Energy Transition Pathways for the 2030 Agenda

Sustainable Energy Transition Road Map for the City of Borongan, the Philippines

United Nations ESCAP
Economic and Social Commission for Asia and the Pacific

NEXSTEP
National Expert SDG Tool for Energy Planning

Energy Transition Pathways for the 2030 Agenda

Sustainable Energy Transition Road Map for the City of Borongan, the Philippines

Developed using the National Expert SDG7 Tool for Energy Planning (NEXSTEP)

UNITED NATIONS ESCAP
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*The shaded areas of the map indicate ESCAP members and associate members.**

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United Nations publication

ST/ESCAP/3087

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Acknowledgements

The preparation of this report was led by the Energy Division of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) in collaboration with Murdoch University, Australia, and the City of Borongan.

The principal authors and contributors of the report were Anis Zaman and Muhammad Saladin Islami. A significant contribution to the overall work was made by the staff of City Planning and Development Office (CPDO) of Borongan, headed by Mr. Daniel Andea, and employees of Eastern Samar Electric Cooperative (ESAMELCO), and Dr Orlando Balderama and his team from the Isabela State University.

The review and valuable suggestions were provided by Hongpeng Liu, Director of the Energy Division, ESCAP and Michael Williamson, Section Chief of the Energy Division.

Robert Oliver edited the manuscript. The cover and design layout were created by Xiao Dong and Qi Yin.

Administrative and secretariat support was provided by Prachakporn Sophon, Nawaporn Sunkpho and Thiraya Tangkawattana.

Foreword: ESCAP

The City of Borongan was one of the leaders in the Philippines in adopting ESCAP's National Expert SDG Tool for Energy Planning (NEXSTEP) methodology to develop a Sustainable Energy Transition Road Map. ESCAP is pleased to partner with the City of Borongan in its endeavour to realize a vision for the city's future based on holistic and sustainable development.

The City of Borongan currently adheres to its vision to be a progressive capital city of Eastern Samar with growing economy sustained by environmentally friendly integrated development under a dynamic multi-sectoral leadership with empowered citizenry. ESCAP's collaboration with the City of Borongan in developing this Sustainable Energy Transition (SET) Road Map further raises the city's sustainable development ambition by identifying the opportunities for city's sustainable energy transition.

This Road Map takes a holistic approach to Borongan' s energy system. It evaluates the city's current progress towards the SDG 7 targets, identifies the priorities for action and suggests opportunities for improvement. For instance, the Road Map highlights the current gap in universal access to modern energy in the city and proposes appropriate long-term solutions to close this gap, which also will enhance socio-economic development for a just energy transition.

The Road Map also details a range of technical opportunities and policy options for reducing emissions and saving energy across the residential and transport sectors. These opportunities include transport electrification as well as substantial reduction in city's emissions through decarbonization of its power supply, while paving the way towards a net zero emissions society.

ESCAP would like to express our gratitude to the City of Borongan and other stakeholders for their continuous support and contributions, without which the development of this Sustainable Energy Transition Road Map would not be possible. I look forward to the City of Borongan's continuing leadership in building a sustainable energy future.

Hongpeng Liu
Director, Energy Division, ESCAP

Foreword: Borongan

This Sustainable Energy Transition (SET) Roadmap is an essential blueprint for development, laying out Borongan City's pathway towards achieving SDG-Goal 7, that is securing access to affordable, reliable and sustainable clean energy. This document will give our policy makers and local leaders deeper understanding of what is the city's current energy situation and will provide guidance on what appropriate interventions to venture to close the gap between the current reality and our vision for a sustainable energy sources and infrastructures.

The City of Borongan, in its own little way is committed to contribute to the global efforts of reducing greenhouse gas emissions, by way of transitioning from fossil fueled energy sources into increasing access to renewable and sustainable energy sources. This may seem enormous challenge, yet the city's strong desire and determina6on will propel its way towards the fulfilment of its goal.

The support extended by the UN ESCAP in the formulation of this SET Roadmap for the City of Borongan, is an attestation that we are not alone in our endeavor. This external support will inspire us to push further towards sustainable energy development in our city.

Hence, the City Government of Borongan warmly extend its heartfelt gratitude to UN ESCAP through Dr. Anisuzzaman as well as Dr. Orlando Balderama and his team from the Isabela State University who painstakingly exerted efforts throughout the process towards the comple6on of this document.

JOSE IVAN DAYAN C. AGDA, CoE
City Mayor

Abbreviations and acronyms

BAU	business-as-usual
BEV	battery electric vehicle
CES	clean energy scenario
CO_2	carbon dioxide
CPS	current policy scenario
CREVI	Comprehensive Roadmap for the Electric Vehicle Industry
DOE	Department of Energy
EE	energy efficiency
ESCAP	(United Nations) Economic and Social Commission for Asia and the Pacific
GB Code	Green Building Code
GDP	gross domestic product
GHG	greenhouse gas
GW	gigawatt
GWh	gigawatt-hour
IEA	International Energy Agency
ktoe	thousand tonnes of oil equivalent
kWh	kilowatt-hour
LCOE	Levelized Cost of Electricity
LEAP	Long-range Energy Alternatives Planning
LPG	liquified petroleum gas
MCDA	Multi-Criteria Decision Analysis
MJ	megajoule
$ktCO_2$-e	thousand tonnes of carbon dioxide equivalent
MCCC	Modified Corona's Climate Classification
MTF	Multi-Tier Framework
MW	megawatt
MWh	megawatt-hour
MVUC	motor vehicle users charge
NEXSTEP	National Expert SDG Tool for Energy Planning
PHP	Philippine peso
RE	renewable energy
REF	reference scenario
SDG	Sustainable Development Goal
SET	sustainable energy transition
TFEC	total final energy consumption
TGFA	total gross floor area
TNZ	towards Net Zero
TPES	total primary energy supply
TWh	terawatt-hour
UNEP	United Nations Environment Programme
US$	United States dollar
WHO	World Health Organization

Executive Summary

Transitioning the energy sector to achieve the 2030 Agenda for Sustainable Development and the objectives of the Paris Agreement presents a complex and difficult task for policymakers. It needs to ensure sustained economic growth as well as respond to increasing energy demand, reduce emissions, and consider and capitalize on the interlinkages between Sustainable Development Goal 7 (SDG 7) and other SDGs. To address this challenge, ESCAP has developed the National Expert SDG Tool for Energy Planning (NEXSTEP).[1] This tool enables policymakers to make informed policy decisions to support the achievement of the SDG 7 targets as well as nationally determined contributions (NDCs). The initiative has been undertaken in response to the Ministerial Declaration of the Second Asian and Pacific Energy Forum (April 2018, Bangkok) and Commission Resolution 74/9, which endorsed its outcome. NEXSTEP also garnered the support of the Committee on Energy in its Second Session, with recommendations to expand the number of countries being supported by this tool.

The City of Borongan, in collaboration with the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), has developed this Sustainable Energy Transition (SET) Road Map to identify technological options and policy measures that will help the city to navigate the transition of its energy sector in line with the 2030 Agenda for Sustainable Development.

The Road Map presents three core scenarios (business as usual, current policy and SDG scenarios) and one ambitious scenario (towards net zero carbon by 2050 scenario) that have been developed using local data, which consider existing energy policies and strategies and reflect on other development plans. The net zero carbon scenario by 2050 offers policymakers a strategic viewpoint on how Borongan could plan for a carbon-free energy pathway in alignment with the global race to achieve zero carbon emissions. These scenarios are expected to enable the city authority to make an informed decision to develop and implement a set of policies to navigate through the sustainable energy transition pathway.

A. Highlights of the road map

In 2020, Borongan's population totalled 71,961 people, who comprised 17,493 households. In 2020, access to electricity was 94.1 per cent, leaving around 1,025 households yet to be connected to any form of electricity supply. About 18 per cent of the population, which amounts to 3,166 households, still relied on unclean and polluting kerosene and biomass stoves as their primary cooking technology. Such practice exposes those people, mostly women, to negative health impacts. Well-planned and concerted efforts will be needed to achieve universal access to clean cooking by 2030.

Energy intensity, the indicator used to measure energy efficiency, was calculated to be 4.56 MJ/USD_{2017} in 2020. For Borongan City to contribute to the global target of energy efficiency improvement of 3.2 per cent reduction per year between 2020 and 2030, this needs to be reduced to 3.3 $MJ/US\$_{2017}$ by 2030, which will require energy efficiency measures to be implemented across the entire demand sectors. The total primary energy supply in Borongan is similar to the Total Final Energy Consumption (TFEC), 15.2 ktoe, as there is no local electricity generation. Borongan is connected to the Visayas grid, importing all of its electricity demand from the central grid. Renewable energy delivered approximately 26.8 per cent of TFEC in 2020, including traditional biomass use for residential cooking. When traditional use of biomass is excluded, the renewable energy (RE) share in TFEC is 9.2 per cent.

1 The NEXSTEP tool has been specially designed to perform analyses of the energy sector in the context of SDG 7 and NDC, with the aim that the output will provide a set of policy recommendations to achieve the SDG 7 and NDC targets.

B. Aligning the City of Borongan's energy transition pathway with the SDG 7 and NDC targets by 2030

1. Universal access to modern energy

As of 2020, 5.9 per cent of Borongan's population lacked access to electricity, while 18.1 per cent lacked access to clean cooking fuels and technologies. More attention is required to setting up initiatives and channel funding to close the access gap. The Road Map proposes that decentralized renewable electricity systems may be the best way forward in electrifying the remaining households.

More attention is required to providing universal clean cooking access to the population of Borongan. Nearly one-fifth of the population relies on polluting cooking fuel and technologies for household cooking, specifically traditional biomass stoves (16.3 per cent of households) and kerosene stoves (1.8 per cent of households). Phasing-out of polluting cooking technologies will improve health and well-being of householders through reducing indoor air pollution as well as foster gender empowered socio-economic development. Electric cooking stoves stand out as an appropriate long-term solution, due to their cost-effectiveness, zero air pollution and minimal maintenance. In addition, coupling this technology with a decarbonized electricity supply results in a zero-carbon solution. However, considering the possible lack of sufficient power supply capacity for some households (i.e., households connected to mini-grid or solar home systems) to meet the power demand of electric stoves, LPG stoves may be an appropriate transitional technology for those households.

2. Renewable energy

The share of RE in the total final energy consumption (TFEC) in Borongan was 9.2 per cent in 2020, excluding the traditional biomass usage. Under the Current Policy Scenario (CPS), the share of RE will increase to 15.2 per cent by 2030. This increase is driven by the high growth of the renewable energy share in grid electricity, which is projected to increase from 48.4 per cent[2] in 2020 to 66.9 per cent in 2030, and a slight increase in biofuel usage in the transport sector. In the Sustainable Energy Transition (SET) scenario, the RE share in TFEC increases to 17.8 per cent. This additional increase of 2.6 percentage points from the CPS is a result both of increased use of RE due to a higher share of electricity in energy consumption and a further reduction of energy demand due to energy efficiency measures.

The RE share in TFEC for the Towards Net Zero (TNZ) by the 2050 scenario is further increased to 37.9 per cent, as the scenario envisions a decarbonized electricity supply and aims to position the energy system towards achieving net-zero carbon. In the TNZ scenario, more electricity-based technologies are adopted in the transport and residential sectors, reducing overall energy demand, and increasing renewable energy usage with a 100 per cent electricity supply. As described later in this Road Map, there are several pathways to achieving a decarbonized electricity supply, with the most promising and cost-effective one being through renewable energy auctions.

3. Energy efficiency

Borongan's energy intensity[3] is estimated to have been 4.56 $MJ/US\$_{2017}$ in 2020. It is expected to be reduced to 3.86 $MJ/US\$_{2017}$ by 2030 in the CPS, as GDP growth outpaces the growth in energy demand. This corresponds to an annual energy efficiency improvement rate of 1.9 per cent.

The SET scenario proposes several energy-efficiency interventions across the demand sectors, which further decrease the energy intensity to 3.23 $MJ/US\$_{2017}$ by 2030. This corresponds to a 3.4 per cent reduction per annum, exceeding the suggested global energy efficiency annual improvement rate of 3.2 per cent (UNSD, 2022). The transport sector accounted for around 51.6 per cent of the total energy

2 Based on the DOE 2020 Power Statistics, gross generation per grid, by plant type.

3 The decline in energy intensity is used as a proxy measure for energy efficiency improvement.

demand in 2020, and energy efficiency measures in the sector may provide substantial savings. The Road Map proposes an increase of the electric vehicle share in the transport fleet to 5 per cent by 2030. The projected result is a 1.3 kilotons of oil equivalent (ktoe) reduction in energy demand, compared with the CPS due the high efficiency of electric vehicles. Other measures include phasing out inefficient lighting appliances in the residential sector. The phasing out of inefficient, polluting cooking technologies allows an estimated energy reduction of 2.4 ktoe, clearly demonstrating the positive interaction between clean cooking access and energy efficiency.

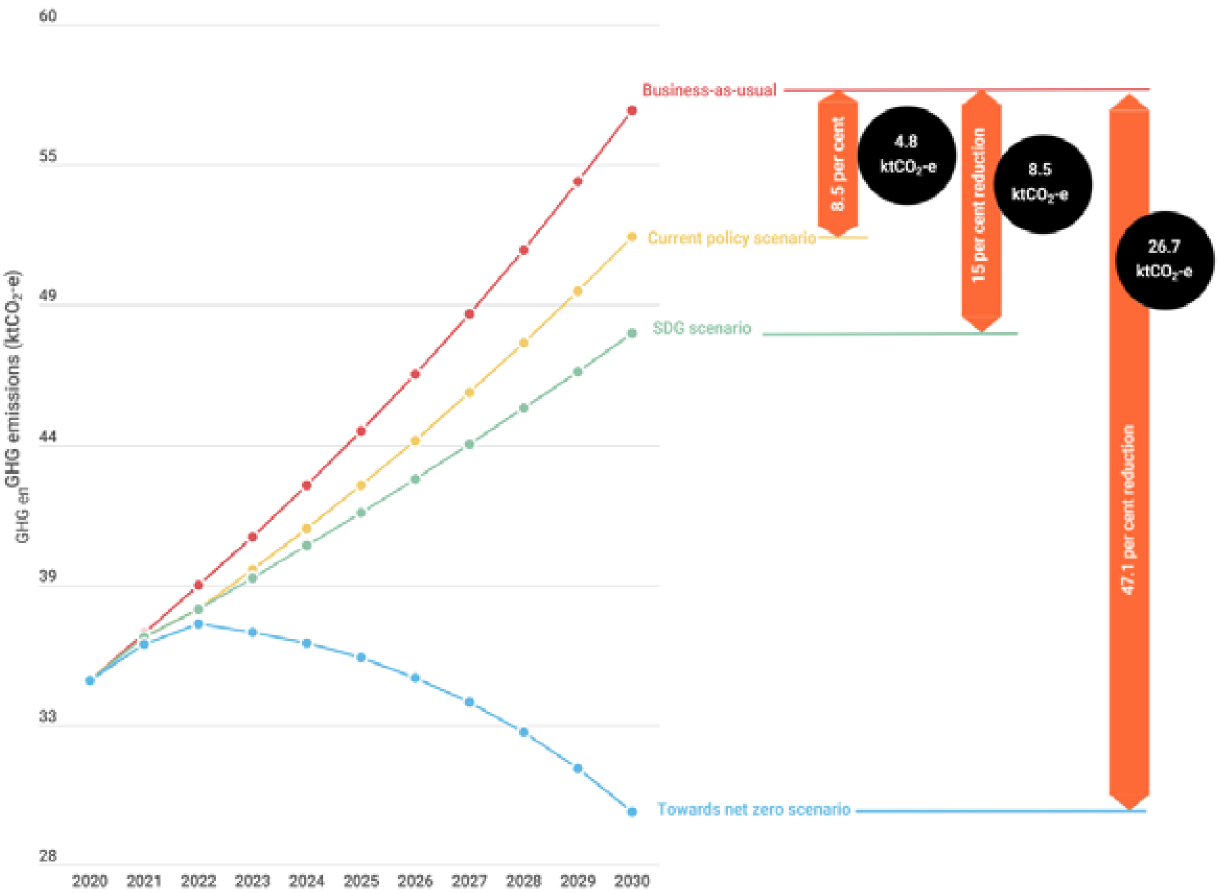
The energy demand reduction can be significant should Borongan follow a net zero carbon pathway, as suggested in the TNZ scenario. The energy intensity in this scenario is projected to decline to 2.67 MJ/US$ $_{2017}$, corresponding to a 5.2 per cent energy efficiency improvement per annum.

