate change. Other mechanisms include the Energy Regulation No. 1-94, national wealth tax, public-private partnerships (PPP), build-operate-transfer (BOT), among others.

Establish a long-term local campaign project on sustainable energy transition

Similar to tourism campaigns, Dumaguete City, through the local energy council, can launch a sustainable energy campaign geared towards raising awareness and establishing Dumaguete City's image as a smart, sustainable city. When a city has certain expectations to uphold, such as an existing green image, this tends to reinforce RE policy.

Reduce red tape for sustainable energy projects and processes

Dumaguete City and NORECO II can co-develop a more streamlined permitting process. Both can also explore developing an online platform for easier access, especially for smaller scale RE systems. This can significantly help the adoption of rooftop solar photovoltaics (PV).

Buildings

Sustainable energy solutions for buildings

1. Rooftop solar - Particularly for residential constituents, rooftop solar offers a highly accessible option while presenting long-term financial benefits. Rooftop solar provides long-term energy security while reducing monthly energy expenses. The cooling factor, in certain cases, can also prove to be relevant. Dumaguete City can opt for an aggressive command and control regulation mandating new residential developments to have bi-directional meters and/or rooftop solar installations.

2. Cooling – In tropical countries such as the Philippines, cooling will often constitute the majority of energy consumption in buildings, in some cases almost 80% of consumption. Increasing efficiency of cooling systems has significant impact in the overall load profile of a building. In commercial establishments, investing in centralized cooling or variable refrigerant flow (VRF) systems can have rapid returns on investment and translate into significant savings. For smaller scale establishments or the residential sector, single-unit inverter type units can still provide significant energy efficiency gains.

3. Energy management and monitoring systems – Through the use of smart and digital technologies, internet-of-things, sensors, and analytics, the ability to monitor and subsequently manage energy demand has been shown to potentially offer between 8-18% reductions in building energy consumption.

Pilot sustainable energy retrofits in city-owned buildings

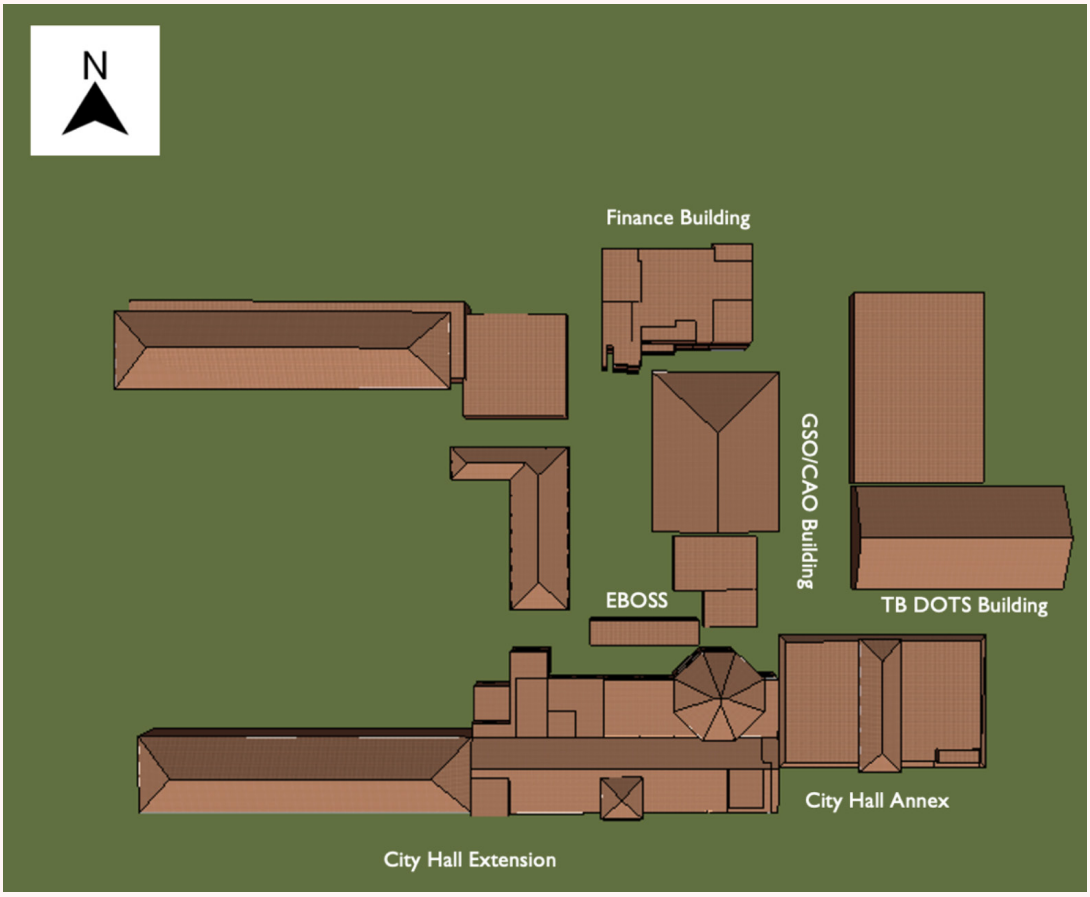
The City of Dumaguete has the opportunity to lead by example in city-owned buildings, piloting energy retrofits to showcase feasibility and opportunities present. The case study developed by ESETD has shown potential for the City Hall Complex of Dumaguete to attain at least 30% energy savings through a combination of technologies, totaling over PHP 2 million annually in savings.

