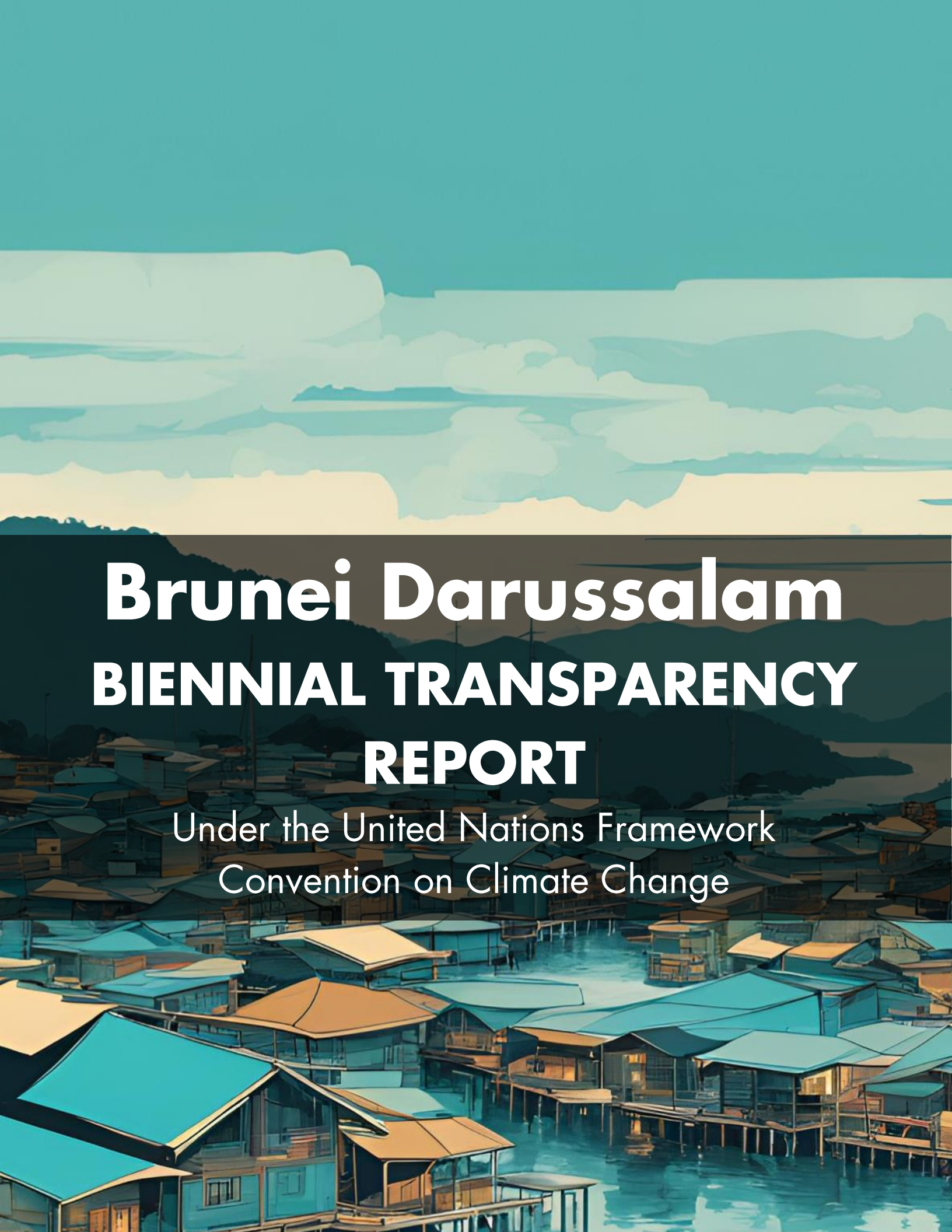


Brunei Darussalam

BIENNIAL TRANSPARENCY REPORT

Under the United Nations Framework Convention on Climate Change

PREFACE



The Government of Brunei Darussalam is pleased to submit its first Biennial Transparency Report (BTR) as part of its reporting obligation to United Nations Framework Convention on Climate Change (UNFCCC). The BTR communicates Brunei Darussalam's contribution to the overall objective of the UNFCCC and takes into account the country's development goals in line with its national vision, the *Wawasan Brunei 2035*, where the country aspires to be widely recognised for its educated, highly skilled and accomplished people, with a high quality of life and a dynamic and sustainable economy by 2035.

The BTR includes information on national circumstances, the national Greenhouse Gas (GHG) inventory, mitigation actions and their impacts, domestic Measuring, Reporting and Verification (MRV) and support needed and received.

The Government of Brunei Darussalam wishes to acknowledge the support provided by our cooperating partners towards the preparation of the BTR. The support received enabled the country to undertake climate actions and facilitated capacity development in the areas of research and systematic observation, transparency, GHG inventory, among others.

It is my expectation that the BTR will provide necessary information for informed decision making on the country's mitigation measures including formulation of strategies, programmes and plans to reduce the emission of GHGs and help the country transition into low carbon pathway.

The Honourable Dato Seri Setia Dr. Awang Haji Mohd. Amin Liew bin Abdullah
Minister at the Prime Minister's Office and Minister of Finance & Economy II
Co-chair of the Brunei Darussalam National Council on Climate Change
Negara Brunei Darussalam

ACKNOWLEDGEMENT

Brunei Darussalam's BTR to the UNFCCC communicates the country's efforts in enhancing reporting on climate actions for enhanced transparency. The BTR contains updates of the national GHG inventory, information on actions to reduce emissions/ enhance sinks and needs and support received.