4. Emissions

The greenhouse gas (GHG) emissions in 2020 are estimated to have been 35,000 tonnes of carbon dioxide equivalent (ktCO_2-e), when considering the direct fuel combustion and emissions attributable to the purchased (grid) electricity. Figure ES 1 shows the GHG emission trajectories for the different scenarios. In the BAU scenario, the emissions are projected to increase to 56.8 ktCO_2-e by 2030.

In CPS, emissions in 2030 will drop to 51.9 ktCO_2-e and it will further decrease to 48.2 ktCO_2-e in the SET scenario. A sharp decrease can be observed in the TNZ scenario, dropping to 30.0 ktCO_2-e driven by the increased adoption of electricity-based technologies in the transport and residential sectors. This entails having 100 per cent electric vehicle sales[4] starting from 2030 onwards to reach a 100 per cent penetration rate by 2050 as well as phasing out of LPG stoves for residential cooking.

Figure ES 1. Comparison of emissions, by scenario, 2020-2030



4 Electric vehicle sales rate is defined as the proportion of the number of electric vehicles compared to the total sales of vehicles in the area. Meanwhile, the electric vehicle penetration rate indicates the proportion of the number of electric vehicles compared to the total on-the-road vehicle in the area.

C. Important policy directions

The Road Map sets out the following five key policy recommendations to help Borongan City achieve the SDG7 targets as well as reduce reliance on imported energy sources:

(1) **Access to electricity and clean cooking technologies should be a high priority.** Decentralised RE electrification systems, e.g., solar mini-grid, should be considered for quick implementation. The Road Map proposes electric cooking stoves as a long-term clean technology substitute. LPG stoves are a strong contender; however, electric cooking stoves are more cost-effective and cleaner in terms of household indoor air pollution. In addition, the use of electric cooking stoves paves the way towards net zero emissions when the electricity supply is decarbonized. LPG stoves may, however, be promoted to households that lack sufficient power supply capacity, i.e., households utilizing decentralised renewable energy systems. The cost of deployment of clean cooking stoves would be US$ 500,000 (US$ 130,000 for LPG cookstoves and US$ 370,000 for electric cookstoves).

(2) **Increasing the efficiency of energy use in the transport sector should be pursued and transport electrification strategies that provide multi-fold benefits in the long term.** The transport sector is the highest energy-consuming sector in Borongan. Therefore, the encouragement of public transportation use can be considered. Total energy saving potential in the transport sector will be 5 ktoe with 14.3 $ktCO_2$-e of emission reduction between 2023 and 2030. Vigorous adoption of electric vehicles reduces the demand for oil products, hence reducing Borongan's reliance on petroleum fuels. At the same time, it can contribute to climate mitigation and improve local air quality. An adoption rate of 5 per cent for passenger cars, motorcycles and freight trucks by 2030 has an additional potential, compared to CPS, to save energy cumulatively by 0.3 ktoe and reduce emissions by 0.8 $ktCO_2$-e under the SET scenario between 2023 and 2030.

(3) **Raising the renewable energy share in electricity supply through urban renewable energy electricity generation, renewable Power Purchase Agreements and renewable energy auctions.** Among the options for increasing the RE generation share, RE auctions provide the best financial case and financial savings due to low solar PV generation costs. In addition, promoting individual-level small-scale installations, such as solar rooftops in households and businesses, would be a further feasible option. Fulfilling 50 per cent of electricity demand from solar rooftop will save around US$ 3.6 million in 2025 and around US$ 5.6 million in 2030 under TNZ scenario. The required rooftop area will be around 22,000 m^2 by 2030. Other opportunity to be explored is to welcome investors to invest in wind power or waste-to-energy installation in the city in which the city will not have any financial involvement.

(4) **Moving towards net-zero carbon.** A net-zero society requires a concerted effort both by the city authorities and citizens. Total decarbonization of the power supply is essential, while increased electrification in the demand sectors is required, including phasing out of internal combustion engine vehicles and LPG stoves. In this net zero scenario, the market sales of electric vehicles should be 100 per cent starting from 2030 onwards to reach a 100 per cent penetration rate by 2050.

1. Introduction

1.1. Background

Transitioning the energy sector to achieve the 2030 Agenda for Sustainable Development and the objectives of the Paris Agreement presents a complex and difficult task for policymakers. It needs to ensure a sustained economic growth, respond to increasing energy demand, reduce emissions as well as consider and capitalise on the interlinkages between SDG 7 and other SDGs. In this connection, ESCAP has developed the National Expert SDG Tool for Energy Planning (NEXSTEP). This tool enables policymakers to make informed policy decisions to support the achievement of the SDG 7 targets as well as nationally determined contributions (NDCs) emission reduction targets. The initiative has been undertaken in response to the Ministerial Declaration of the Second Asian and Pacific Energy Forum (April 2018, Bangkok) and Commission Resolution 74/9 which endorsed the meeting's outcome. NEXSTEP also garnered the support of the Committee on Energy in its Second Session, with recommendations to expand the number of countries being supported by this tool.

The NEXSTEP tool has been specially designed to support policymakers in analysing the energy sector and developing an energy transition plan in the context of SDG7. Further details of the NEXSTEP methodology are discussed in section 1.3. While this tool has been designed to help develop SDG7 Road Maps at the national level, it can also be used for subnational energy planning.

The City of Borongan (Borongan), in collaboration with ESCAP, has developed a Sustainable Energy Transition (SET) Road Map, which seeks to assess Borongan's baseline, as well as identify technological options and policy measures that will help the city to navigate the transition of the energy sector in line with the 2030 Agenda for Sustainable Development.

1.2. SDG 7 targets and indicators

SDG7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all. It has three key targets, which are outlined below.

- Target 7.1. "By 2030, ensure universal access to affordable, reliable and modern energy services." Two indicators are used to measure this target: (a) the proportion of the population with access to electricity; and (b) the proportion of the population with primary reliance on clean cooking fuels and technology.
- Target 7.2. "By 2030, increase substantially the share of renewable energy in the global energy mix". This is measured by the renewable energy share in TFEC. It is calculated by dividing the consumption of energy from all renewable sources by total energy consumption. Renewable energy consumption includes consumption of energy derived from hydropower, solid biofuels (including traditional use), wind, solar, liquid biofuels, biogas, geothermal, marine and waste. Due to the inherent complexity of accurately estimating the traditional use of biomass, NEXSTEP focuses entirely on modern renewables for this target.
- Target 7.3. "By 2030, double the global rate of improvement in energy efficiency", as measured by the energy intensity of the economy. This is the ratio of the total primary energy supply (TPES) and GDP. Energy intensity is an indication of how much energy is used to produce one unit of economic output. As defined by the International Energy Agency (IEA), TPES comprises production plus net imports, minus international marine and aviation bunkers, plus stock changes. For comparison purposes, GDP is measured in constant terms at 2017 PPP.

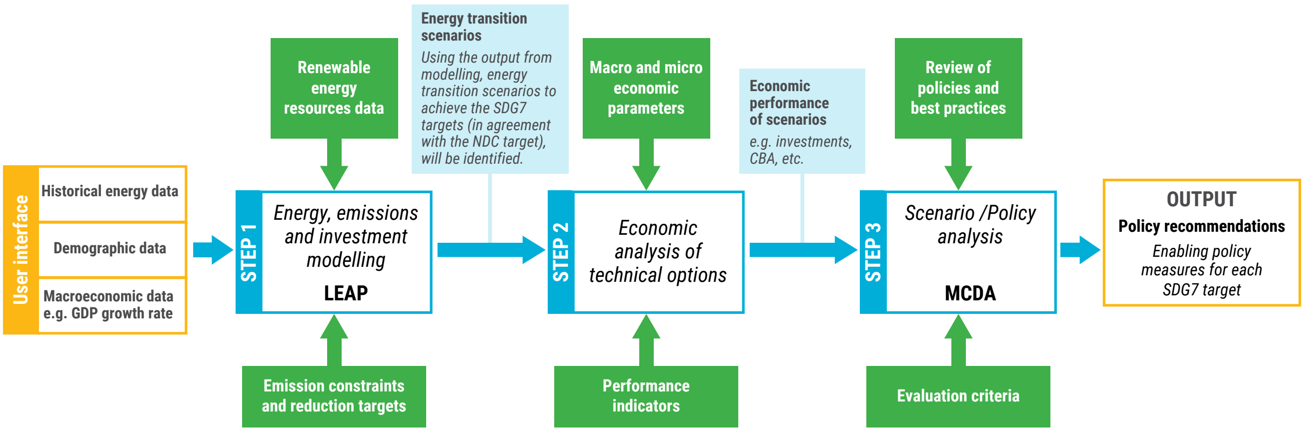
In addition to the above-mentioned targets, the SDG 7 goal also includes target 7.A – promote access, technology and investments in clean energy, and target 7.B – expand and upgrade energy services for developing countries. These targets are not within the scope of NEXSTEP.

1.3. NEXSTEP methodology

The main purpose of NEXSTEP is to help design the type and mix of policies that would enable the achievement of the SDG 7 targets and the emission reduction target (under NDCs) through policy analysis.

The tool helps modelling energy, emissions and economics to analyse a range of policies and options for their suitability. This tool is unique in the way that no other tools look at developing policy measures to achieve SDG 7. One key feature is a back-casting approach to energy and emissions modelling, which is important in planning for SDG 7 where the trajectory is developed backwards from the (known) 2030 targets to the present day. Figure 1 shows different steps of the methodology.

Figure 1. Different components of the NEXSTEP methodology



1.3.1. Energy and emissions modelling

NEXSTEP begins by developing a model of the energy system for each scenario, defining the technical options in terms of the final energy (electricity and heat) requirement for 2030, possible generation/supply mix, emissions and the size of investment required. The energy and emissions modelling component uses the Low Emissions Analysis Platform (LEAP) tool. This proprietary software is used by many countries to (a) develop scenarios for the energy sector, (b) policy analysis and (c) develop NDC targets.

1.3.2. Economic analysis

The second step builds on the selection of appropriate technologies through an economic optimization process which identifies the least-cost energy supply options for the country. A comparative assessment of selected power generation technologies is done using the Levelized Cost of Electricity (LCOE) as an economic indicator. This provides policymakers with insights into the costs and benefits of the economically attractive technology options, allowing better allocation of resources and better-informed policy decisions. While the economic analysis has been kept at a simple level, it contains enough information to support policy recommendations in this Road Map. Some key cost parameters used in this analysis are (a) capital cost, including land, building, machinery, equipment and civil works, and (b) operation and maintenance cost, comprising fuel, labour and maintenance costs.

1.3.3. Scenario analysis

The scenario analysis evaluates and ranks scenarios, using the Multi Criteria Decision Analysis (MCDA) tool, with a set of criteria and weights assigned to each criterion. Although the criteria considered in the MCDA tool can include the following, stakeholders may wish to add/ remove criteria to suit the local context:

- Access to clean cooking fuel;
- Energy efficiency;
- Share of renewable energy;
- Emissions targets in 2030;
- Alignment with the Paris Agreement;
- Fossil fuel subsidy phased out;
- Price of carbon;
- Fossil fuel phase-out;
- Cost of access to electricity;
- Cost of access to clean cooking fuel;
- Investment cost of the power sector;
- Net benefit from the power sector.

This step is performed using the NEXSTEP online portal[5] as a means to suggest the best way forward for cities by prioritizing the scenarios. Stakeholders can update this scenario ranking by using a different set of criteria and their weights. The top-ranked scenario from the MCDA process is used to inform the Government on the best possible energy transition pathway for the city.

5 Available at https://nexstepenergy.org/

2. City overview

2.1. Demographic and macro-economic profile

Geography and climate: Borongan, officially known as the City of Borongan, is the capital of the province of Eastern Samar, the Philippines and is composed of 61 barangays. The City of Borongan is located along the middle coastal part of the province of Eastern Samar and lies between longitudes of 125°12' 33.83" and 125° 30' 13.6" and between latitudes of 11° 43' 10.55" and 11° 27' 44.54". The city has a total land area of 58,941 hectares (ha) or 589.41 square kilometres (sq. km).

The climate map of the Philippines used the Modified Corona's Climate Classification (MCCC) which has four climate types (Types I to IV) based on the monthly rainfall received during the year. Borongan is classified as a Type II Climate, characterized by not having a dry season with a very pronounced maximum rainfall during November to December. Based on the observed seasonal rainfall from 1971-2000, average rainfall volume from December to February (DJF) is estimated at 987 mm, while from March-May (MAM) at around 464 mm, from June to August (JJA) at 560 mm and from September to November (SON) at 871mm. Borongan's cloud cover is at its lowest during the hot months of March to May.

Population and economy: The City of Borongan had a population of 71,961 in 2020, which is equivalent to 15.1 per cent of the total provincial census. This is an increase of 2,664 compared with the 2015 Census of Population and Housing. The increase in the city population translated into an annual growth rate at 0.80 per cent. Among the 23 cities and municipalities in the province, in 2020 Borongan had the largest population share at 15.1 per cent with 71,961 persons in 2020.

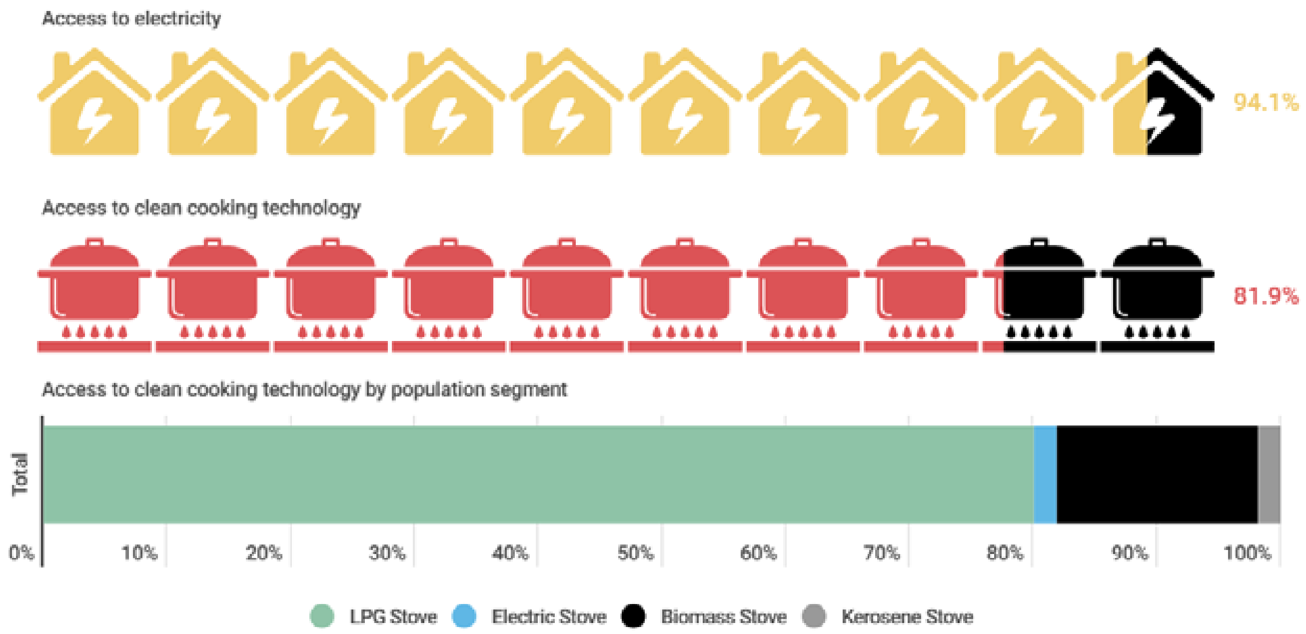
Borongan is part of the Eastern Visayas region. The Eastern Visayas' main economic activities consist of agriculture commercial and services, industrial, fisheries and mining. The Eastern Visayas' economy recovered to 6 per cent in 2021, from the 2020 contraction of 7.4 per cent. The economic growth was led by the positive performance of all major industries. The total value of goods and services in the region, as measured by the Gross Regional Domestic Product (GRDP) in 2020, was PHP 434.8 billion (US$ 8.8 billion). The city's GDP in 2020 is estimated to have been US$ 138.9 million with a GDP per capita of US$ 1,931.