Support energy transitions

1. Finance and incentives – A major barrier to energy retrofits for buildings is access to finance. Enabling access and supporting energy service companies (ESCO) to employ shared savings models can help overcome this challenge. Similarly, offering tax incentives for retrofits or for ESCOs can support growth in the sector, allowing for deeper penetration of energy retrofits.

2. Technologies and solutions – Dumaguete City can support energy retrofits by ensuring access and availability of the solutions needed to decarbonize, such as inverter-type air-conditioning units, rooftop solar PV, and smart meters. Similarly, the workforce needed to support, operate, and maintain these technologies need to be available and have the technical capacity to ensure long-term sustainability.

Case Study: Comprehensive Energy Audit



Dumaguete City Hall Compound

The Dumaguete LGU employs various electricity and fuel conservation measures in the city hall's day-to-day operations such as the use of LEDs or efficient lighting fixtures and the use of daylight instead of electric lighting whenever possible. In terms of cooling, single-type air-conditioning are used wherein the temperature is set to no lower than 25°C and is run strictly from 9 a.m. to 5 p.m., while set to "fan mode" during lunch break. Air-conditioned rooms are properly sealed to keep cooling efficiently. Dumaguete also implements a fuel conservation program, performs preventive maintenance of official service vehicles, and avoids idle engines while waiting or parking.