The Brunei Climate Change Office (BCCO) wishes to encourage all stakeholders to continue contributing their respective roles in mitigating GHG emissions and accounting as this will require concerted efforts from both national and international stakeholders through provision of technical and financial support. The collaboration demonstrated in the preparation of the BTR, if continued, will assist the country in meeting its emission reduction ambitions and contribute to the global goal on keeping the global average temperature to well below 2 °C above preindustrial levels.

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GASES

Gas	Explanation
CO_2	Carbon dioxide
CH_4	Methane
HFCs	Hydrofluorocarbons
N_2O	Nitrous Oxide
PFC	Perfluorocarbons
SF_6	Sulphur Hexafluoride

UNITS

Unit	Explanation
10^3Nm^3	One thousand normal cubic metre
10^6m^3	One million cubic metres
°C	Degree Celsius
Bo	Maximum Methane Producing Capacity for Domestic Wastewater
BOD	Degradable organic component
CO_2e	Carbon Dioxide equivalent
COD	Chemical Oxygen Demand
DOC	Degradable Organic Carbon
DOCf	Dissolved Organic Carbon fraction
F	Fraction of methane in developed gas
FNON-CON	Factor for non-consumed protein added to wastewater
FNPR	Fraction of Nitrogen in protein
Gg	10^6 grams
ha	Hectare
k	Methane generation rate constant
Kbbl	Thousand barrels
Kboe	Thousand barrel of oil equivalent
Ktoe	Thousand tonnes of oil equivalent
km	kilometre
km^2	Kilometre square
kWh	Kilowatt hour
m^3	Cubic metre
mm	Millimetre
MMbtu	Metric Million British Thermal Unit
Mt	Million Tonnes
$MtCO_2e$	Million tonnes of carbon dioxide equivalent
Mtoe	Million tonnes of oil equivalent
MW	Megawatt
MWh	Megawatt hour
OX	Oxidation factor
SOC	Soil Organic Carbon
t	Tonnes
T	Degrees of Treatment Utilisation
TJ	Terajoules

CONVERSION TABLE

1 tonne	= 10^3 kg	= 10^6 g
1 kt (kilo tonne)	= 10^6 kg	= 10^9 g
1 Mt (Mega tonne)	= 10^9 kg	= 10^{12} g
1 km^2 (kilo metre)^2	= 100 ha	
1 TJ (tera joules)	= 10^{12} Joules	

ACRONYMS AND ABBREVIATIONS

Abbreviations	Explanation
3Rs	Reduce, Reuse and Recycle
5W1H	What, Who, Where, When, Why and How
ACE	ASEAN Centre for Energy
AD	Activity Data
ADPC	Asia Disaster Preparedness Centre
AFOLU	Agriculture, Forestry and Other Land-Use
AFSIS	ASEAN Food Security Information System
AGB	Above-Ground Biomass
AI	Artificial Intelligence
AIT	Asian Institute of Technology
ALARP	As Low As Reasonably Practicable
APAN	Asia Pacific Adaptation Network
APEC	Asia-Pacific Economic Cooperation
API	Application Programming Interface
AR5	Fifth Assessment Report
ARWG	Adaptation and Resilience Working Group
ASEAN	The Association of Southeast Asian Nations
ASEAN-CRN	ASEAN Climate Resilience Network
AWD	Alternate wetting and drying
BAU	Business As Usual
BCCO	Brunei Climate Change Office
BCCS	Brunei Climate Change Secretariat
BDMD	Brunei Darussalam Meteorological Department
BFI	Brunei Fertilizer Industry
BFRD	Brunei Fire and Rescue Department
BGAP	Brunei Good Agriculture Practice
BGB	Below-Ground Biomass
BLNG	Brunei Liquefied Natural Gas
BMC	Brunei Methanol Company
BNCCC	Brunei Darussalam National Council on Climate Change
BNCCP	Brunei Darussalam National Climate Change Policy

BPC	Berakas Power Company
BRIN	National Research and Innovation Agency
BSFS	Brunei Selective Felling System
BSM	Brunei Shell Marketing
BSP	Brunei Shell Petroleum
BTR	Biennial Transparency Report
BYOR	Bring Your Own Reusable
CBD	Convention on Biological Diversity
CCUS	Carbon Capture, Utilisation and Storage
CEO	Chief Executive Officer
CHP	Combined Heat and Power Generation
COP	Conference of Parties
CORDEX	Co-ordinated Regional Climate Downscaling Experiment
CRT	Common Reporting Tables
CS	Country Specific
CSA	Climate-Smart Agriculture
D	Default IPCC methodology and emission factor
DDS	Department of Drainage and Sewerage
DEPR	Department of Environment, Parks and Recreation
DEPS	Department of Economic Planning and Statistics
DITP	Department of International Trade Promotion
DoAA	Department of Agriculture and Agrifood
DOE	Department of Energy
DTS	Department of Technical Services
EEC	Energy Efficiency and Conservation
EEZ	Exclusive Economic Zone
EF	Emission Factor
EHW	Excessive Hot Weather
ENSO	El-Niño Southern Oscillation
ERIA	Economic Research Institute for ASEAN and East Asia
ETF	Enhanced Transparency Framework
EV	Electric Vehicle
EVWG	Electric Vehicle Working Group
ExComm	Executive Committee on Climate Change
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FL	Forest Land
FRA	Forest Resources Assessment
GAHP	Good Animal Husbandry Practice
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHGMI	Greenhouse Gas Management Institute
GIR	Greenhouse Gas Inventory and Research Centre
GIS	Geographical Information System
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit

GLP	Good Laboratory Practice
GWP	Global Warming Potential
HER	Hazards and Effects Register
ICE	Internal Combustion Engine
ICT	Information and communications technology
IEWG	Industrial Emissions Working Group
IFAD	International Fund for Agricultural Development
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
KCA	Key Category Analysis
KPI	Key Performance Indicator
LEAP	Long-range Energy Alternatives Planning
LED	Light-Emitting Diode
LEG	Least Developed Countries Expert Group
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LTD	Land Transport Department
LULUCF	Land Use, Lad-Use Change and Forestry
M	Methods
MANAGE	National Institute of Agriculture Extension Management
MCF	Methane Correction Factor
MD	Managing Director
MEPS	Minimum Energy Performance Standard
MICE	Meetings, Incentives, Conventions and Exhibitions
MMS	Manure Management System
MPG	Modalities, Procedures & Guidelines
MSME	Micro, Small, Medium Enterprise
MOD	Ministry of Development
MOFE	Ministry of Finance and Economy
MOH	Ministry of Health
MOHA	Ministry of Home Affairs
MPRT	Ministry of Primary Resources and Tourism
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
MTIC	Ministry of Transport and Infocommunications
MYCE	Mid-Year Conference and Exhibition
NAP	National Adaptation Plan
NC	National Communication
NCVA	National Climate Vulnerabilities Assessment
NGO	Non-Governmental Organization
NIC	National Inventory Report
NIES	National Institute for Environmental Studies
NIR	National Inventory Report
NC	National Communication

NCCS	National Climate Change Singapore
NDC	Nationally Determined Contribution
NDMC	National Disaster Management Centre
NDP	National Development Plan
NE	Not Estimated
NFP	National Focal Point
NIES	National Institute for Environmental Studies
NO	Not Occurring
OECC	Overseas Environmental Cooperation Centre
PASTI-JAIF	Partnership to Strengthen Transparency for Co-Innovation by the Japan-ASEAN Integrated Fund
PATPA	Partnership on Transparency in the Paris Agreement
PBFI	Plastic Bottle Free Initiative
PEARL	People, Environment, Asset, Reputation and Legal
PMO	Prime Minister's Office
PS	Plant-Specific
PV	Photovoltaic
PWD	Public Works Department
QA/QC	Quality Assurance / Quality Check
RAM	Risk Assessment Matrix
RBA	Royal Brunei Airlines
RCP	Representative Concentration Pathway
RE	Renewable Energy
RFFS	Rice Farmer Field School
RFP	Request For Proposal
SCE	APEC Senior Officials' Meeting Steering Committee on Economic and Technical Cooperation
SCF	Stock Change Factors
SEAMEO-STEM-ED	Southeast Asian Ministers of Education Organization Regional Centre for STEM Education
SPARK	Sungai Liang Industrial Park
STP	Science, Technology, and Policy
SWDS	Solid Waste Disposal Sites
TACCC	Transparency, Accuracy, Consistency, Completeness, and Comparability
TCP	Department of Town and Country Planning
TCTP	Third Country Training Program
TSB	Tenaga Suria Brunei
T1, T2, T3	Tier 1, Tier 2, Tier 3
UN-HABITAT	United Nations Human Settlements Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNOSD	United Nations Office for Sustainable Development
US EPA	United States Environmental Protection Agency
WCRP	World Climate Research Programme
WEAP	Water Evaluation and Planning

WTD	Wastewater Treatment and Discharge
WTE	Waste To Energy

EXECUTIVE SUMMARY

This report presents Brunei Darussalam's first Biennial Transparency Report (BTR) to the United Nations Framework Convention on Climate Change (UNFCCC). It is prepared in line with Decision 18/CMA.1 and Decision 1/CP.24 under the Paris Agreement, which lay out the modalities, procedures, and guidelines (MPGs) for such reports. Additionally, the report aligns with Decision 1/CP.16, paragraph 60(c) of the Conference of the Parties (COP), which commits Parties to provide updates on their greenhouse gas emissions and the actions being taken to reduce these emissions, in accordance with their national circumstances.

The BTR contains the following elements:

1. National circumstances;
2. National greenhouse gas inventory and inventory report;
3. Climate Change Impacts and Adaptation;
4. Progress of Nationally Determined Contribution (NDC);
5. Financial, Technical and Potential Constraints and needs.

National Circumstances

Brunei Darussalam is a small Southeast Asian nation covering 5,765 square kilometres and located on the northern coast of the island of Borneo, bordered by the South China Sea to the north and surrounded by the Malaysian state of Sarawak on three sides. Brunei experiences a tropical rainforest climate characterized by high humidity, heavy rainfall, and consistently warm temperatures throughout the year. While generally free from natural disasters such as earthquakes and typhoons, the country does experience seasonal monsoons contributing to substantial rainfall.

The population of Brunei is relatively small, with most residents living in urban areas, particularly in the capital city, Bandar Seri Begawan, located in the Brunei-Muara District. The nation enjoys a high standard of living, largely due to significant revenues from oil and gas production, which dominate its economy and account for a substantial portion of its GDP, government revenue, and exports. This economic reliance on fossil fuels is a critical factor in its national circumstances, especially in the context of climate change mitigation efforts.