2.2. Energy sector overview

2.2.1. National energy profile

Borongan's population was 71,961 in 2020, which comprised 17,493 households. The electrification rate in Borongan had progressed to 94.1 per cent by 2020. About 18.1 per cent[6] of the population, which corresponds to 3,165 households, relied on unclean and polluting kerosene and biomass stoves as their primary cooking technology. Such practice exposes those people, mostly women and children, to negative health impacts. Overall, liquefied petroleum gas (LPG) stoves were the most dominant primary clean cooking technology, with an estimated share of 80 per cent. This was followed by electric cooking stoves, which were estimated at 1.9 per cent (figure 2).

Figure 2. Electricity and clean cooking access share



The following details describe the estimated energy consumption using data[7] collected with a bottom-up approach, such as activity level and energy intensity for the different sectors. The majority of the following 2020 energy data has been provided by ESCAP's local consultant, unless

6 Estimated based on the cooking distribution data provided by the local consultant from Isabella University.

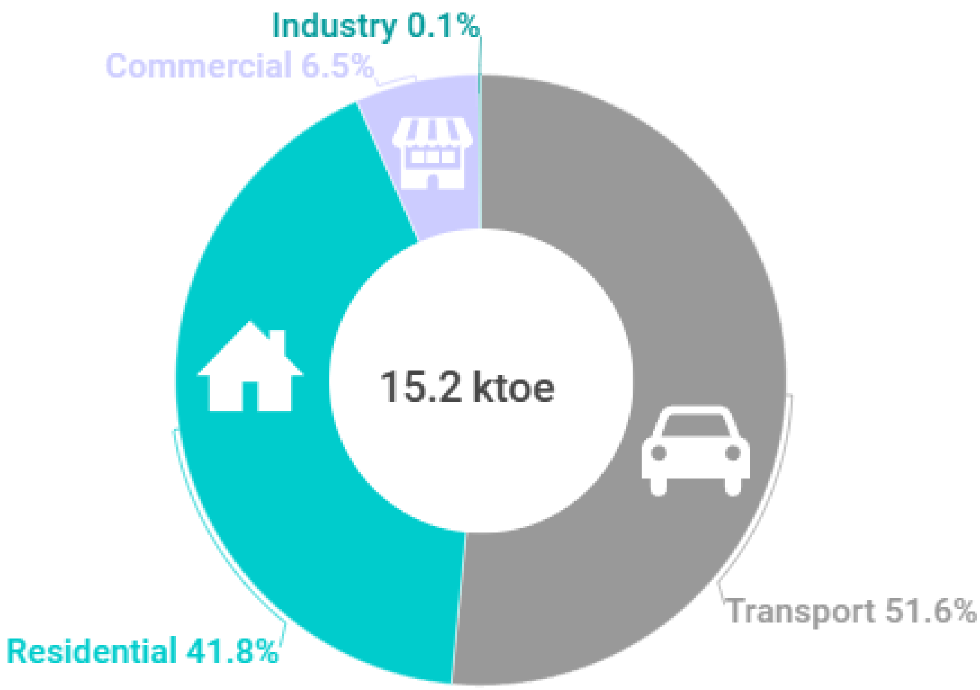
7 National data was compiled by Dr. Orlando Balderama and his team with reference to publicly available sources.

stated otherwise. Further details on the data and assumptions used can be found in Annex II.

The total final energy consumption (TFEC) in 2020 was 15.2 ktoe. As shown in figure 3, the main energy consuming sector is the transport sector, which consumed 7.8 ktoe (51.6 per cent) of TFEC, in 2020. The existing transport fleet (in 2020) was almost exclusively made up of internal combustion engine vehicles, consuming diesel (73.3 per cent), petroleum (23.8 per cent) and small amounts of biodiesel (1.3 per cent) and ethanol (1.7 per cent).

The residential sector comes second in terms of final energy consumption, consuming 6.3 ktoe (41.8 per cent) of Borongan's TFEC in 2020. Nearing a quarter (22 per cent) of the energy consumed was in the form of electricity, while biomass (42.2 per cent), LPG (35.2 per cent) and kerosene (0.5 per cent) were used for residential cooking purposes. In terms of electricity usage, 29.3 per cent was used for refrigeration, 20.9 per cent was for air-conditioners, 11.2 per cent was for electric fans, 10 per cent was for washing machines, 9.8 per cent for lighting, 7 per cent for televisions, and the remainder for other appliances (ironing, water pump etc.). The energy consumed in the commercial sector and industry sectors is exclusively electricity, at 1 ktoe (6.5 per cent) and 0.02 ktoe (0.1 per cent) in 2020, respectively.

Figure 3. Total final energy consumption by sector in 2020



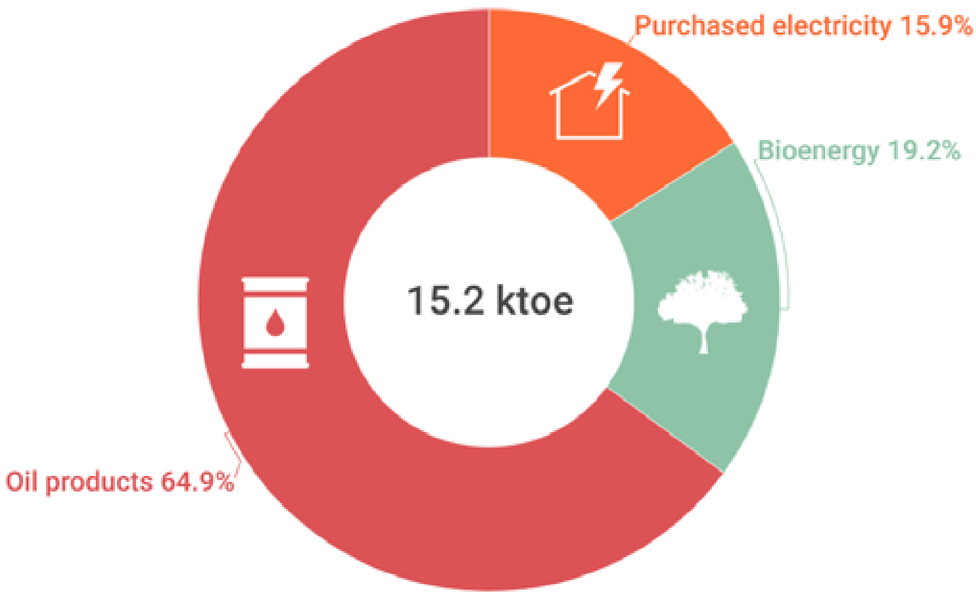
Renewable energy delivered approximately 26.8 per cent of TFEC in 2020. This included traditional biomass use in residential cooking, which corresponds to an estimated 2.7 ktoe (17.6 per cent) of TFEC. If the traditional biomass was excluded, the modern renewable share was 9.2 per cent of TFEC. The electricity requirement of the region is met exclusively by purchased electricity from the central grid, i.e., the Visayas grid. The eastern Visayas (Leyte-Samar) grid is already 100 per cent renewable, but the electric cooperatives in the region are being supplied by coal power plants from another region, within the Competitive Selection Process mechanism. These coal power plants and Eastern Samar local electric cooperatives entered into Power Supply Agreements (PSA) which would be valid up to 25 years. Consequently, the percentage share of renewable energy considers the share of the central grid, which was estimated as 48.4 per cent in 2020.[8] Other usage of renewable energy includes a small amount of biofuel consumption

8 Based on DOE's 2021 Power Statistics, gross generation per grid, by plant type.

in the transport sector. The current blend of biofuel in the Philippines is 2 per cent for biodiesel and 10 per cent for bioethanol (DOE, 2021a).

The energy intensity in 2020 was calculated as 4.56 MJ/US$$_{2017}$. Figure 4 shows the total primary energy supply (TPES) breakdown by fuel type in 2020, which was 15.2 ktoe, the same as TFEC, as local electricity generation was minimal. Borongan is connected to the Visayas grid, importing all (100 per cent) of its electricity required from the central grid. The energy supply mix was as follows: bioenergy (biomass and biofuel) 19.2 per cent; oil products, 64.9 per cent; and purchased electricity, 15.9 per cent.

Figure 4. **Total primary energy supply by fuel type in 2020**



The GHG emissions in 2020 are estimated to have been 35 ktCO_2-e. The emissions from the residential sector were from the use of LPG and kerosene in household cooking. The transport emissions were from direct fuel combustions in internal combustion engines. In the LEAP analysis, emissions related to electricity usage are estimated separately. The grid emission factor considered for the base year 2020 is 0.46 tCO_2/MWh. This is the average of the combined margin emission factors for the Visayas grid, 2015-2017 (DOE, 2021b).

2.2.2. National energy policies, plans, strategies and institutions

Borongan's energy sector development is guided by several national and local policies. These policies have been used as guiding references for the NEXSTEP modelling, to create a better understanding of the city's context and to provide recommendations in adherence to the national Government's overarching direction. Where applicable, the currently implemented and adopted policies or regulations are considered in the current policy scenario, in order to identify gaps in achieving the SDG 7 targets. The following policies or strategic documents have been consulted.

- **The Philippine Energy Plan, 2020-2040 and the Philippine Development Plan, 2017-2022** have set out ambitions to provide access to basic electricity for all Filipinos by 2022.
- **The Philippine Energy Plan, 2020-2040.** The power sector development in the Philippines will evolve over time, with increasing renewable energy (RE) penetration. This should also result in a reduced grid emission factor throughout the analysis period. The Philippine Energy Plan, 2020-2040 stipulates two scenarios for the national power sector – the Reference Scenario (REF) and the Clean Energy Scenario (CES). NEXSTEP utilized the projected electricity generation of the CES scenario in projecting the emission factor for 2030. The author's estimated emission factor in 2030 is

0.3 tCO_2/MWh. DOE is targeting an increase in the current biodiesel share, from 2 per cent by volume to 5 per cent, starting in 2022. DOE is also targeting a 10 per cent penetration rate by electric vehicles for road transport (motorcycles, cars, jeepneys) by 2040.

- **Solar and RE technologies in buildings (Department Circular, 2020-12-26).** The recently issued department circular mandates the use of solar PV and other RE technologies in new and existing buildings. This applies to buildings with electrical loads of at least 112.5 kilovolt-ampere or with a total gross floor area of at least 10,000 square metres. NEXSTEP assumes that the new and existing buildings do not meet the implementation requirements.
- **The Philippines' Nationally Determined Contribution (NDC).** The Philippines intends to reduce its GHG emissions unconditionally by 2.71 per cent from the BAU baseline by 2030. The conditional target is 72.29 per cent from the BAU baseline by 2030, subject to adequate and enhanced access to technology development and transfer, financial resources and capacity-building support. The given targets are representing the Philippines ambition for the sectors of agriculture, waste, industry, transport and energy. Unfortunately, there is no specific reduction target for each sector.
- **The Minimum Energy Performance Standards (MEPS) and/or energy labelling standards** have been introduced for various household appliances, covering window-type air-conditioners (since 1993) and split-type room air-conditioners (since 2000), refrigerators and freezers (since 1999, applicable to sizes between 142-227 litres), compact fluorescent lamps (CFL), linear fluorescent lamps (LFL), ballasts and circular fluorescent lamps (Hernandez, 2005). As MEPS for household appliances were introduced between 1993 and 2010, NEXSTEP assumes that existing appliances have already conformed to the minimum energy performance standards set out by DOE, where applicable. Hence, no additional potential savings are to be achieved.
- **The Philippines Green Building Code (GB Code)** was launched in 2015 and is applied to all new construction and/or alteration of buildings with a minimum total gross floor area (TGFA) as follows: (PGBI, 2016). NEXSTEP assumes that the new and old buildings in Borongan do not meet the minimum TGFA, hence the mandatory building code does not apply to the buildings in Borongan.

Table 1. Minimum TGFA for different building types to comply with the Philippines Green Building Code

Building type	Minimum total gross floor area (TGFA)
Residential condominium	20,000
Hotel/resort	10,000
Educational school	10,000
Institutional hospital	10,000
Business office	10,000
Mercantile mall	15,000
Mixed occupancy	10,000

2.2.3. Local energy resources and potentials

Borongan depends on indigenous resources and energy imports to meet its energy needs. The city's geographical location and climatic conditions will allow broader development of solar energy. Borongan is also endowed with hydropower potential through the existence of the major Suribao, Ca-obing, Lo-om, Borongan and Maypangdan Rivers. According to the Global Wind Atlas by World Bank (2022), The average wind speed in Borongan is around 3.5 to 4.5 m/s at the height of 100 meters. However, a more detailed feasibility study is required to understand the wind potential distribution in the city. Table 2 presents an analysis of strengths, weakness, opportunities and threats (SWOT) of renewable energy resources in Borongan.

Table 2. SWOT analysis of renewable energy resources in Borongan

	Strengths	Weakness	Opportunites	Threats
Solar energy	- Abundant resource availability - Potential to deliver sustainable energy (heat and electricity)	- The lack of domestic industry for installing solar PV - Lack of financial mechanism - Grid instability	- Huge potential to meet the supply and demand gap - Reduction in GHG emissions	- Low feed-in-tariff - High capital (upfront) cost
Hydro energy	- Endowed with enormous water resources - Already established technology	- Seasonal variability	- The key player in the current market - Huge potential for micro-scale hydropower	- Potential impacts on biodiversity

3. Modelling assumptions

This section presents an outline of the scenarios considered by NEXSTEP, together with the key demographic and economic assumptions used in modelling Borongan's energy system.

3.1. Scenario definitions

NEXSTEP is designed for scenario analysis, using the LEAP modelling system to enable energy specialists to model energy system evolution based on current energy policies. The baseline year 2020 was chosen, as it is the most recent year with sufficient data information for modelling. In the NEXSTEP model for Borongan, four scenarios have been modelled. These include three core scenarios: (a) business-as-usual (BAU) scenario; (b) current policy scenario (CPS); and (c) sustainable energy transition (SET) scenario. In addition, one ambitious scenario has been developed – towards net zero by 2050 scenario.

3.1.1. BAU scenario

This scenario follows historical demand trends, based on growth projections, such as using GDP and population growth. It does not consider the emission limits or renewable energy targets set out in policy and legislation. For each sector, the final energy demand is met by a fuel mix reflecting the current shares in TFEC, with the trend extrapolated to 2030. Essentially, this scenario aims to indicate what will happen if enabling policies are not implemented or the existing policies fail to achieve their intended outcomes. The main purpose of this scenario is to be able to compare the emissions trend with the baseline and estimate the emissions reduction target.