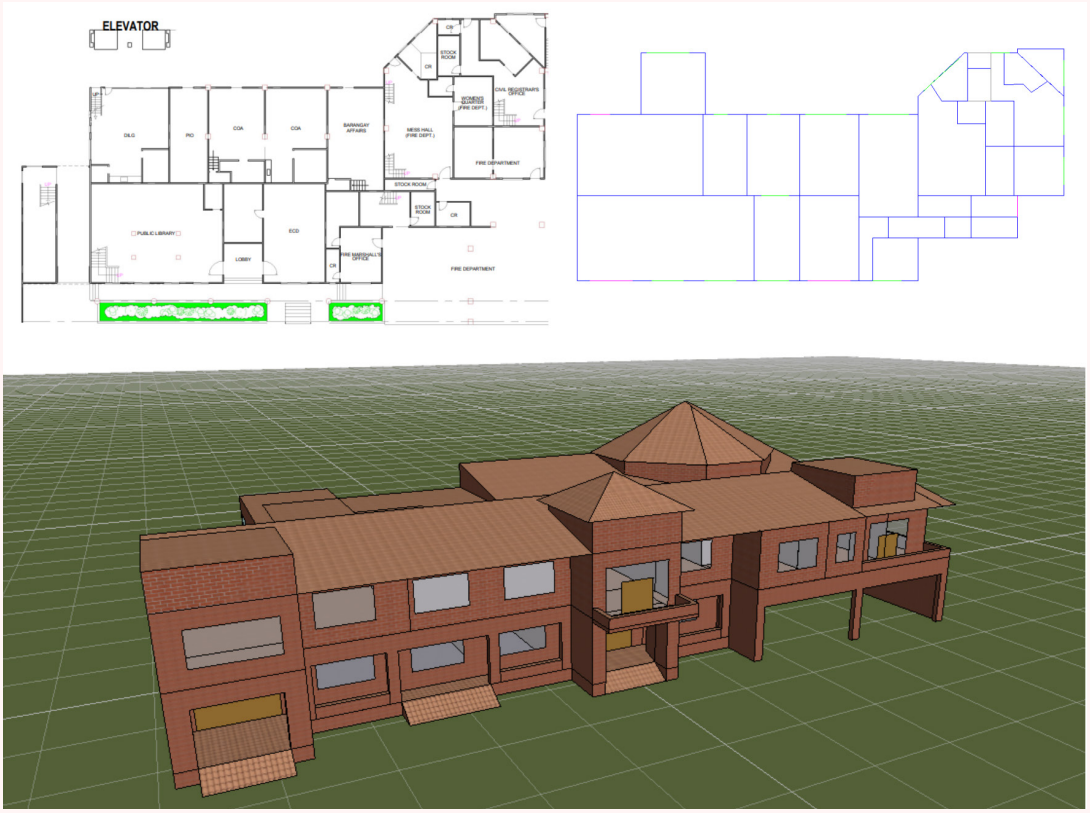
Based on the consultation with the Dumaguete LGU, six (6) buildings within the Dumaguete City Hall Compound were selected for the energy survey, i.e., the City Hall Extension, the City Hall Annex, the EBOSS Building, the TB DOTS Building, the General Services Office and City Assessor's Office Building, and the Finance Building. For the purpose of the case study, Dumaguete City Hall Compound shall refer to the selected six buildings and shall not include the other buildings located in the compound.