Given its small size and geographic location, Brunei is particularly vulnerable to the impacts of climate change, including sea-level rise, increased rainfall, and potential biodiversity changes. Recognizing these vulnerabilities, the government is actively working to diversify the economy and transition towards a more sustainable and resilient future.

In the context of institutional arrangements, the Executive Committee on Climate Change (ExComm) plays a crucial role in overseeing and assessing the development and implementation of climate change policies and projects, offering advice and guidance on emerging challenges and

opportunities; this information is subsequently reported to the Brunei National Council of Climate Change (BNCCC), which is responsible for making high-level decisions and providing endorsements to ensure effective climate governance and strategic alignment with national priorities.

The GHG national inventory is compiled by the Brunei Climate Change Office (BCCO), a process that has been further strengthened by the introduction of a Mandatory Reporting Directive, which is designed to ensure that TACCC (Transparency, Accuracy, Completeness, Consistency, and Comparability) quality objectives are met, along with the timeliness of the national GHG inventories. Quality requirements are consistently fulfilled through the implementation of inventory quality management procedures. Each sector expert responsible for emission estimation handles data collection and entry for their respective emissions and submits this data to the BCCO. The BCCO then compiles the data, conducts key source and uncertainty analyses, performs final quality checks, and submits the national GHG inventory to the UNFCCC Secretariat.

The National Greenhouse Gas Inventory

Brunei Darussalam's National Greenhouse Gas Inventory covers the period 2010-2022. In accordance with the IPCC 2006 guidelines for national greenhouse gas inventory. The inventory covers all four of the Intergovernmental Panel on Climate Change (IPCC) sectors, namely, Energy; Industrial Process and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU) and Waste. The gases covered in this inventory include the major gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). However, emissions from Land-use changes were not included in the inventory due to data limitations.

Brunei Darussalam's total gross GHG emissions increase by 27% from 9.88 $MtCO_2e$ (million tonnes CO_2 equivalent) in 2010 to13.57 $MtCO_2e$ in 2022. CO_2 remain the most dominant GHG gas in the overall inventory throughout the inventory period contributing to more than 95% of total overall emissions. This is followed by CH_4 and the least being N_2O at less than 1%.

The Energy sector was the most significant source of emissions for all three gases contributing to 97% of total GHG emissions in 2022. This is followed by the Waste sector (1.54%), IPPU (0.96%), and AFOLU (0.26%). Brunei's net emissions amounted to 9.11 $MtCO_2e$ in 2022.

The total emissions from the energy sector were 9.44 $MtCO_2e$ in 2010, growing at an average rate of 8% to 13.20 $MtCO_2e$ in 2022 mainly due to the steady increase in the country's energy consumption and increase use of fossil fuel to generate power.

Emissions from Industrial Processes and Product Use (IPPU) were 0.13 $MtCO_2e$ in 2022. The chemical industries represent the sole source of emissions from industrial processes and product use from 2010 to 2022, and on average, accounts for only 3% of total aggregate GHG emissions. Although Brunei's chemical industry includes both methanol and ammonia production, only data from methanol has been included in the inventory for this period. There remains a significant gap in estimating emissions from this sector due to limited data. Additionally, emissions from other industries

were not estimated for the same reason. Currently, the GHG emissions reported in the Industrial Processes and Product Use (IPPU) sector include data from only one plant (Brunei Methanol Company).

For the Agriculture, Forestry, and Other Land Use (AFOLU) sector, GHG emissions in agriculture were estimated from livestock, liming, urea application, as well as direct and indirect N_2O emissions from managed soils and manure management. Globally, this sector significantly contributes to total GHG emissions, however, in Brunei, agriculture is the smallest source of anthropogenic GHG emissions, accounting for, on average, less than 1% of total national emissions, equivalent to 0.04 $MtCO_2e$. In 2022, emissions from forestland were estimated at 0.4 $MtCO_2e$, primarily due to carbon loss from human activities such as deforestation and forest fires.

The waste sector consists of emissions from solid waste disposal as well as wastewater treatment and discharge which is further categorized into domestic and industrial. The waste sector constitutes around 1.6% of total national GHG emissions. In Brunei, 85% of solid waste goes directly to Brunei's landfill, 15% are recycled. These landfills are the main source of CH_4 generation and emissions through anaerobic decomposition of solid waste. Domestic and commercial wastewater are either treated by centralized sewage treatment facility or septic tanks.

The GHG inventory presented in this report was prepared in accordance with the TACCC principles and the MPGs. Despite adherence to these standards, various constraints, data gaps, and other challenges were encountered during the preparation of the National GHG Inventory. Among these challenges are unreported GHG emissions due to limited data availability in certain sectors, particularly in Agriculture, Forestry, and Other Land Use (AFOLU) and Industrial Processes and Product Use (IPPU), which have contributed to gaps in the inventory.

Many areas still require significant improvement, especially in transitioning to higher-tier methodologies for key categories within sectors such as energy, IPPU, and waste. The issue of unreported emissions, particularly in sectors where data collection is challenging, will also be a focus of future improvements. These areas are planned to be addressed during future inventory cycles and within the framework of the next reporting phase. To address these issues, a list of improvement plans has been identified and outlined in this document.