3.1.2. Current policies scenario

Inherited from the BAU scenario, this scenario considers initiatives implemented or scheduled to be implemented during the analysis period of 2021-2030. These are, for example, the power development plan and energy efficiency programmes. Otherwise, the energy intensities from different demand sectors are assumed as constant throughout the analysis period, with demand growth as detailed in Annex II. Only policies with concrete measures are considered in the scenario modelling for the current policy scenario. Plan/strategy/policy documents without concrete measures enforced are not considered but are compared with scenario result findings later in this Road Map.

3.1.3. SET scenario

The SET scenario builds on the current policy settings to provide recommendations for aligning Borongan's energy transition pathway with the SDG7 targets. Energy efficiency improvement has been modelled in alignment with the global energy intensity improvement rate, while the renewable energy share has substantially increased with a higher energy efficiency and projected increase in the share of renewable electricity of the grid supply.

3.1.4. Ambitious scenario

Like the SDG scenario, the ambitious scenario aims to achieve the SDG 7 targets. In addition, these scenarios also look to increasing the socio-economic and environmental benefits for the city from raising its ambition beyond just achieving the SDG 7 targets, such as by further improving its energy efficiency beyond the SDG 7.3 target.

Further analysis shows that there are ample opportunities for Borongan to raise its ambition beyond just achieving the SDG 7 targets. More can be done from a whole-economy perspective for Borongan to decarbonize its energy system and achieve a higher energy efficiency improvement rate. For example, additional energy efficiency measures can substantially increase energy savings and reduce fuel imports. This is further discussed in section 6.

3.2. Assumptions

The energy demand is estimated by using the activity level and energy intensity in the LEAP model. The demand outlook throughout the NEXSTEP analysis period is influenced by factors such as annual population growth and annual GDP growth. The assumptions used in the NEXSTEP modelling are further detailed in Annex II, while table 3 provides a summary of key modelling assumptions for the three main scenarios (i.e., BAU, CPS and SDG scenarios).

Table 3. Important factors, targets and assumptions used in NEXSTEP modelling

Parameters	Business as usual scenario	Current policy scenario	Sustainable energy Transition scenario
Economic growth	US$ 138.9 million in 2020, assumed growth rate of 6 per cent per annum.		
Population growth	71,961 in 2020, assumed growth rate of 0.8 per cent per annum.		
Commercial floor space	0.33 million square metres in 2030, assumed growth as GDP.		
Transport activity	Transport activities in 2020: 0.19 billion passenger-kilometres and 0.1 billion tonne-kilometres, with assumed growth as GDP per capita.		
Industrial activity	GDP contribution in 2020: US$ 2.8 million; assumed growth as GDP.		
Residential activity	The appliance ownership for electrical appliances is projected to grow at a rate like the growth in GDP per capita.		
Access to electricity	100 per cent by 2022		
Access to clean cooking fuels	Similar share as 2020 value since no policies are being implemented to improve clean cooking access		100 per cent clean cooking access rate through the promotion of LPG stoves and electric stoves
Energy efficiency	Additional energy efficiency measures not applied	Improvement based on current policies	Global improvement in energy intensity adopted
Power plant	Based on 2020 existing RE installation within the city boundaries. Purchased electricity from the central grid is assumed to have the same fuel mix throughout the period.	Based on 2020 existing RE installation within the city boundaries. The purchased (grid) electricity mixes in 2030 references the projected generation mix in the reference (CES) scenario in the Philippine Energy Plan 2020-2040.	

4. Energy transition outlook in the current policy scenario

This section presents the key results of modelling under the NEXSTEP's current policy scenario, focusing on impacts in key areas of the economy and the energy sector.

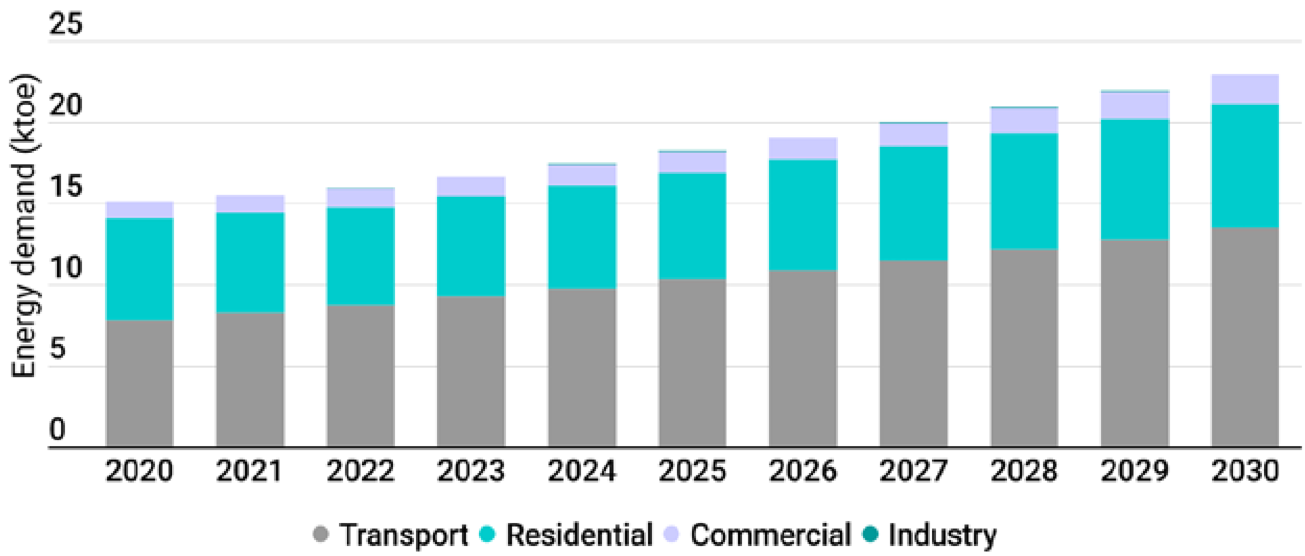
4.1. Demand

The CP scenario considers policy measures that have come into force or already have a concrete implementation timeline within the analysis period.[9] Otherwise, the energy intensities from different demand sectors are assumed constant throughout the analysis period, with demand growth as detailed in table 3. The following policies have been considered:

- **Energy efficiency:** As noted in the Philippine Energy Plan, DOE is targeting an increase in the current biodiesel share, from 2 per cent by volume to 5 per cent, starting in 2022. DOE is also targeting a 10 per cent penetration rate of electric vehicles for road transport (motorcycles, cars and jeepneys) by 2040.
- **Power generation:** The electricity required to fulfil the demand in Borongan is exclusively purchased from the grid, as local generation units are limited. Currently, installation of RE power capacity within the city by Government authorities is still at the planning stage. However, without further information on future installed capacity, the remaining demand is expected to be fulfilled with central grid electricity from the Visayas grid.

Figure 5 shows the forecast of TFEC by sector under the CP scenario.

Figure 5. Energy demand outlook in the CP scenario, 2020-2030



Under the current policy setting, the demand for total final energy is expected to increase from 15.2 ktoe in 2020 to 23 ktoe in 2030, at an average annual growth rate of 4.2 per cent. A 0.5 ktoe reduction in energy demand compared to the BAU scenario is due to the adoption of energy efficiency measures in the transport sector. In 2030, the transport sector consumption will be by far still the largest at 58.8 per cent, followed by the residential sector 33.4 per cent, the commercial sector 7.7 per cent, and the industrial sector 0.2 per cent. The sectoral energy efficiency measures are described further below.

9 Only policies with concrete and implemented measures are considered in the scenario modelling for the current policy scenario. To further explain, measures mentioned in strategy policy or planning documents that are yet to be enforced or implemented prior to December 2022 are not considered in the modelling of the current policy scenario.

4.1.1. Transport sector

Under the current policy setting, the transport sector will continue to dominate Borongan's TFEC, with a 58.8 per cent share in 2030. The transport sector will consume 13.5 ktoe, with an annual growth of 5.6 per cent, up from 7.8 ktoe in 2020. Borongan's transport sector consists of land passenger transport and freight transport. Among the passengers' vehicle categories in 2030, private cars will consume 10.2 ktoe, followed by motorcycles at 1.5 ktoe and buses at 0.1 ktoe. Freight trucks will consume 1.8 ktoe.

Under the current policy setting, the Government of the Philippines has a plan to increase the current biodiesel share and raise the penetration rate of electric vehicles. If the government of Borongan implements the same measures, these will save a total of 1.1 ktoe.

Table 4. Energy efficiency measures– CP scenario compared with BAU scenario by 2030

Sector	Measure	2030	
		Energy demand reduction (ktoe)	GHG emission reduction ($ktCO_2$-e)
Transport	An increase in the current biodiesel share to 5 per cent, starting in 2022.	0.04	0.16
Transport	A 10 per cent penetration rate of electric vehicles for road transport (motorcycles, cars and jeepneys) by 2040.	0.46	2.35
Total		**0.50**	**2.51**

4.1.2. Residential sector

The residential sector will consume 7.7 ktoe, an annual growth of 1.9 per cent, up from 6.3 ktoe in 2020. In terms of fuel, biomass will be the main energy source at around 37.6 per cent, followed by oil products at 31.9 per cent and electricity at 30.5 per cent. Biomass and oil products are used mainly for cooking purposes. Electricity will be used mainly for air-conditioning (23.9 per cent) and refrigeration (33.4 per cent) while the remainder will be used for lighting, television, electric fans, washing machines, water pumps etc.

4.1.3. Industrial sector

In the CPS, the industrial sector will consume only 0.04 ktoe in 2030, an annual growth of 6 per cent, up from 0.02 ktoe in 2020. Within the industrial sector, 100 per cent of energy consumption will be consumed by machinery and transport equipment categories.

4.1.4. Commercial sector

Total energy consumption in the commercial sector (including government buildings) under the CPS will increase from 1 ktoe in 2020, at an average annual growth of 6 per cent, to 1.8 ktoe in 2030. Government buildings will account for a total of 62.8 per cent of the energy demand followed by private offices (19.5 per cent) and educational institutions (7.3 per cent). Hotels and shopping malls will account for 5.8 per cent and 0.7 per cent of commercials energy demand, respectively. The remaining share will be used by worship centres and hospitals.

4.2. Power sector

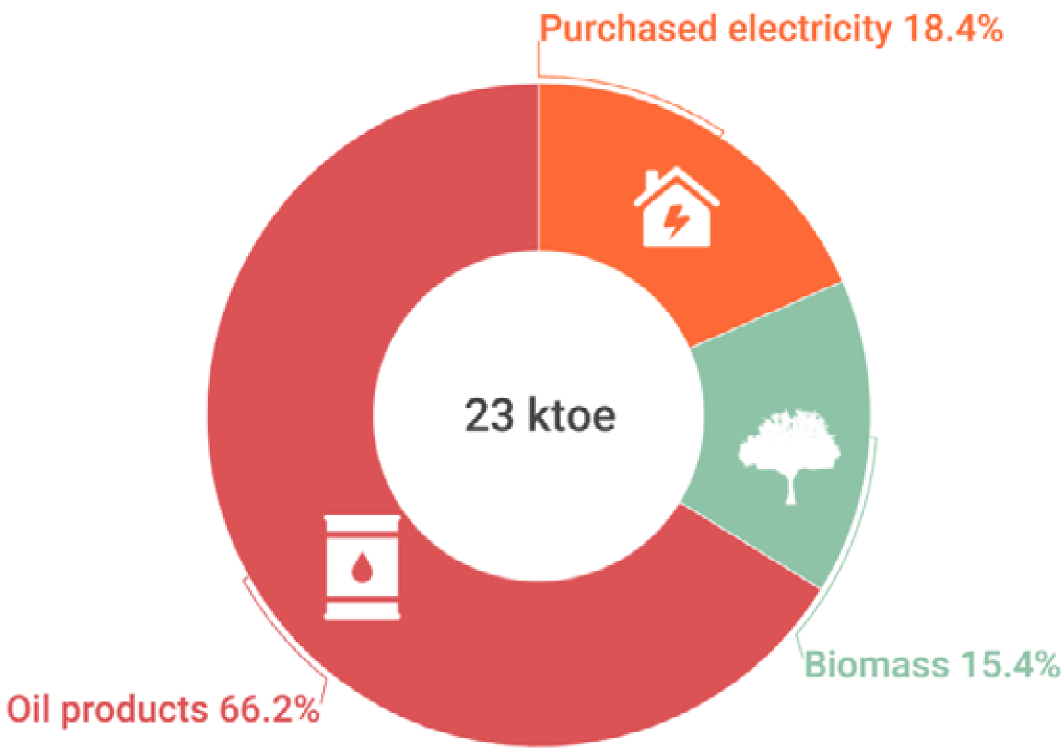
The 2030 demand for electricity in the current policy scenario is projected to be 49 gigawatt-hours (GWh), increasing from 28 GWh in 2020. The demand will be the highest in the residential sector at 27.2 GWh (54.2 per cent) followed by the commercial sector at 20.6 GWh (41 per cent) and the industry sector at 0.4 GWh (0.8 per cent). If the city government increases the adoption rate of electric vehicles to 10 per cent by 2040, around 0.9 GWh of electricity will be required by the transport sector in 2030.

The electricity required to fulfil the demand in Borongan is exclusively purchased from the grid, as there is no local generation facility. Currently, installation of RE power capacity by city government authorities is in the planning stage. Therefore, without further information on future installed capacity, the remaining demand is expected to be fulfilled with central grid electricity from the Visayas grid.

4.3. Supply

In the current policy scenario, the TPES is forecasted to increase from 15.2 ktoe in 2020 to 22.4 ktoe in 2030. As shown in figure 6, oil products are the dominating fuel supply, followed by grid electricity and bioenergy.

Figure 6. Total primary energy supply by fuel type in 2030, CPS scenario



5. SET scenario – sustainable energy transition pathway for the City of Borongan

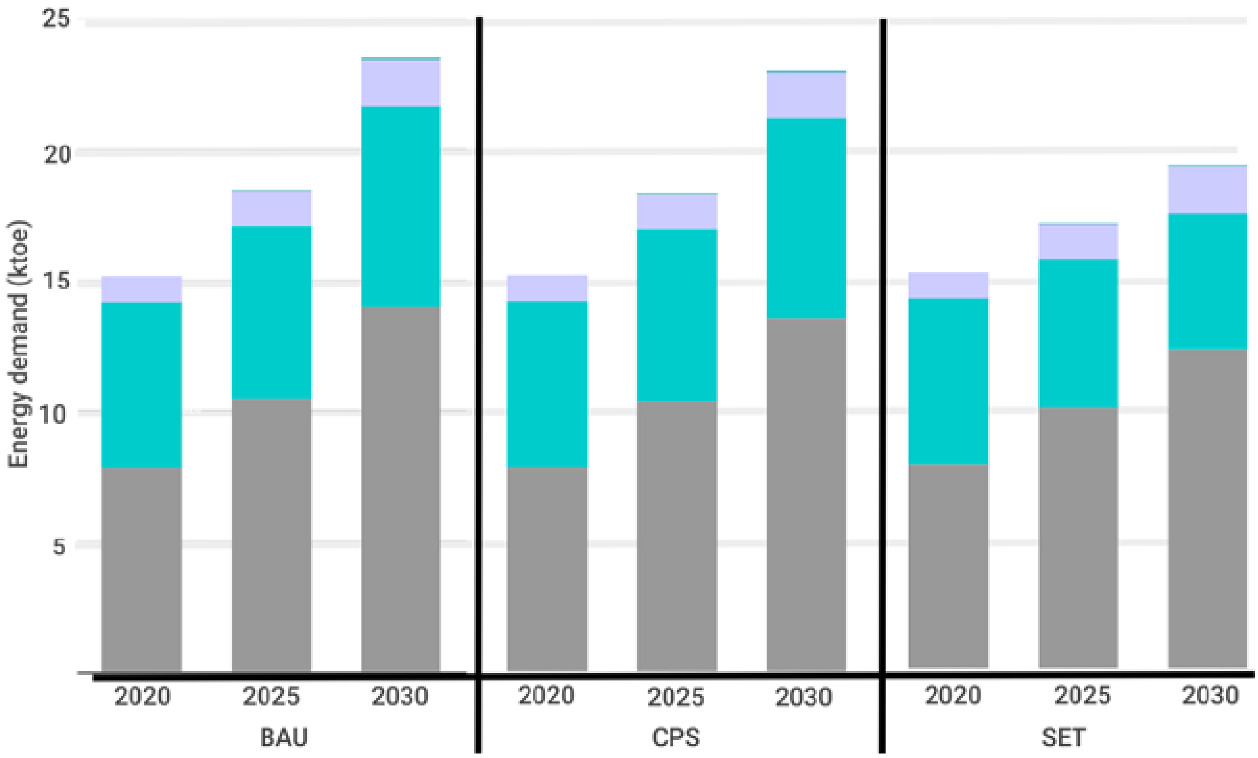

NGAN

Subnational and national efforts are both imperative in achieving the 2030 Agenda for Sustainable Development and Paris Agreement on climate change. In particular, cities around the world contribute around 75 per cent of global anthropogenic emissions and represent about 75 per cent of global energy demand (REN21, 2021). This chapter provides details of the SET scenario, exploring how economy-wide efforts may improve the energy and climate sustainability of the City of Borongan. It starts with the energy demand forecast and then discusses the energy sector in relation to the SDG 7 targets.