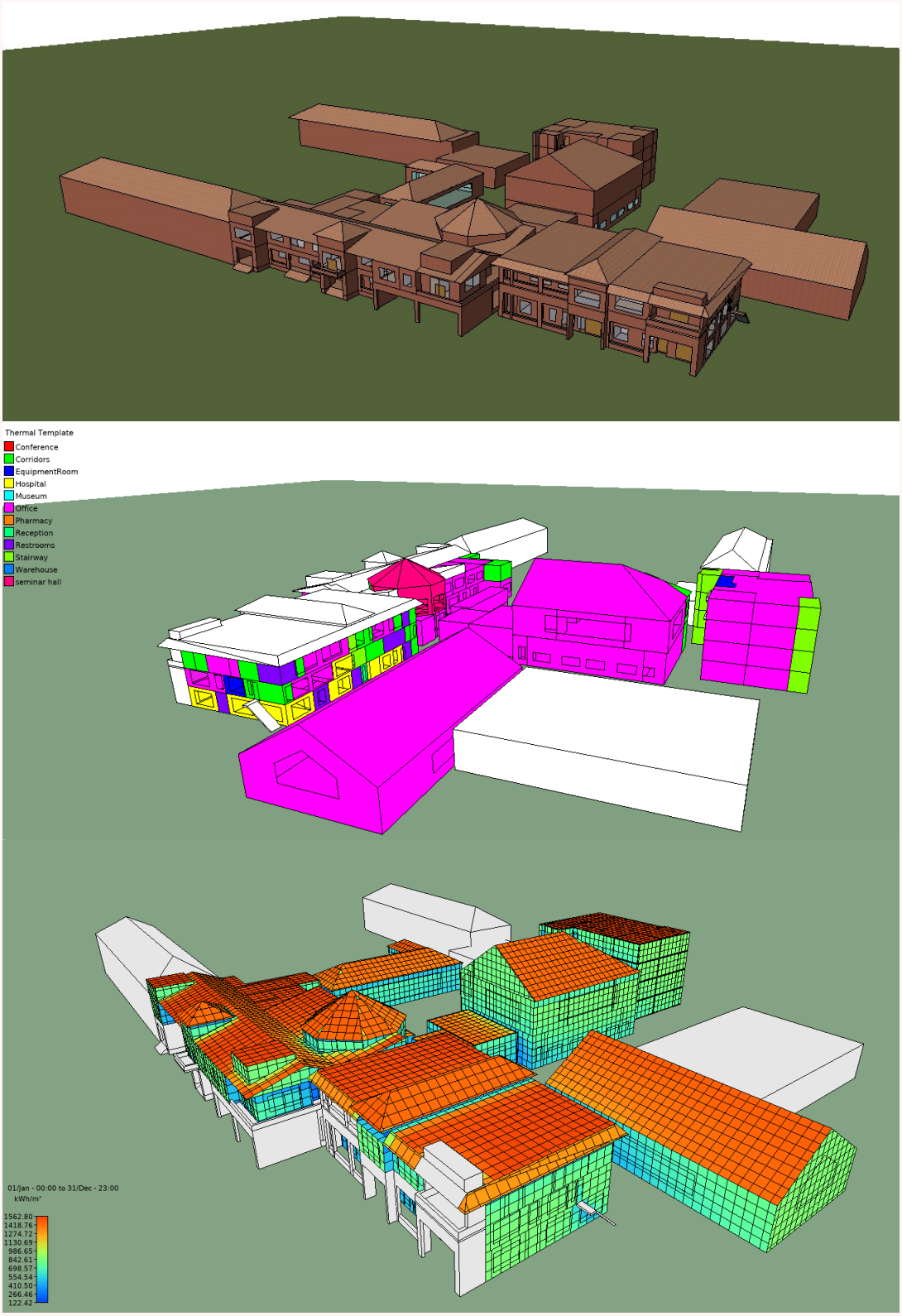
Methodology

On-site energy audit. Assessments on the Dumaguete City Hall Compound's lighting system, air-conditioning system, electrical system, motorized and other equipment units, and vehicle fuel consumption were conducted.

Virtual audit. The virtual model of the city hall compound was created based on the available data that was provided by the Dumaguete LGU. This will serve as a model wherein energy conservation measures (ECM) can be tested and simulated using IESVE, a modeling tool that employs digital twin technology. 3D models of the Dumaguete City Hall Compound were developed using existing floor plans. The models were also supplemented with findings from the on-site energy audit. Rooms were assigned specific thermal and operational templates.

The virtual model falls within the permitted calibration metric range for actual energy consumption versus the simulated energy consumption of the virtual model. The calibration metrics used are Normalized Mean Bias Error (NMBE) and Coefficient of Variation of Root Mean Square Error (CVRMSE) with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) maximum permitted values of ±5% and 15% respectively. While both metrics met the maximum permitted values, certain months show more than ~10% difference. This may be attributed to multiple external factors that are uncontrollable such as vagaries of weather, occupancies, time schedules, etc., and hence, the governing methodology allows for the deviation limits while calibrating.