Progress of Nationally Determined Contribution (NDC)

This chapter provides an overview of Brunei Darussalam's actions aimed at meeting its climate targets. On December 31, 2020, Brunei submitted its first Nationally Determined Contribution (NDC) under the Paris Agreement, committing to a 20% reduction in greenhouse gas (GHG) emissions by 2030 compared to Business-As-Usual (BAU) levels. This commitment is made in the context of global climate actions, particularly those of developed countries, reflecting principles of equity and differentiated responsibilities.

As a developing nation, Brunei aims to balance infrastructure and energy needs with GHG mitigation through ten strategic approaches outlined in its Brunei National Climate Change Policy (BNCCP). The BNCCP sets forth six primary mitigation approaches: targeting reductions in industrial emissions, increasing forest cover, minimizing emissions from land transportation, boosting the share of renewable energy (RE), reducing emissions from power generation, and reducing emissions from waste. In addition, it includes four cross-cutting strategies: exploring carbon pricing mechanisms, enhancing adaptation and resilience to climate impacts, maintaining a comprehensive carbon inventory for effective tracking and policymaking, and fostering climate awareness and education among the public. These strategies are all aimed at achieving sustainable development while effectively addressing the challenges posed by climate change.

Brunei Darussalam is also currently updating its BNCCP to address evolving climate challenges and align with new international and national strategies. Additionally, Brunei Darussalam is developing its long-term projections for major emitting sectors and identifying interventions towards achieving net-zero emissions by 2050.

Adaptation and Resilience

The chapter highlights the significant impacts of climate change on Brunei Darussalam, including rising temperatures, increased rainfall and flooding, forest fires, droughts and threats to biodiversity. To effectively address the economic and social challenges posed by climate change, Brunei Darussalam must prioritize robust adaptation measures. These measures are vital for mitigating immediate impacts and preparing for future climate challenges, particularly in key sectors such as marine protection, biodiversity and environment, water resources, agriculture and food security, infrastructure and urban resilience, and health.

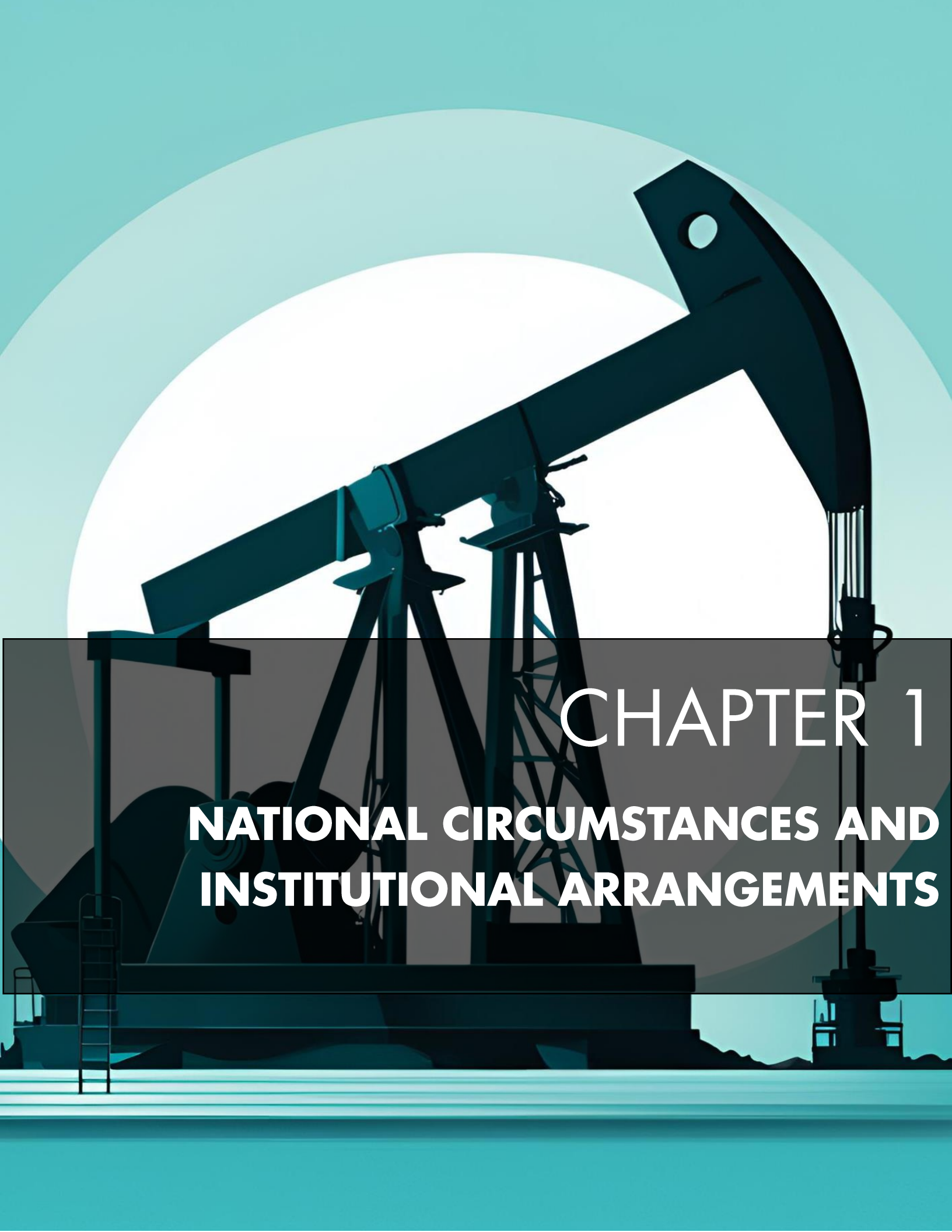
The chapter also highlights Brunei Darussalam's current efforts in developing a National Adaptation Plan (NAP) and on-going work to assess the nation's vulnerabilities to climate change, prioritize adaptation strategies, and outline specific actions and resources needed to enhance resilience, while ensuring that the plan remains flexible and responsive to emerging climate data and changing conditions.