5.1. SET energy demand outlook

In the SET scenario, TFEC increases at a much slower pace than CPS, from 15.2 ktoe in 2020 to 19.2 ktoe in 2030. The reduction of 3.7 ktoe in TFEC in this scenario, compared with CPS, is due to the improvement in energy efficiency across the demand sectors. The proposed energy efficiency interventions are further described in subsection 5.2.4. In 2030, the transport sector will still have the largest share of TFEC at 12.2 ktoe (63.5 per cent), followed by the residential sector at 5.2 ktoe (27.1 per cent), the commercial sector at 1.8 ktoe (9.2 per cent), and the industry sector at 0.04 ktoe (0.2 per cent). Figure 7 shows TFEC by scenario in 2030.

Figure 7. Comparison of energy demand between scenarios



5.2. SDG 7 targets

5.2.1. SDG 7.1.1, Access to electricity

According to the Philippine Energy Plan, 2020-2040 and the Philippine Development Plan, 2017-2022 the electrification rate was supposed to reach 100 per cent by 2022.[10] In the event this has not been reached, the NEXSTEP analysis proposes that decentralised renewable electricity systems, such as solar mini-grids and solar home systems, could be provided to the unconnected households to speed up the access to electricity. The ease of implementation, compared to extending the grid infrastructure, should allow the 100 per cent electrification target to be reached sooner.

10 The current figure is unknown as there is a data lag. The most complete data set was available only up to 2020.

Table 5. Assessment of access to electricity

Existing policy	NEXSTEP analysis – gaps and recommendations
The Philippine Energy Plan, 2020-2040 and the Philippine Development Plan, 2017-2022 have set out ambitions to provide access to basic electricity for all Filipinos by 2022.	In case Borongan has not yet achieved universal access to electricity, promotion of decentralized systems, e.g., solar PV min-grid or solar home systems should be used to connect the remaining households.

5.2.2. SDG 7.1.2 - Access to clean fuels and technologies for cooking

Accelerated effort is required to achieve universal access to clean cooking. As of 2020, 18.1 per cent of households relied on polluting cooking technologies, including traditional biomass stoves and kerosene stoves. WHO has warned about the severity of health impacts arising from the exposure to kerosene and traditional use of biomass for cooking, and is encouraging policymakers to adopt measures to address this challenge. Women and children disproportionately bear the greatest health burden from indoor air pollution as they spend more time exposed to harmful smoke from polluting stoves and fuels. NEXSTEP analysis proposes the use of electric cooking stoves as the most appropriate technology in filling in the gap because:

(a) it does not cause any air pollution;
(b) it requires minimal follow-up required (as opposed to improved cooking stoves); and
(c) it's cost effectiveness compared to the more commonly used LPG stove.

However, the operation of an electric cooking stove requires substantial power supply capacity that may not be available for households connected to mini-grid or solar home systems. In that case, the LPG stove would be the most appropriate technology.

Box 1 provides a summary of cost analysis and qualitative analysis of the pros and cons of different clean cooking technologies, in supporting the adoption of electric cooking stoves and LPG stoves as the most appropriate technologies.

Box 1. Cost and qualitative analysis of clean cooking technologies

Table 6 below summarizes the annualized cost and annual fuel cost of the different cooking technologies in the context of Borongan. Annex III summarises the cost and technical assumptions used in the economic analysis.

Table 6. Annualized cost of cooking technologies

Technology	Annualized cost
Electric cooking stove	US$ 107
Improved cooking stove (ICS)	US$ 28
LPG cooking stove	US$ 119

While ICS is estimated to have a lower annualised cost than electric cooking stoves, concerns have been raised by various studies of their suitability as a long-term clean cooking solution for the general population, particularly the urban population. A short qualitative analysis of the pros and cons of the different clean cooking technologies is detailed below.

(a) Electric cooking stoves

Electric cooking technology is classed as Level 5 in the World Bank MTF for Indoor Air Quality Measurement. Electric cooking stoves are more efficient than other cooking stoves, including gas stoves. Electric cooking stoves can generally be divided into two types – solid plate and induction plate. While solid plate cooking stoves use a heating element to transmit radiant energy to the food and reach about 70 per cent efficiency, induction plate cooking stoves use electromagnetic energy to directly heat pots and pans and can be up to 90 per cent efficient.

(b) Improved cooking stoves

Studies suggest that ICS programmes often have low adoption rates due to inconvenience of use, preference for traditional cooking stoves and the need for frequent maintenance and repairs. ICS programmes initially require strong advocacy to promote adoption, after which they require ongoing follow-up, monitoring, training, maintenance and repairs in order to facilitate continuing usage (ESCAP, 2021b). In addition, based on the WHO guidelines for emission rates for clean cooking, only certain types of ICS technology comply, particularly when considering that cooking stove emissions in the field are often higher than they are in the laboratory settings used for testing.

(c) LPG cooking stoves

LPG cooking stoves generate lower indoor air pollution compared with ICS. They are classified as Level 4 in the World Bank Multi-Tier Framework (MTF) for cooking exposure and reduce indoor air pollution by 90 per cent compared with traditional cooking stoves. However, the LPG stove is estimated to have a higher cost than the electric cooking stove, as shown in the above table.

Table 7 summarises the gap assessment and recommendations for addressing the clean cooking in Borongan.

Table 7. Assessment of access to clean cooking

Existing policy	NEXSTEP analysis – gaps and recommendations
Not available.	**Gap:** Without any policy intervention, the NEXSTEP analysis projects that Borongan may only reach an 82 per cent clean cooking access rate, similar to the share in 2020. **SDG scenario:** the NEXSTEP analysis suggests bridging the remaining gap with a combination of electric cookstoves and LPG cookstoves.

5.2.3. SDG 7.2. Renewable energy

SDG 7.2 does not have a quantitative target but requires a substantial increase in the renewable energy share in TFEC. The RE share in TFEC for Borongan is determined using the required improvement in energy efficiency as a constraint, for which NEXSTEP considers the alignment of Borongan's annual average energy efficiency improvement with the suggested global improvement rate of 3.2 per cent per annum (UNSD, 2022) (detailed further in subsection 5.2.4). The RE share in TFEC also considers the increase in RE percentage in the grid electricity mix.

The share of renewable energy in TFEC in 2030 will be 15.2 per cent by 2030 in the current policy scenario (figure 8). This is an increase from just 9.2 per cent in 2020. The increase is mainly driven by two factors:

(a) The projected increase in RE share of the grid electricity in Visayas, from 48.4 per cent in 2020[11] to 66.9 per cent in 2030, based on the estimate from CES scenario in the Philippine Energy Plan 2020-2040;

(b) Increased biodiesel usage in the transport sector.

In the SET scenario, the renewable energy share in TFEC is projected to increase to 17.8 per cent by 2030. This is a result of further reduction of energy demand due to energy efficiency measures in the demand sectors (see subsection 5.2.4), and increased use of grid electricity (in the transport sector) which has a relatively high share of RE generation.

Figure 8. Renewable energy in TPES and TFEC, 2030

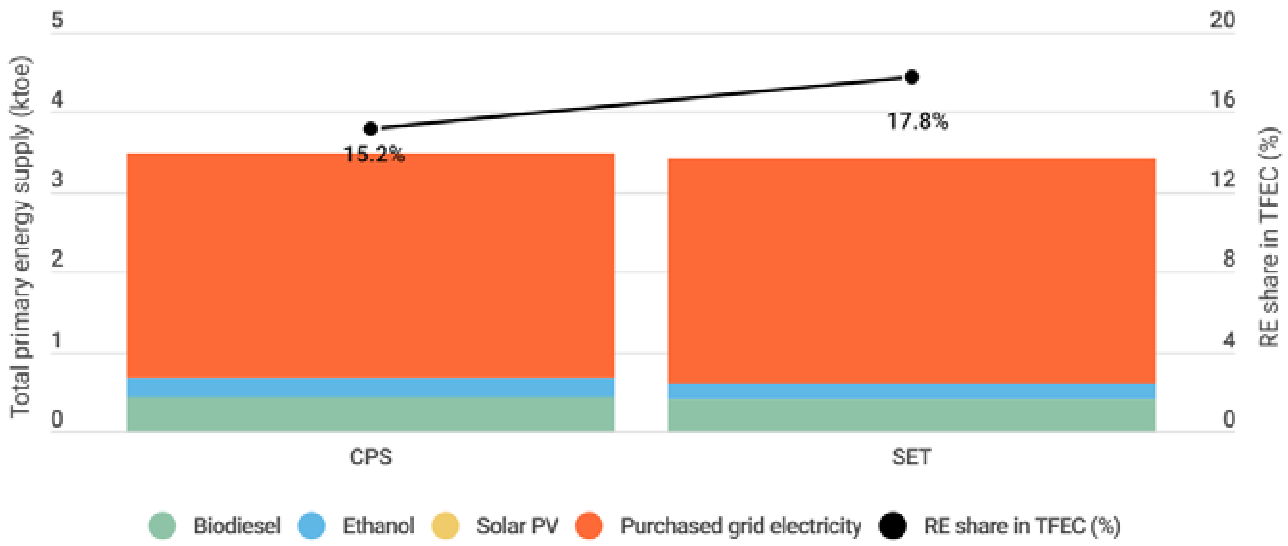


Table 8. Assessment of renewable energy share in TFEC

Existing policy	NEXSTEP analysis – gaps and recommendations
The Philippine Energy Plan, 2020-2040. The power sector development in the Philippines will evolve over time, with increasing RE penetration. This should also result in a reduced grid emission factor throughout the analysis period. The Philippine Energy Plan, 2020-2040 stipulates two scenarios for the national power sector, i.e., the Reference Scenario (REF) and the Clean Energy Scenario (CES). NEXSTEP utilized the projected electricity generation of CES scenario in projecting the emission factor for 2030. The author's estimated emission factor in 2030 is 0.3 tCO2/MWh. DOE is targeting an increase in the current biodiesel share, from 2 per cent by volume to 5 per cent, starting in 2022.	**CP scenario** The renewable share in TFEC is projected to be 15.2 per cent in the CP scenario due to the increase of planned renewable power capacities and biodiesel share. **SDG scenario** The inefficient traditional biomass cooking and heating stoves are phased out with electric cookstoves and LPG stove. The renewable energy share in TFEC is projected to be 17.8 per cent in 2030. This increase also results from the improvement in energy efficiency.

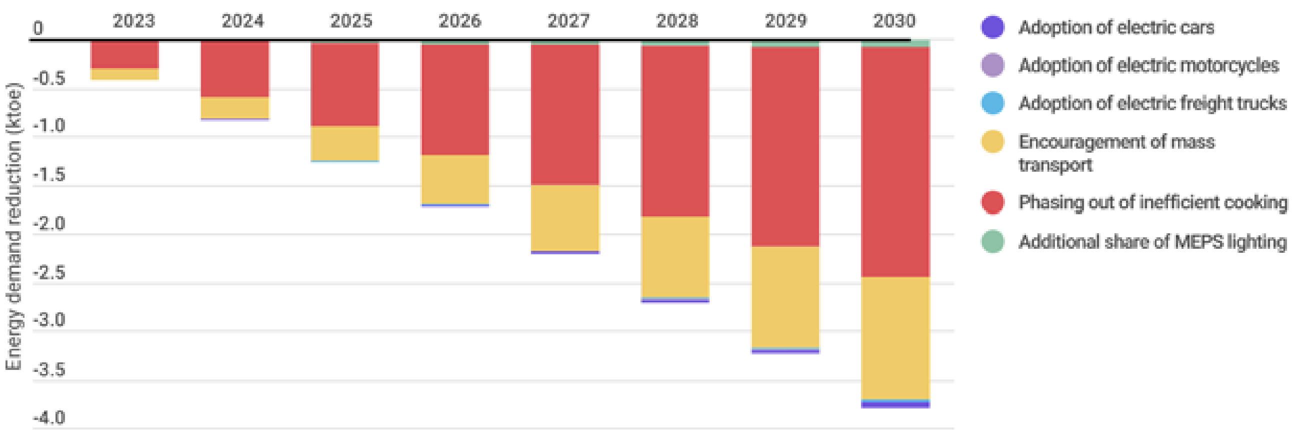
11 Based on the DOE 2020 Power Statistics, gross generation per grid, by plant type.

5.2.4. SDG 7.3. Energy efficiency

The primary energy intensity, a proxy for the measurement of energy efficiency improvement, is calculated as 3.86 MJ/US$2017 in 2030 under the current policy scenario, which corresponds to an annual rate of improvement of 1.7 per cent. The primary energy intensity is further reduced to 3.23 MJ/US$2017 in the SET scenario by 2030, made possible through the proposed economy-wide energy efficiency improvement measures. This corresponds to an average annual rate of improvement of 3.4 per cent, exceeding the suggested global improvement rate of 3.2 per cent (UNSD, 2022).

Figure 9 shows the energy savings that may be achieved through the implementation of energy efficiency measures across the demand sectors, compared with CPS. The transport sector is the largest energy consuming sector in Borongan; it can also be expected to have a large contribution (1.3 ktoe in 2030), through the increased adoption of electric vehicles in multiple transport subcategories as well as encouragement of public transport. Energy demand reduction can also be realised through the phasing out of inefficient technologies in residential households.

Figure 9. Additional energy saving measures under the SET scenario compared to the CP scenario



Further details of the energy efficiency measures and their impacts are provided below.

(a) Transport sector

The current share of electric vehicles in the existing fleet is zero. The transition to electric vehicles is a complex process as there will be direct impacts on phasing-out of existing businesses, such as gas stations, fossil-fuelled vehicles manufacturers, and the existing fossil fuelled vehicle owners. Additionally, the cost of acquiring these electric vehicles, which are more expensive than the internal combustion engine (ICE) vehicles, is a major challenge to private vehicle operators in the transport sector. In the absence of electric vehicle charging stations and other support facilities, this would certainly entail a very high investment.

However, the promotion of electric vehicles is an effective way to reduce energy demand as well as GHG emissions in the transport sector. In the SET scenario, NEXSTEP proposes that the uptake of electric vehicles can be promoted across different vehicle categories, reaching a considerable share of the transport fleet (5 per cent) by 2030. In addition, the city government should encourage the utilization of public transportation in order to increase the passenger-kilometre of buses by 10 per cent. Further details and the estimated annual savings are shown in table 9.