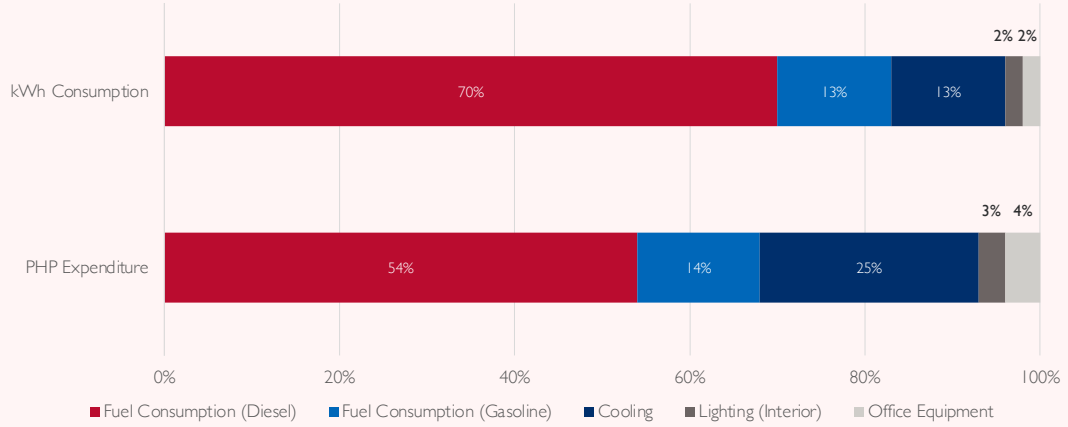



Thermal Template
Conference
Corridors
EquipmentRoom
Hospital
Museum
Office
Pharmacy
Reception
Restrooms
Stairway
Warehouse
seminar hall
01/Jan - 00:00 to 31/Dec - 23:00
kWh/m²
1562.80
1418.76
1274.72
1130.69
986.65
842.61
698.57
554.54
410.50
266.46
122.42

Summary of Findings

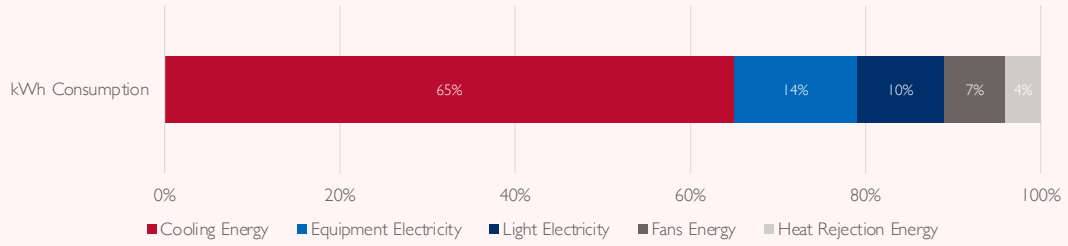
The city hall compound has a mixed use of fuel and electricity consumption for their vehicles, office equipment, lighting, and air-conditioning systems. Based on historical utility data, particularly from January 2017 to March 2022, the major contributor to the energy use of the city hall compound is the fuel consumption of vehicles. The second most energy-intensive contributor is the cooling or air-conditioning system, with a yearly consumption of 298,746 kWh. Converting the combined fuel and electrical end-use to PHP values, more than half of the city hall compound's energy expenditure goes to diesel consumption at around PHP 6.2 million per year, followed by cooling at around PHP 2.8 million per year.

Combined Fuel and Electricity End-Use of the Dumaguete City Hall Compound and Vehicle Fleet



End Use	kWh Consumption			PHP Expenditure		
	L	kWh	% kWh	Unit Cost	Cost per year	% PHP
Cooling	–	298,746	13%	PHP 9.37/ kWh	PHP 2,799,252.27	25%
Lighting (Interior)	–	36,707	2%		PHP 343,940.47	3%
Office Equipment	–	53,248	2%		PHP 498,924.08	4%
Fuel Consumption (Gasoline)	30,598	297,485	13%	PHP 53.55/L	PHP 1,638,547.53	14%
Fuel Consumption (Diesel)	144,250	1,562,705	70%	PHP 42.7/L	PHP 6,163,685.22	54%
Total Estimated	174,848	2,248,890	–	–	PHP 11,444,359.56	–

Simulated Energy Consumption Breakdown (kWh)



Using the virtual model of the city hall compound, a breakdown of energy consumption was simulated. The simulation does not include the fuel consumption of the vehicle fleet. Similar to historical utility datata, the major contributor to energy consumption is cooling, with a yearly consumption of 245,519 kWh, followed by electricity consumed by equipment (52,479 kWh) and lighting (36,625 kWh).