Financial, Technical and Potential Constraints and Needs

Brunei Darussalam faces several constraints, gaps, and needs in undertaking climate change-related actions. One of the most significant challenges is the country's inadequate capacity, encompassing technical expertise, financial resources, and overall capability. This inadequacy hampers effective climate action. Overcoming these challenges will require addressing the serious institutional, financial, and technical constraints and gaps that currently impede progress. With adequate support,

Brunei has the potential to build resilience to climate change and explore viable low-emission development pathways, ensuring a more sustainable future.

Brunei has received various forms of support for the implementation of climate change-related actions and the preparation of its Biennial Transparency Report (BTR). This support includes technical assistance and capacity-building initiatives provided by several organizations, as detailed in this chapter. These contributions have been instrumental in enabling Brunei to make strides in its climate action efforts, despite the challenges it faces.



CHAPTER 1

NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1.0 NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1.1 Introduction

This report presents Brunei Darussalam's (Brunei) first BTR to the UNFCCC. The Convention was adopted by Parties at the World Summit on Sustainable Development in 1992 and entered into force in 1994. Its objective is to stabilize GHG concentrations in the atmosphere to levels that would prevent dangerous anthropogenic interference with the climate system. As part of the global response to climate change, Brunei acceded to the UNFCCC in 2007 and ratified the Kyoto Protocol on 20 August 2009. The Kyoto Protocol is an international treaty which extends the 1992 UNFCCC and commits state parties to reduce GHG emissions, based on the scientific consensus that global warming is occurring and it is extremely likely that human-made carbon dioxide (CO_2) emissions have predominantly caused it.

The Government of Brunei submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC in 2015 and ratified the Paris Agreement on 21 September 2016. The Paris Agreement seeks to hold the increase in the global average temperature to well below 2 °C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above preindustrial levels.

Brunei further submitted its Nationally Determined Contribution (NDC) to the UNFCCC on 30 December 2020 committing itself to a reduction in greenhouse gas (GHG) emissions by 20% relative to Business-As-Usual levels in 2030.

Brunei is expected to demonstrate progress towards this goal by providing periodical updates as well as formulate an updated NDC at least every five years.

Under the Enhanced Transparency Framework (ETF), Parties to the Paris Agreement are required to submit BTR every two years, with the first submission due by 31 December 2024. According to the modalities, procedures and guidelines (MPGs) for the ETF (annex to decision 18/CMA.1), BTR includes information on national inventory reports (NIR), progress towards Nationally Determined Contributions (NDCs), policies and measures, climate change impacts and adaptation, levels of financial, technology development and transfer and capacity-building support, capacity-building needs and areas of improvement.

The report provides the status of Brunei's GHG emissions and removals by sinks, as well as on the actions to reduce emissions or enhance sinks, and support needed and received to implement the said actions.

This section provides an update of the changing national circumstances that are relevant to climate change in Brunei. It also gives the country's socio-economic development perspectives and priorities including policy, legal framework and institutional arrangement relevant to climate change.

1.2 Geographical and Physical Context

The land surface is developed on bedrock of tertiary age, comprising of sandstones, shales and clay. The terrain in the western part of the country is hilly lowland, which rises in the hinterland to about 300 metres (m). To the east, the wide coastal plain reaches up to a height point of 1,850 m above sea level at Bukit Pagon in the Temburong District. Brunei has a coastline of about 161 kilometre (km). The beaches facing the South China Sea are largely sandy and a mixture of sand and mangrove in areas away from the sea.

Brunei's capital, Bandar Seri Begawan, covers an area of 100.36 km sq^2 and is situated in the Brunei-Muara District, the most populous of the country's four districts and serves as for government and businesses. Other significant towns include Kuala Belait, Pekan Tutong, and Bangar, which are the administrative centres for the Belait, Tutong, and Temburong Districts, respectively. Additionally, Seria, another town in the Belait District, holds substantial importance as it has been the centre of Brunei's oil and gas industry since oil was first discovered there in 1929.

Figure 1.1 Map of Brunei Darussalam



Source: Nations Online Project NOP (2022)

1.3 Climate

Brunei has an equatorial climate characterized by a uniform high temperature, high humidity and heavy rainfall. Weather is influenced by the monsoon systems known as northeast monsoon and southwest monsoon. The northeast monsoon season occurs from December to March and southwest monsoon season occurs from June to September. The two seasons are separated by two transitional periods known as inter-monsoon periods of which the first occurs in April and May, while the second period occurs in October and November.

The country generally experiences wet conditions throughout the year with average annual rainfall of 3,000 millimetres (mm) (2010-2014). Being in an equatorial climate country, the temperature is hot throughout the year. Temperatures range from 23 to 32 degree Celsius (°C), while rainfall varies from 2,500 mm annually on the coast to 7,500 mm in the interior. There is no distinct wet season. However, Brunei is already experiencing evident changes in climate pattern. The country's mean temperature has already increased by 1.25 °C since 1970 with the warmest year recorded in 2019. Brunei also recorded a new highest daily rainfall in 2019 and highest cases for forest fire in 2019. At present, biodiversity loss is estimated to be around 40%.