Table 9. **Energy efficiency measure applied and estimated cumulative savings between 2023 and 2030 (relative to CPS) in the transport sector**

Subcategory	Energy efficiency measures	Energy demand reduction (ktoe)	GHG emission reduction ($ktCO_2$-e)
Freight trucks	Encouraging the adoption of electric freight trucks, reaching a share of 5 per cent by 2030.	0.1	1.0
Private passenger cars	Encouraging the adoption of electric passenger cars, reaching a share of 5 per cent by 2030	0.2	0.7
Motorcycles	Encouraging the adoption of electric motorcycles, reaching a share of 5 per cent by 2030	0.03	0.1
Public transport	Encouraging the use of public transportation (buses), increasing the passenger kilometres by 10 per cent by 2030.	5.0	14.3
Total		**5.3**	**16.1**

An increase in market penetration of electric vehicles is required to reach the targeted shares by 2030. For example, the annual sales[12] of electric-motorcycles, passenger cars and trucks should slowly pick up from the current zero per cent to reach 15 per cent by 2030.

(b) Residential sector

Energy demand reduction can also be realised in the residential sector, particularly through achieving a 100 per cent access rate to clean cooking technologies. As inefficient cooking practices are gradually replaced by electric cooking stove and LPG stove usage, substantial energy savings can be expected. In addition, the use of more efficient household appliances (e.g., LED lighting) provides energy saving opportunities.

Table 10. **Energy efficiency measures applied and the cumulative savings between 2023 and 2030 in the residential sector**

Household appliance	Energy efficiency measures	Energy demand reduction (ktoe)	GHG emission reduction ($ktCO_2$-e)*
LED Lighting	Phasing out of compact fluorescent lamps (CFL) with LED lighting7	0.4	1.2
Cooking	Achieving 100 per cent clean cooking access rate through induction electric cooking stoves and LPG stoves	10.4	1.5
Total		**10.8**	**2.7**

* GHG emission reduction for electrical appliance is calculated using the grid emission factor 0.298 kg CO_2-e/kWh.

12 Electric vehicle sales rate is defined as the proportion of the number of electric vehicles compared to the total sales of vehicles in the area. Meanwhile, the electric vehicle penetration rate indicates the proportion of the number of electric vehicles compared to the total on-the-road vehicles in the area.

Table 11. Assessment of energy efficiency

Existing policy	NEXSTEP Analysis – Gaps and recommendations
The Philippine Energy Plan, 2020-2040. DOE is targeting a 10 per cent penetration rate of electric vehicles for road transport (motorcycles, cars, jeepneys) by 2040.	**Gap(s):** It is projected that the energy intensity will be 3.86 MJ/ USD2017 in 2030 under the CP scenario. **SDG scenario:** The energy intensity is further reduced to 3.23 MJ/ USD_{2017} in 2030 or 3.4 per cent EE improvement rate, which exceeds the global energy efficiency improvement target. Achievement of the target requires phasing out inefficient cooking technologies, encouragement of mass transport, and increasing the adoption of EV to 5 per cent to realise an additional energy demand reduction of 3.7 ktoe in 2030, compared with the CP scenarios.

5.3. Energy supply outlook

Under the SET scenario, the total primary energy supply is estimated to be 19.2 ktoe by 2030, a 3.7 ktoe reduction compared with the CP scenario. The phasing out of traditional biomass for cooking will reduce biomass supply by 2.4 ktoe. The remaining reduction comes from oil products due to additional energy efficiency improvements in the transport sector.

The demand for electricity in 2030 is projected to be 49 GWh in the SET scenario, slightly similar with CPS. The electricity demand in the residential sector will be 26.4 GWh, around 0.8 GWh reduction compared to CPS due to the introduction of more efficient lighting. Meanwhile in the transport sector, an increase in electricity demand by 0.8 GWh can be expected as it has more electric vehicles. The electricity demand in the transport, commercial, and industry sectors will be 1.6 GWh, 20.6 GWh and 0.4 GWh respectively. The demand will be fulfilled by grid electricity from Visayas, assuming that there is no other additional RE capacity within the city.

5.4. Nationally Determined Contribution targets

The energy sector emissions, from the combustion of fossil fuel, are calculated based on IPCC Tier 1 emission factors assigned in the LEAP model and expressed in terms of 100-year global warming potential (GWP) values. For the combustion of biomass and biomass products, the carbon emissions are not attributed to the energy sector, but are accounted for in the agriculture, forest and land-use change (AFOLU)[13] as per the accounting system suggested by IPCC. Nevertheless, the emissions of other GHGs, such as methane and nitrous oxide, are included in the total emissions in the energy sector.

Under the CPS, total emissions are expected to grow from 35 $ktCO_2$-e in 2020 to 51.9 $ktCO_2$-e in 2030. This corresponds to a 4.8 $ktCO_2$-e (8.5 per cent) reduction compared to the BAU scenario, meeting the unconditional NDC target of 2.71 per cent. The decrease in GHG emissions, relative to the BAU scenario, is due to the higher RE share in electricity supply.

13 The AFOLU sector is not within the scope of NEXSTEP.

In the SET scenario, total emissions are expected to grow to 48.2 $ktCO_2$-e by 2030. This corresponds to a 8.5 $ktCO_2$-e (or a 15 per cent) reduction compared to the BAU scenario, which exceeds the unconditional NDC target in the energy sector. The additional decrease in GHG emissions compared with the CP scenario is due to measures discussed in the previous section. Figure 10 shows additional emissions reduction under the SET scenario, compared with the CP scenario. Figure 11 summarizes the SDG 7 indicators from the three different main scenarios.

Figure 10. Additional emission reduction measures under the SET scenario

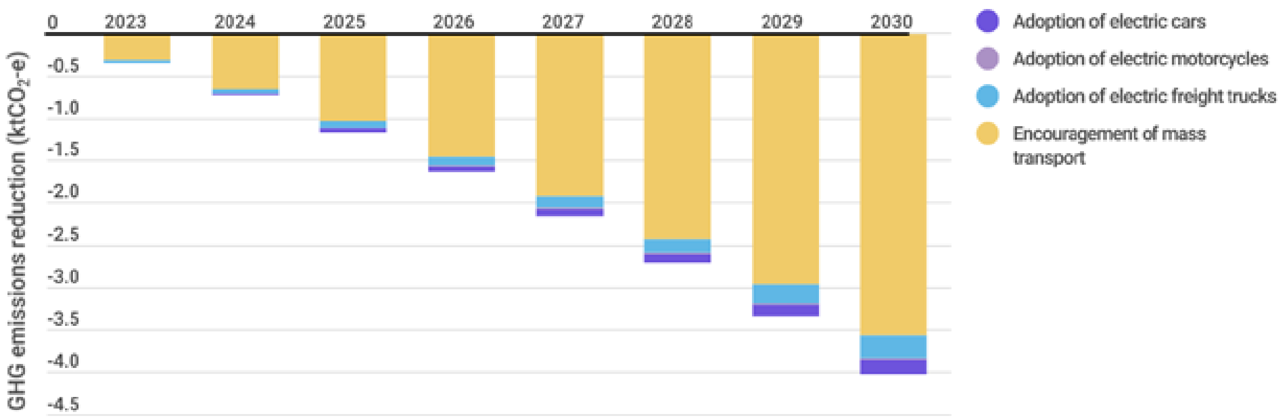
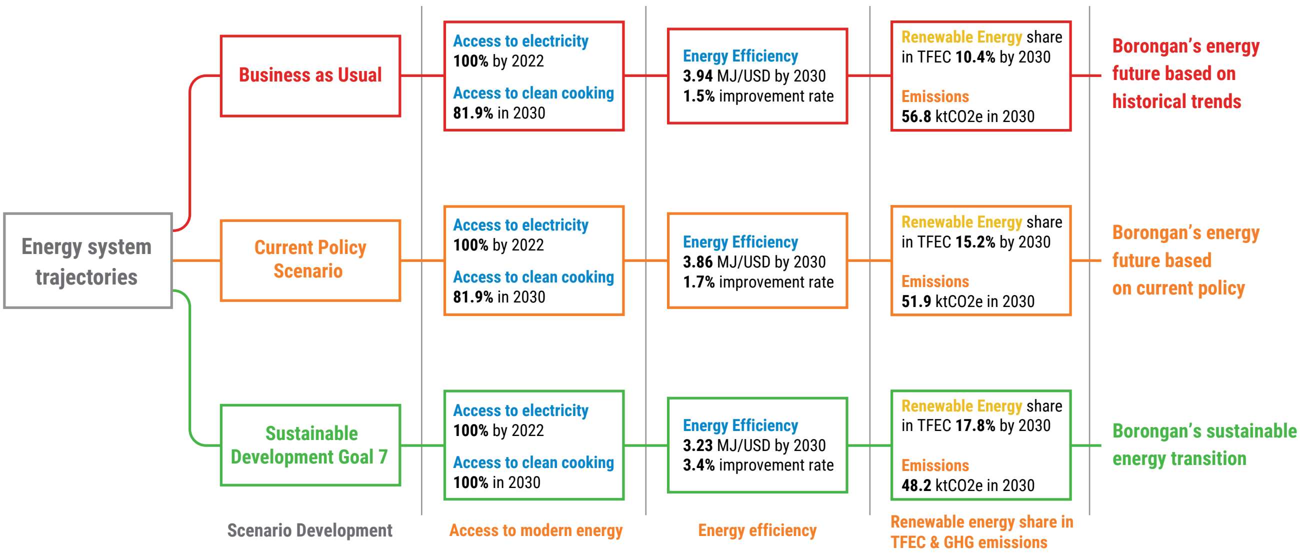


Figure 11. Summary of SDG 7 indicators for different main scenarios



6. Moving towards a net zero society with climate ambitious pathways

The SET scenario sets out various strategies for facilitating an economy-wide, energy efficiency improvement in alignment with the global goals as well as appropriate technology options in advancing modern energy access in the City of Borongan. These allow GHG emissions reduction and an increase in the renewable energy share in TFEC. However, the City of Borongan could consider more climate ambitious pathways, moving towards a net zero society.

Substantial energy demand and emission reduction have been achieved in the SET scenario through energy-efficiency improvement measures. These measures have allowed an energy demand reduction of 3.7 ktoe and emission reduction of 3.7 $ktCO_2$-e, relative to CPS. This corresponds to a 15 per cent reduction from the BAU scenario. With the increasing number of countries and cities pledging net zero emissions by 2050, the Towards Net Zero (TNZ) scenario has been developed to explore how Borongan city can raise its ambitions in moving towards net zero in its power supply as well as its energy system as a whole.

Around three-quarters of current greenhouse gas emissions globally come from the energy sector. Although this sector might have a critical role in averting the worst impact of climate change, a significant challenge cannot be avoided. Limiting the temperature rise to 1.50C requires climate mitigation effort on an unprecedented scale and speed to reduce GHG emissions by 2030 by about 45 per cent from 2010 levels, reaching net zero around 2050 (IPCC, 2018). Failing to act on the most pressing issue of this generation may lead to a catastrophic impact on human livelihoods.

In addition, COP26 in Glasgow has created momentum and called for transitioning towards net zero. This scenario examines the potential for Borongan to achieve net zero by 2050. The rationale for the choice of a longer timeframe for this scenario is to allow the non-electric energy consumers, e.g., direct fuel combustion in the transport sectors, gradually transition to a fully electric system. As this scenario builds upon the previously discussed SET scenario, electricity in Borongan is assumed to become carbon-free by 2030.

6.1. Demand sector strategy

The energy system of Borongan is well-positioned for an accelerated decarbonization effort as some required net zero technologies in decarbonizing its energy system are readily available in the Philippines, i.e., electric cooking stoves, electric vehicles and renewable power technologies. Building on the SET scenario, the TNZ 2050 scenario explores how the city can transition its demand side towards decarbonization of its whole economy. There are two different timeframes for the implementation of multiple renewable energy and energy efficiency measures. These are discussed below.

6.1.1. The present until 2030

The total energy demand is expected to increase from 15.2 ktoe in 2020 to 15.9 ktoe in 2030, a reduction of about 3.3 ktoe relative to the SET scenario. The transport sector consumption will remain the largest at 56.4 per cent, followed by the residential sector at 32.3 per cent, the commercial sector at 11.1 per cent, and the industry sector at 0.2 per cent.

The energy demand reduction mainly stems from increased ambition in transport electrification. In the transport sector, NEXSTEP suggests the increase of electric vehicle sales to 100 per cent starting from 2030 to reach a 100 per cent penetration rate by 2050. In the residential sector, NEXSTEP suggests adoption of electric cooking stoves to reach at least 20 percent of all households by 2030, increasing from 1.9 per cent in 2020.

Table 12. **Proposed measures and their respective cumulative energy and GHG emission reduction between 2023 and 2030 in the TNZ scenario compared to the SET scenario**

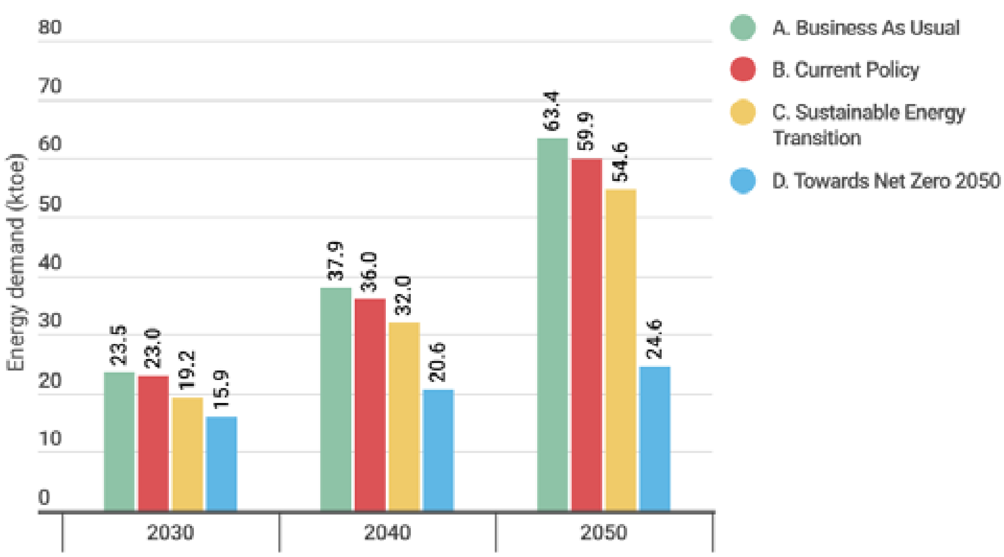
Subcategory	Measures	Energy demand reduction (ktoe)	GHG emission reduction ($ktCO_2$-e)
Transport			
Freight trucks	The market sales of electric vehicles should be 100 per cent starting from 2030.	0.6	6.3
Private passenger cars		10.1	34.9
Motorcycles		2.3	6.7
Buses		0.05	1.2
Total		**13.0**	**48.9**
Residential			
Residential cooking	Increase the adoption of electric cooking stove to 20 per cent of households	0.4	7.3

6.1.2. Beyond 2030

For the measures implemented beyond 2030, NEXSTEP suggests the utilization of 100 per cent electric cooking stoves by 2050 to achieve net zero in the residential sector. The adoption of 100 per cent e-mobility is also critical to decarbonize the transport sector.

While this scenario requires an additional 12.3 ktoe (143 GWh) of electricity, compared to the BAU scenario, it requires the least amount of energy among all scenarios by 2050, as shown in figure 12. Energy demand in this scenario in 2050 is 38.8 ktoe less than the BAU scenario, 35.4 ktoe less than CPS, and 30.1 ktoe less than the SET scenario. Further implementation of energy efficiency would help to reduce this electricity demand.