The conducted assessments on the Dumaguete City Hall Compound's lighting system, air-conditioning system, electrical system, motorized and other equipment units, and vehicle fuel consumption revealed varying results. Some of the key technical findings are described below:

Air-conditioning system. The thermostat settings in all the audited rooms were set to 16˚C to 24˚C for split-type air-conditioning units (ACUs), and High Cool for the window-type units. In terms of cooling load requirements, only one room had an acceptable value, while the rest would either be undersized or have capacities beyond the recommended requirements. Moreover, the majority of the tested ACUs have lower temperature differences compared to the recommended 9°C to 12°C temperature difference and have low compressor pressures. A few ACUs were observed to have negative heat loads. Dirty ACU filters and outdoor unit exhaust grills, tintless or unshaded windows, as well as minor leaks in windows and doors were also observed in various offices.

Lighting system. The Dumaguete City Hall Compound already uses windows and glass walls to provide natural daylight to various offices. Lights are also switched off when not in use in all offices. While 99% of the facility's lighting fixtures are already the more efficient LED lamps, a few offices still use ballasts-type lighting. The estimated electricity consumption of all the lighting fixtures is 36,706.56 kWh/year with an estimated cost of PHP 343,940.50 every year using the computed electricity rate of PHP 9.37/kWh. This value assumes all lighting fixtures are switched on all day, regardless of if the room receives daylight or not, and busted lamps are not replaced.

Electrical system and motorized equipment units. The power factor of most of the loads in the panel board of the offices are mostly more than 85% and have temperatures within the allowable range based on thermal imaging. However, the panel boards are not properly tagged and maintained, with most showing signs of deterioration. The deviation from the rated voltage levels of all equipment units, as well as the phase voltage unbalance levels and line current unbalance levels of all three-phase panel boards are within standard or acceptable ranges based on the Philippine Distribution Code, the U.S. National Electric Manufacturers Association, and the U.S. Department of Energy.

Other equipment. All computer monitors used in the compound use LCD/LED technology. An inventory of all office equipment in the compound was provided by the Dumaguete City Government.

Vehicle and fuel consumption. A logbook of vehicle and fuel use was provided by the Dumaguete City Government EECO. A copy of the annual fuel consumption from 2017 to September 2022 was also provided.

The recommended energy conservation measures mainly comprise of operational changes such as improvements in cleaning and maintenance of lighting fixtures and ACUs, and proper documentation and monitoring of equipment and vehicles. The installation of smart meters in main distribution panels and a fleet management system in vehicles are also advised.

The table below lists the ECMs that the LGU can prioritize to minimize their energy consumption for cooling. With an annual base consumption of 378 MWh, the Dumaguete City Hall Compound can achieve an overall savings of 52.33% by installing solar PV, upgrading non-inverter ACUs to inverter ACUs, installing lighting occupancy sensors, and increasing the set point temperature of common areas by 2°C.

The upgrade of existing non-inverter ACUs to inverter ACUs and the increase of set point temperature in common areas generate 14.36% savings in annual energy consumption or around PHP 650,000 saved in electricity bills. Additionally, by employing regular maintenance and cleaning of existing ACUs, as well as by operating the ACUs in Fan Mode for the first 30 minutes to 1 hour, around PHP 225,000 additional will be saved based on on-site energy assessment recommendations. Moreover, by addressing the audited ACUs with negative heat loads as well as by maintaining the ACUs in good condition, e.g., clean evaporators and condensers, the LGU can save up to 40,582.70 kWh, which has an equivalent of PHP 380,259.90 in PHP savings. Adding all of these can help the LGU save around PHP 1.25 million.