Table 1.1 Brunei's 2022 Weather Profile

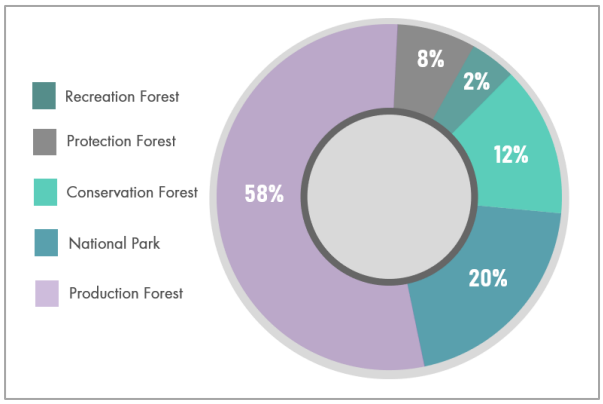
Mean daily maximum temperature	32.0°C
Mean daily minimum temperature	24.1°C
Mean daily maximum relative humidity	91%
Mean daily minimum relative humidity	60%
Total rainfall	3,733.2 mm
Number of rainy days	241
Mean daily bright sunshine hours	6.4 hours

Source: Brunei Darussalam Meteorological Department.

1.4 Forest and Biodiversity

Forests play an invaluable role to mitigating climate change and supporting society as they act as both a carbon sink and a home for biodiversity. At present, the total forest area in Brunei is recorded at 380,000 hectares (ha)[1]. Of these, 263,000 hectares are primary forests, 112,000 ha are other naturally regenerated forests and around 5,000 ha are planted forests. The national forest reserves constitute 41% of the country's total land area

Figure 1.2 Forest Classification by Share (%)

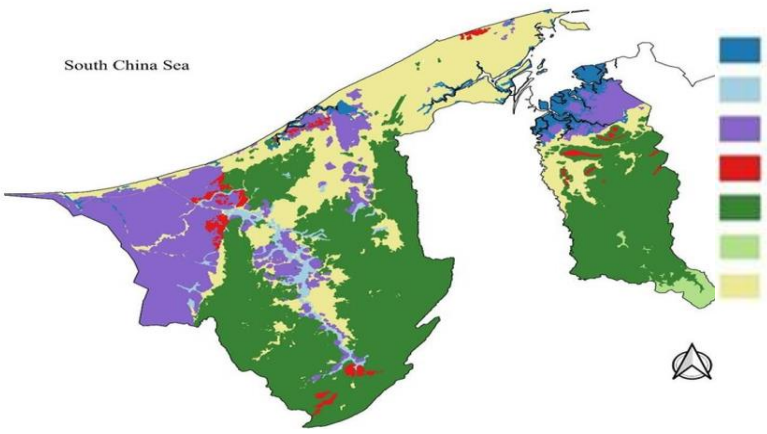


[1] Brunei's forest inventory is expected to be updated by Mid-2025.

and are protected by law. Brunei's forest reserves are classified into five categories: Protection Forest, Production Forest, Recreational Forest, Conservation Forest, and National Park *(Figure 1.2)*.

In 2017, the Government issued a no-logging policy in pristine peatland areas. Additionally, a reduced-cut policy was introduced, limiting annual timber extraction to 100,000 cubic meters (m^3) in production forests. Harvesting of domestic timber supply is only allowed in production forests. The Forestry Department strictly supervises timber harvesting in designated logging compartments to ensure that activities adhere to the Brunei Selective Felling System (BSFS), which follows a Sustainable Forest Management approach. These policies have increased forest conservation areas, and Brunei has set a target to increase its forest reserves to 55% of the total land area. The country has seven distinguishable forest types *(Figure 1.3)*: Mangrove Forests, Beach Forests, Freshwater Swamp Forests, Peat Swamp Forests, Heath '*Kerangas*' Forests, Mixed Dipterocarp Forests and Montane Forests. The landscapes of these forests are very evident based on their floral composition, forest formations, soil conditions and micro-environment.

Figure 1.3 Brunei's Main Forest Types by Area (ha)



Forest Type	Area (HA)
Mangrove	18,418
Freshwater Swamp	12,668
Peat Swamp	90,884
Kerangas	3,455
Mixed Dipterocarp	192,575
Montane	7,196
Non-Forest Area	54,804

Figures 1.2 and 1.3 Source: Forestry Department, Ministry of Primary Resources and Tourism

Despite its relatively small land area, Brunei Darussalam harbours remarkable floral richness. At present, the country has documented a total of 204 families of angiosperms and gymnosperms, representing 1,088 genera and 5,221 species. A total of 71 species identified are known to be endemic to the country. The country's faunal diversity is equally impressive, with 186 species of mammals, 534 species of birds, 89 species of amphibians, 132 species of reptiles and 260 species of arachnids. This diverse array of flora and fauna underscores Brunei Darussalam's ecological significance and its vital role in preserving regional biodiversity.