Figure 12. **Energy demand comparison among all scenarios**



6.2. Supply sector strategy

The electricity demand in 2030 under the TNZ scenario is projected to be 65 GWh. Borongan currently purchases all of its required electricity from the Visayas grid. Significant challenges exist for the city in increasing the share of renewable energy in purchased electricity as the city currently does not have any control over how the electricity is produced on the Visayas grid. There are also a few pathways that the city could explore in order to achieve a net zero carbon power supply objective. These three pathways are explained below:

(a) Rooftop solar PV installation for new and existing buildings

Incentivising rooftop solar PV installation will provide two benefits to the city by reducing (i) the financial burden on the city for establishing its own solar PV system, and (ii) offsetting the land-use requirement from ground-mounted PV. As noted by IEEFA (2018), rooftop solar PV costs range between PHP 2.50 per kWh (US$ 0.052 per kWh; without financing expenses) and PHP 5.30 per kWh (US$ 0.11 per kWh; with financing expenses). By comparison, the average retail electricity tariff in the Philippines is around US$ 0.185 per kWh where the current rate in Borongan is around US$ 0.28 per KWh This provides a substantial financial gain to solar PV owners. Table 13 illustrates the financial savings that can be gained by increasing the solar rooftop by 50 per cent. It seems that Borongan might save around US$ 3.6 million in 2025 and around US$ 5.6 million in 2030. Assuming a power generation potential of 4 kWh per square metre per day (IEEFA, 2018), the required rooftop area to increase the generation from solar rooftop by 50 per cent is around 22,000 m^2. However, ground-mounted solar PV on vacant land within the city boundaries can also be considered.

Table 13. Comparison of costs for different modes of electricity purchase and estimated savings for selected years

Supply	2025	2030
Electricity demand (GWh)	42.5	65.5
Cost		
Cost of purchasing 50% renewable energy from solar rooftop (million US$)	2.3	3.6
Cost of purchase from grid (million US$)	6.0	9.2
Total cost at 50% solar rooftop mix (million US$)	8.3	12.8
Saving		
Cost of purchase without increasing local RE generation (million US$)	11.9	18.3
Saving for switching to solar rooftop (million US$)	3.6	5.6

(b) Establishing power purchase agreements

The city can enter into a special renewable energy power purchase agreement (PPA) for its own consumption in city buildings and facilities with interested suppliers who are located along the Visayas grid. In turn, the supplier will supply Borongan with an agreed RE share of electricity at an agreed price. However, this may not allow the city to take advantage of the lower generation costs available, such as through renewable energy auctions.

(c) Lowering cost through renewable energy

A more workable solution and the recent policy instrument is the renewable energy auction. This approach is likely to substantially decrease the cost of electricity supply through competitive pricing bidding and, therefore, return a greater net benefit. Please refer to box 3 for further details on renewable energy auctions.

During the stakeholder consultation workshop, the city government mentioned its plan to install a 5 MW solar power farm. Assuming a 16 per cent capacity factor, this power plant might supply an additional 7 GWh of electricity out of 65 GWh electricity demand in 2030 under the TNZ scenario. To supply the remaining needs through indigenous generation, the Government might consider promoting individual-level small-scale installations, such as increasing its solar rooftop capacity. Installation of wind power might not be a technically/economically viable option for individual-level generation compared to solar rooftop. The city government can explore the Private and Public Partnership (PPP) platform and explore financing programmes from different institutions for the different programmes, projects and activities of the LGU.

6.3. Emission outlook

Decarbonizing the whole economy would be beneficial to the country since it would significantly reduce GHG emissions in 2030 (compared to the BAU scenario) by 26.8 $ktCO_2$-e (figure 13). Therefore, economy-wide emission reduction will be around 47.1 per cent compared to BAU. Moreover, transitioning to a fully renewable energy-based power system would be more cost-effective in the long term than relying on fossil fuel-based power generation.

Figure 13. GHG emission comparison in Borongan in the BAU, CPS, SET and TNZ scenarios

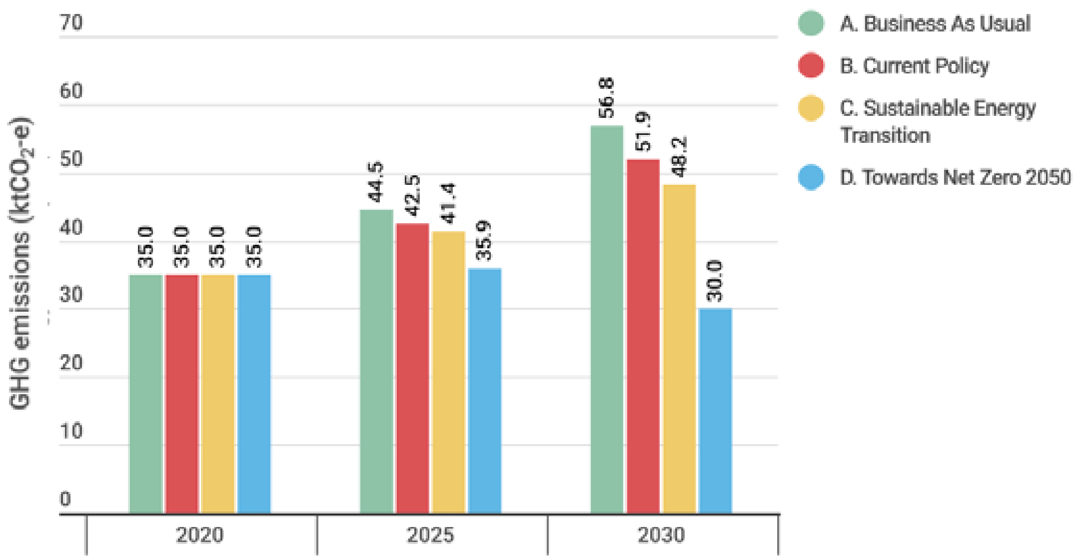
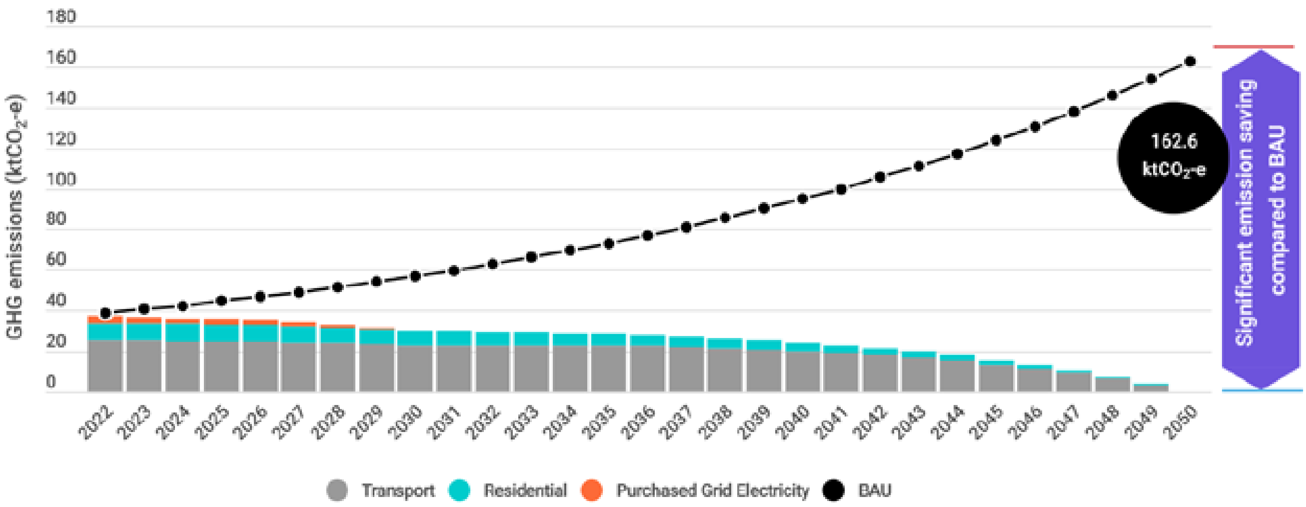


Figure 14 illustrates the GHG emissions in the demand sector under the BAU and TNZ scenarios by 2050. It appears that the emissions will increase by almost three times to 162.6 $ktCO_2$-e in 2050 under the BAU scenario if no significant measures are implemented during this period. However, under the TNZ scenario, the emissions will reach zero in 2050.

Figure 14. GHG emission in Borongan, 2022-2050, by sector in the TNZ scenario



7. Policy recommendations

7.1. Scenario evaluation

The current policy, SET and the ambitious scenarios have been evaluated and ranked, using the Multi-Criteria Decision Analysis (MCDA) tool, with a set of 12 criteria and weights assigned to each criterion (table 14). While the criteria and weights have been selected based on expert judgement, ideally the process should incorporate a stakeholder consultation. If deemed necessary, this step can be repeated, using the NEXSTEP tool in consultation with stakeholders where the participants may want to change the weights of each criterion. The following factors have been considered to assume comparative weights across the set of criteria, where the total weight needs to be 100 per cent:

(a) Universal access to electricity to be achieved;
(b) Universal access to clean cooking fuel to be achieved;
(c) Renewable energy share in the total final energy consumption to increase;
(d) Energy efficiency improvement should be doubled, and where there is an economic benefit, it should be further enhanced;
(e) The emissions trajectory will need to align with the unconditional NDC target. Where possible, the conditional target should be achieved if it is economically viable;
(f) Total investment should be kept low, but the net benefit should be high. This was done by assigning both indicators the same weight to ensure that a scenario is chosen on the value-for-money basis; and
(g) Carbon pricing should be introduced to encourage investments in clean energy.

Table 14. Criteria with assigned weights for MCDA

Criterion	Weight
Access to clean cooking fuel	10%
Energy efficiency	10%
Share of renewable energy	11%
Emissions targets in 2030	10%
Alignment with Paris Agreement	10%
Fossil fuel subsidy phased out	5%
Price on carbon	5%
Fossil fuel phase-out	5%
Cost of access to electricity	7%
Cost of access to clean cooking fuel	7%
Investment cost	10%
Net benefit from the power sector	10%
Total	**100%**

Table 15 shows the summary of results obtained through this evaluation process. The scenario recommendation suggests that the ambitious scenario, "Towards Net Zero by 2050" scenario, is the highest-ranked energy transition pathway for Borongan.

Table 15. Scenario ranking based on MCDA

Scenarios	Weighted scores	Rank
Towards Net Zero 2050	51.0	1
SDG scenario	26.8	2
Current policy scenario	9.4	3
Business-as-usual scenario	0	4

Based on the above analysis, this Road Map recommends that Borongan consider the adoption of the scenario "Towards Net Zero by 2050".

7.2. Policy actions for sustainable energy transition and moving towards net zero

7.2.1. Electric cooking stoves and liquified petroleum gas stoves provide a sustainable solution with multifold benefits

Access to clean cooking fuels and technologies generally lacks attention from the policymakers. In turn, the inaction in closing the gap has led to substantial premature deaths due to household air pollution caused by unclean cooking practices. Nearly one-fifth of Borongan's population relies on the use of traditional biomass stoves and kerosene stoves. Positive benefits that can arise from the adoption of clean cooking technologies include fuel savings (as evidenced in the SET scenario), less time spent on cooking and less use of cooking fuels, and reduced health risks from indoor air pollution.

NEXSTEP proposes that initiatives should be launched by providing electric cooking stoves as a long-term clean technology substitute. LPG stoves are a strong contender; however, electric cooking stoves are more cost-effective and cleaner in terms of household indoor air pollution. In addition, the use of electric cooking stoves paves the way towards net zero emissions when the electricity supply is decarbonized. LPG stoves may, however, be promoted to households that lack sufficient power supply capacity, i.e., households utilizing decentralised renewable energy systems. It will cost the Government around US$ 0.37 million to distribute electric cooking stoves towards 3,459 households and another US$ 0.13 million to distribute LPG stoves to 1,156 households.

7.2.2. Transport electrification and mass transport should be pursued

It is critical for the Government to reduce the energy demand in the transport sector. Mass transportation must be promoted to reduce the passenger-km by private vehicles. The number of buses must be increased by at least three times to increase the passenger kilometres of bus by 10 per cent in 2030. Total energy saving potential through this measure between 2023 and 2030 will be 5 ktoe with 14.3 ktCO_2-e of emission reduction.

The transition to a clean energy sector will require a shift from fossil fuel-powered transport to electric vehicles (EVs) supplied with electricity, which will have an increasing RE component. Although transitioning towards electric vehicles is a complex process, vigorous adoption of electric vehicles would reduce the demand for oil products, hence reducing Borongan's reliance on petroleum fuels. Another advantage of EVs is their ability to absorb excess renewable energy. With specialised networks and large numbers of EVs plugged into the grid at any one time, there is the possibility to use the combined stationary battery capacity as an element of load levelling. At the same time, it can contribute to climate mitigation and improve local air quality.

To minimize the costs, In the SET scenario, NEXSTEP proposes the uptake of electric vehicles across different vehicle categories by 5 per cent in 2030 as the starting point. This number is selected to align with the national target of 10 percent by 2040 as well as to reach the energy efficiency target. An adoption rate of 5 per cent for passenger cars, motorcycles and freight trucks by 2030 has the potential to save energy cumulatively by 0.3 ktoe and reduce emissions by 0.8 ktCO_2-e under the SET scenario between 2023 and 2030. More ambitious target, however, must be considered to achieve net zero by 2050.

The Republic Act No. 11697 or the Electric Vehicle Industry Development Act which promotes innovation in the field of clean energy and sustainable transportation might provide incentives for the electric vehicle owners. Under the Comprehensive Roadmap for the Electric Vehicle Industry (CREVI), battery electric vehicle (BEV) owners are entitled to a 30 per cent discount on the motor vehicle users charge (MVUC), while hybrid owners get 15 per cent off. BEV and hybrid users will have the registration process expedited for them. These discounts will also apply to EV and hybrid inspection fees for the first eight years of this Act's effectivity. Box 2 discusses the global progress of electric vehicles.

Box 2. Electric vehicle gains global interest

Electric vehicles have garnered great interest globally, growing exponentially during the past decade. Electric car sales passed two million globally in 2019, with a projected compound annual growth rate of 29 per cent through to 2030 (Deloitte, 2020). Various government policies have been introduced that directly or indirectly promote the adoption of electric vehicles as a means to achieve environmental and climate objectives. For example, 17 countries have stated their ambition to phase out internal combustion engines before 2050, while the European Union's stringent CO_2 emissions standard has accelerated the adoption of electric vehicles (IEA, 2022a).

Despite supply chain bottlenecks and the ongoing COVID-19 pandemic, electric car sales hit a new high in 2021. Sales nearly doubled to 6.6 million, representing a world sales share of approximately 9 per cent, compared to 2020, increasing the total number of electric vehicles on the road to 16.5 million. In 2021, the sales share of electric vehicles rose by 4 percentage points. China had the most sales in 2021, tripling those of 2020 with 3.3 million, followed by Europe with 2.3 million sales, an increase from 1.4 million in 2020. In 2021, 630,000 electric vehicles were sold in the United States, doubling their market share to 4.5 per cent. Electric car sales increased more than twice as much in emerging nations, although sales are still relatively small (IEA, 2022a).

7.2.3. Pursuance of a high share of renewables in the power sector through cost-effective pathways

Renewable capacity has increased significantly across the world amid climate change concerns. The decarbonization of the power sector is generally regarded as the low-hanging fruit, as the cost of renewable power technologies decreased rapidly during the past decade. Decarbonizing the electricity supply provides a quick decarbonization pathway, while providing financial benefits. NEXSTEP proposes four different pathways that may be considered in decarbonizing the electricity supply, as described in subsection 6.2. A combination of these three pathways can also be adopted.