Condition	Annual kWh Savings	% Annual Savings	Unit Cost	Cost PHP	Annual PHP Savings	Indiv. Payback Years
Solar PV on roof - Power production	139,312	36.80%	PHP 50,000 per kWp	PHP 5,000,000	PHP 1,305,353.44	3.83
Inverter ACU upgrades	53,541	14.14%	PHP 18,000 per TR (61 TR)	PHP 1,098,000	PHP 501,679.17	2.19
Occupancy sensors in regularly occupied areas	3,662	0.97%	PHP 400 per unit (155 rooms)	PHP 62,000	PHP 34,312.94	1.81
Common areas set point temperature increase by 2°C	817	0.22%	_	–	PHP 7,655.29	–
Solar PV on roof - HVAC saving due to solar shading	768	0.20%	–	–	PHP 7,196.16	–
Total	198,100	52.33%		PHP 6,160,000	PHP 1,856,197.00	–

Transportation

Prioritize pedestrian mobility

Dumaguete can prioritize developing dedicated and protected bike lanes and sidewalks. Increasing mobility within the city has been shown to drastically reduce fuel consumption and transport-related emissions. It is key that walking and cycling are made safer and more convenient in order to promote them over other fuel-based modes of transport. Iloilo City's developments in this regard can be used as the best example.

Vehicle electrification

Dumaguete City has been touted as the "motorcycle capital of the Philippines", with the highest number of motorcycles per capita in the country. This provides a strong opportunity for Dumaguete to transition to electric vehicles, particularly electric two-wheelers. Fiscal incentives such as tax holidays may be granted to suppliers of electric vehicles in the city. Permitting processes can be streamlined in partnership with national bodies such as the Land Transportation Office (LTO) to facilitate adoption from end-users.

Dumaguete City can lead by electrifying its own fleet, in support of EVIDA, and by supporting the electrification of public utility vehicles, including the many Motorcabs-For-Hire (MCH) that ply their routes. According to the Dumaguete LGU, the city has 2,500 registered MCH units. The LGU is aiming to provide 100 additional new franchises to operators, through City Ordinance No. 45, Series of 2022, provided that the MCH units shall be powered by either Euro 4 compliant combustion engines or electronic-powered engines.

Fuel efficiency

Where vehicle electrification may be difficult and/or expensive to implement, Dumaguete City can enforce stricter fuel efficiency standards, which offer a lower hanging fruit in terms of increasing transport efficiency and reducing emissions. Enforcing strict Euro 4 compliance for operating vehicles is a step in this regard.

Dumaguete's position as a major marine transport hub offers it the opportunity to lead in reducing marine transport emissions, through similar enforcement of stricter fuel efficiency standards.

Waste

Waste-to-energy

Waste-to-energy offers a unique opportunity for Dumaguete City's climate and energy goals. There are around 2,500 active WtE plants worldwide with a capacity to dispose of 420 million tons of waste per year. Six of these plants are operating within the Philippines, such as the Montalban and Payatas landfills that have transformed into methane gas power plants which currently produce 8.19 MW and 2.5 MW of power respectively. Within WtE, there exists a range of technologies and solutions, including gasification, incineration, anaerobic digestion, bioreactors, and pyrolysis. Further studies into the waste composition and supply chain of Dumaguete City need to occur before discrete technology pathways can be recommended.

Support better waste management and segregation

While it is key to better manage and develop waste sites such as landfills and WtE, it is just as critical to reduce waste generation and increase recyclable and organic collection. Expanding organic collection, recycling programs, reduction of single-use plastics, and supporting reuse and donation are all key strategies for better waste management. Since 2011, the use of plastic bags for both dry and wet goods in Dumaguete City has been regulated through the enactment of City Ordinance No. Series of 231 of 2011. Local efforts under this ordinance include no-plastic days in public markets every Monday. The Dumaguete LGU can further support better waste management by supporting local manufacturers of alternative packaging materials and shopping bags, as well as providing incentives to consumers and barangays for waste reduction efforts. Mainstreaming of circular economy principles in the City of Dumaguete will also drastically improve its waste sector, with several co-benefits in energy and public health.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