The stakeholders can utilize their local renewable energy for energy generation. Such initiatives may come in two forms of arrangement, to be considered by the city government. First, the city government may opt to self-invest and self-govern the renewable facility. This may, however, require huge investment and operational responsibilities. A better solution would be to attract potential investors to establishing such facilities, while contributing positively to the city's economy and providing job opportunities. A power purchase agreement can be set up with the respective suppliers, enabling a supply to the city with a higher share of renewable electricity at an agreed price. On the other hand, citizen initiatives in setting up rooftop installations on both new and existing buildings should be promoted. For example, the city government is providing a tax incentive to small businesses that establish a minimum of 3 kW of RE systems, in the form of a 10 per cent discount from their gross sales for their corresponding business taxes in the city. The outcome of the initiative should be closely monitored to make sure that it aligns with the city's aspirations.

Renewable energy auctions may, however, be the best and cheapest option, whereby contracts and agreements are awarded through competitive bidding. The Department of Energy of the Philippines was planning to launch a 2,000 MW renewable energy auction around mid-2021 (Rivera, 2020). While the renewable energy auction mechanism and its associated standards are set at the national level, the City of Borongan can work with the central Government to implement RE auctions at the city level, Box 3 explains further the renewable energy auction in detail.

Box 3. Mechanism of a renewable energy auction

A renewable energy auction, also known as a "demand auction" or "procurement auction", is essentially a call for tenders to procure a certain capacity or generation of renewables-based electricity. The auction participants submit a bid with a price per unit of electricity at which they are able to realise the project. The winner is selected on the basis of the price and other criteria, and a power purchase agreement is signed. The auctions have the ability to achieve deployment of renewable electricity in a well-planned, cost-efficient and transparent manner. Most importantly, it makes the achievement of targets more precise than would be possible by other means, such as a Feed-in-Tariff (FiT). Auctions are flexible and they allow the Government to combine and tailor different design elements to meet deployment and development objectives. Unlike a FiT, where the Government decides on a price, auctions are an effective means of discovering the price appropriate to the industry, which is the key to attracting private sector investment. In addition, an auction provides greater certainty about future projects and is a fair and transparent procurement process. However, the administrative and logistic costs associated with auctions are very high unless multiple auctions are undertaken at regular intervals.

It is imperative that an auction be appropriately designed to (a) avoid the risk of underbuilding and project delays, and (b) allow sufficient competition among different levels of bidders in order to drive down the cost. IRENA suggests the following key design elements:

- **Auction demand.** A Government needs to clearly indicate the scale or size of each auction, the preferred technology (technology neutral or a specific technology), auction frequency, and the upper and lower limits of projects size and price;
- **Pre-qualification.** A strict or high pre-qualification for bidders will leave out the smaller entities, while a relaxed pre-qualification may undermine the quality of the project and increase the administrative costs. Governments need to make a trade-off, depending on the project size and other development objectives;
- **Selection criteria.** Commonly two selection criteria are used: (a) the lowest bid where only the lowest bidder will win; and (b) lowest bids plus other objectives where, in addition to the price, other objectives such as local content and jobs are taken into consideration;
- **Payment modalities.** The pay-as-bid model is good for minimizing the cost; however, the marginal cost payment model, where the same price (selected based on the highest cost winner) is paid to all winners is also practised;
- **Penalties for non-compliance.** There could be cases where the developer either delays the project or fails to complete it. To avoid such cases, penalties should be in place. There are two modes of penalty. In the monetary penalty, money will be deducted from bidder's "bond" or the price of energy will be reduced for a delayed completion. A form of non-monetary penalty can be the exclusion of the bidder from future auctions.

7.2.4. Moving towards net zero carbon

Efforts from all levels and sectors are imperative in the emissions race to net zero. Cities can play a significant role as they contribute around 75 per cent of global anthropogenic emissions and represent about 75 per cent of global energy demand (REN21, 2021). As of April 2021, more than 700 cities in 53 countries had committed to a net zero target by 2050, with a medium target of halving emissions by 2030 (C40 Cities, 2021). The energy system of Borongan is well-positioned for an accelerated decarbonization effort as the required net zero technologies in decarbonizing its energy systems are readily available and mature – i.e., electric vehicles, electric cooking stoves, solar irrigation systems and renewable power technologies.

As detailed in chapter 6, a decarbonized electricity supply is required to complement the rapid adoption of electricity-based technologies, such as electric vehicles and electric cooking stoves. Further studies should be conducted to identify possible challenges to the electricity grid resulting from a high electricity load and a high level of RE penetration. Possible mitigating solutions may be required, such as integrated energy storage, demand side management and smart ICT solutions, in managing the possible burden that large-scale demand electrification may place on the electricity grid.

8. Conclusion and the way forward

The 2030 Agenda for Sustainable Development and the Paris Agreement provide a common goal of achieving sustainability and climate objectives. While achieving the SDG7 targets is principally a national effort, it requires combined contributions from stakeholders at various levels, such as subnational jurisdictions and cities. Borongan is an active advocate for localizing SDGs, by various initiatives and programmes benefiting its citizens. Borongan and ESCAP have collaborated in the development of a Sustainable Energy Transition Road Map, which aims to inform the city about sustainable energy transition pathways tailored to its local context.

Borongan is best recognised for its environmental initiatives. The GDP of Borongan is projected to grow at 6 per cent per annum, while the population is expected to increase by 0.8 per cent each year. Under the current policy settings, Borongan may fall short of achieving universal clean cooking access. The overall energy demand is projected to rise by an annual average rate of 4.2 per cent, to 22.3 ktoe. GHG emission is projected to be 51.9 $ktCO_2$-e, a reduction of 4.8 $ktCO_2$-e, compared to the baseline.

The SET scenario proposes an energy transition pathway that strategically allows Borongan to close its existing gaps in clean cooking access. It also suggests several energy efficiency opportunities that would lead to energy savings and GHG emission reduction. Qualitative and quantitative analyses have suggested that electric cooking stoves may be the best way forward in closing the clean cooking gap. However, clean cooking technology selection between electric cooking stoves and LPG stoves should be done based on households' power supply capacity. Closing the clean cooking gap will also provide a substantial energy demand reduction by phasing out polluting, inefficient cooking technologies (i.e., traditional biomass stoves and kerosene stoves).

The transport sector provides the greatest sustainable energy potential. The promotion of EVs in multiple vehicle subcategories as well as increasement of public transport use are estimated to provide a total energy saving of 1.3 ktoe in 2030 only. At the household level, energy savings can be realised through the adoption of more efficient appliances, specifically by switching to LED lighting. With the proposed measures, the final energy demand and GHG emissions in the SET scenario are projected to be 19.2 ktoe and 48.2 $ktCO_2$-e, respectively.

Climate change is one of the most pressing issues of this century, requiring rapid and widespread climate mitigation from all sectors. Borongan may play its part by raising its climate efforts through decarbonizing its electricity supply and whole economy as explored in the most ambitious Towards Net Zero scenario. More can be done with co-operation from its citizens to adopt more electricity-based technologies, i.e., electric vehicles and electric cooking stoves. The penetration of electric vehicle and electric cook stoves must be 100 per cent to achieve a net zero carbon target. However, strong institutional support is imperative in supporting a successful energy transition and sustainable development. The scenario requires an additional 143 GWh of electricity by 2050 to fulfil the increasing electricity demand. The city could undertake several pathways in decarbonizing its electricity supply to support the achievement of net zero target, with renewable energy auctions standing out as the cheapest option.

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Annexes

I. National Expert SDG 7 tool for energy planning methodology

The analysis presented in this national Road Map is based on the results from the National Expert SDG 7 Tool for Energy Planning (NEXSTEP) project. NEXSTEP is an integrated tool for assisting policymakers in making informed policy decisions that will help in achieving SDG 7 and NDC targets by 2030. The SDG 7 and NDC targets are integrated in the LEAP energy model and back-casted from 2030, since the targets for 2030 are already defined.

Annex table 1. Targets and indicators for SDG 7

Target	Indicators	2020	2030
7.1. By 2030, ensure universal access to affordable, reliable, and modern energy services.	7.1.1. Proportion of population with access to electricity.	100%	100%
	7.1.2. Proportion of population with primary reliance on clean fuels and technology for cooking.	81.9%	100%
7.2. By 2030, increase substantially the share of renewable energy in the global energy mix.	7.2.1. Renewable energy share in total final energy consumption.	9.2% (excluding traditional biomass)	17.8%
7.3. By 2030, double the global rate of improvement in energy efficiency.	7.3.1. Energy intensity measured as a ratio of primary energy supply to gross domestic product.	4.6 MJ/US$ (2017) PPP	3.2 MJ/US$ (2017) PPP

SDG 7.3. Energy Efficiency. "By 2030, double the global rate of improvement in energy efficiency", as measured by the energy intensity of the economy. This is the ratio of the total primary energy supply (TPES) and GDP. Energy intensity is an indication of how much energy is used to produce one unit of economic output. As defined by IEA, TPES is made up of production, plus net imports minus international marine and aviation bunkers and plus stock changes. For comparison purposes, GDP is measured in constant terms at 2017 PPP.

$$Primary\ energy\ intensity = \frac{Total\ Primary\ Energy\ Supply\ (MJ)}{GDP\ (USD\ 2017\ PPP)}$$

$$CAGR = \left(\frac{EI_{t2}}{EI_{t1}}\right)^{\frac{1}{(t2-t1)}} - 1$$

where EI_{t1} is energy intensity in year t1 and EI_{t2} is energy intensity in year t2.

SDG 7.3. improvement rate for Borongan (suggested global improvement rate): 3.2 per cent.

SDG 7.2. Renewable Energy.

Methodology: Share of renewable energy in total final energy consumption, where TFEC is total final energy consumption, ELEC is gross electricity production and HEAT is gross heat production.

$$\%TFEC_{RES} = \frac{TFEC_{RES} + \left(TFEC_{ELEC} \times \frac{ELEC_{RES}}{ELEC_{TOTAL}}\right) + \left(TFEC_{HEAT} \times \frac{HEAT_{RES}}{HEAT_{TOTAL}}\right)}{TFEC_{TOTAL}}$$

II. Key assumptions for NEXSTEP energy modelling

(a) General parameters

Annex table 2. GDP, PPP and growth rate

Parameter	Value
GDP (2020)	139 million
Growth rate	6%

Annex table 3. Population, population growth rate and household size

Parameter	Value
Population (2020)	71,961
Population growth rate	0.8%
Number of households (2020)	17,492
Household size (constant throughout the analysis period)	4.1

(b) Demand-side assumptions

(i) Industry

- There is one industry subcategories in Borongan: machinery and transportation equipment. The fuel consumption data (exclusively electricity consumption) are shown in annex table 4.
- The industrial GDP is assumed to grow at an annual rate of 6 per cent, similar to the GDP growth rate. The energy intensity is assumed constant throughout the analysis period in the absence of energy efficiency interventions

Annex table 4. Fuel consumption by industry subcategories in 2020

Industry subcategory	Electricity consumption in 2020 (toe)	Consumption share
Machinery and transportation equipment	20	100%

(ii) Transportation

- Land transport sector consumption is estimated using the vehicle statistics, load factor, annual travel mileage and estimated fuel economy as shown in annex table 5. The factors are based on vehicle statistics compiled by the local consultant and assumptions made by ESCAP and the local consultant, as local specific data is scarce.
- Transport activities in 2020 are estimated to have been 0.19 billion passenger-kilometres (0.02 billion-km when considering only public transport) and 0.1 billion tonne-kilometres. The growth in both passenger transport and freight transport activities is assumed as growing at the same rate as the population, i.e., 1.5 per cent per annum.

Annex table 5. Transport sector floorspace baseline assumptions

Passenger transport	No. of vehicles	Annual mileage (km)	Load factor (pass-km/veh-km)	Fuel consumption	% share of passenger-km
Passenger car	519 (gasoline) 1,840 (diesel)	24,000	2.5	8.5 km/l 8.3 km/l	73%
Motorcycle	1,900 (gasoline)	9,000	1.6	15 km/l	14%
Bus	6 (gasoline)	80,000	50	8.5 km/l	13%
Freight transport	**No. of vehicles**	**Annual mileage (km)**	**Load factor (tonne-km/veh-km)**	**Fuel consumption**	**% share of tonne-km**
Freight truck	162 (diesel)	56,000	11	8 km/l	100%

(iii) Commercial sector

- The total annual energy consumption in the commercial sector was 0.99 ktoe in 2020. It is projected to grow at an annual rate of 6 per cent, similar to the GDP growth rate in the BAU scenario.
- The commercial sector is further differentiated into four categories and the energy consumption by categories are as shown in annex table 6.

Annex table 6. Commercial sector fuel consumption in 2020

Category	Floor space in 2020 (million m^2)	Electricity intensity (kWh/m^2)	Consumption in 2020 (ktoe)
Private office	0.034	65	0.19
Government building	0.206	35	0.62
Shopping mall	0.010	8	0.01
Hotel	0.026	25	0.06
Hospital	0.012	11	0.01
University	0.025	34	0.07
Religious temple	0.013	26	0.03

(iv) Residential

- The residential households have achieved a 94.1 per cent electricity access rate and the overall clean cooking rate was 81.9 per cent in 2020. The breakdown is shown in annex table 7.

Annex table 7. Cooking distribution in households

Stove type	Energy intensity (GJ/household)	Share
Electrified		
LPG stove	6.67	85%
Electric stove	5.57	2%
Biomass stove*	39.02	12%
Kerosene stove*	3.66	1%
Non-electrified		
Biomass stove*	39.02	85%
Kerosene stove*	3.66	15%

* *This is assumed as unclean fuel/technology.*

- The residential appliance ownership data and energy use intensity in the baseline year were provided by the local consultant. The appliance ownership is projected to grow a rate similar to the growth in GDP per capita. The average electrical demand per owning household for the different appliances are assumed to be constant throughout the analysis period, unless further energy efficiency measures are implemented.

Annex table 8. Residential appliance baseline assumptions

Appliance	Electricity intensity (kWh/HH/year)	Ownership
Lighting	96.6	100%
Air-conditioner	414.0	50%
Refrigerator	386.4	75%
Television	69.0	100%
Electric fan	110.4	100%
Water pump	124.2	25%
Iron	69.0	80%
Washing machine	110.4	90%

III. Economic analysis data for clean cooking technologies

The NEXSTEP economic model utilizes the technological and cost parameters to estimate the. annualised cost of clean cooking technologies (annex table 9). The calculation assumes an annual cooking thermal energy requirement of 3,840 MJ per household (Putti and others, 2015). In addition, a discount rate of 5.37 per cent is assumed.

Annex table 9. Technology and cost data for clean cooking technologies

Technologies	Efficiency[14] (%)	Lifetime[15] (years)	Stove cost (US$)	Variable O&M[16] (US$/year)	Fuel cost (US$)
ICS	35	4	35	10	0.03 per kg
LPG stove	56	7	56	10	1.49 per kg
Electric stove	84	15	40	10	0.164 per kWh

IV. Summary results for the scenarios

	BAU scenario 2030	CPS scenario 2030	SET scenario 2030	TNZ Scenario 2030	TNZ Scenario 2050
Universal access to electricity	100%	100%	100%	100%	100%
Universal access to clean cooking	81.9%	81.9%	100%, via electric cooking stoves	100%, via electric cooking stoves	100%, via electric cooking stoves
Energy efficiency	3.94 MJ/US$	3.86 MJ/US$	3.23 MJ/US$	2.67 MJ/US$	1.29 MJ/US$
Renewable energy share in TFEC	10.4%	15.2%	17.8%	37.9%	100%
GHG emissions	56.8 ktCO_2-e	51.9 ktCO_2-e	48.2 ktCO_2-e	30 ktCO_2-e	0 ktCO_2-e

14 Sources: ICS – own estimation, LPG stove efficiency ranges – (World Bank, 2014), electric cooking stove (induction stove) – (IEA, 2012).

15 Sources: ICS – own estimation, LPG stove – (Clean Cooking Alliance, 2021), electric stove – (IEA, 2012).

16 Variable O&M is based on own assumptions