The country is also endowed with rich marine biodiversity, which can be located in the limited marine area covering a rectangular strip of about 41,188 km sq^2 from the coast to the end of the 200 nautical mile Exclusive Economic Zone (EEZ) as shown in Figure 1.4. With the Fisheries Order 2009,

a Marine Protected Area Network was established as one of the measures to protect and conserve the biodiversity of the coral reef habitat and its marine plants and animals. Currently, Brunei has 6 marine protected areas *(Figure 1.5)* covering around 182.53 km sq^2. The coral reef along the coastline comprises 45 km sq^2 and is most notable for its unusual co-occurrence of a highly distinctive suite of hard and soft corals and gorgonian sea fans, with more than 50% live coral cover. These are host to a surprisingly rich coral fauna, with a total of 400 reef-building coral species.

Figure 1.4 Brunei's EEZ and Fishing Zonation

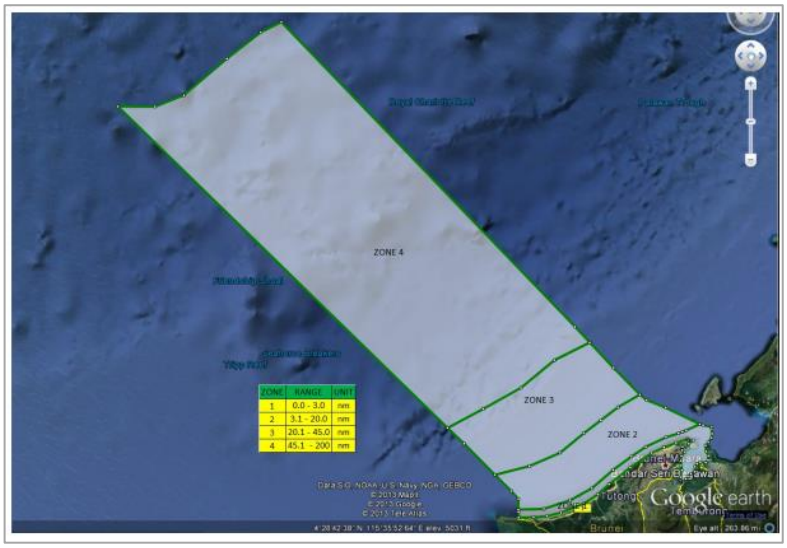
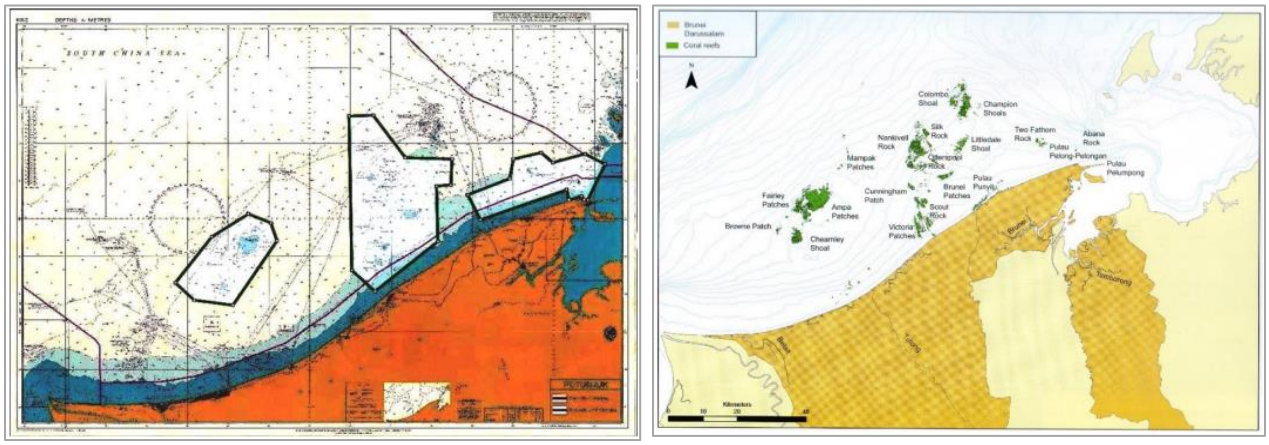


Figure 1.5 Brunei's Marine Protected Areas and Coral Reefs



Figures 1.4 and 1.5 Source: Forestry Department, Ministry of Primary Resources and Tourism

The Brunei Darussalam Long Term Development Plan – *Wawasan 2035*, among others, stresses the development of forest resources, conservation and protection of the natural forest and environment and the development of ecological tourism industry as the main focus of the forestry sector. In addition, Brunei's accession to the Convention of Biological Diversity (CBD) on 27 July 2008 provides the country an international conservation platform. It further strengthens the ongoing conservation efforts and strategies on sustainable uses of biological and natural resources in accordance with national and international standards and obligation.

1.5 Water Resources

Water supply in Brunei is solely dependent on 4 main river systems: Belait River, Tutong River and Brunei River in the west and Temburong River in the east. The largest among the four is the Belait River. These river systems cover a catchments area of around 4,260 km sq[2] which represent around 75% of the country's land area. The Belait and Tutong rivers drain into the South China Sea while the Brunei and Temburong rivers discharge into Brunei Estuary towards Brunei Bay. In the supply of potable water, the Department of Water Services, Public Works Department had established 4 water supply dams, and these are: Mengkubau Dam in Mentiri, Tasek Dam in Bandar Seri Begawan, Benutan Dam in Tutong, and Kargu Dam in Labi. Another dam which is currently under construction is the Ulu Tutong Dam in Tutong District.

1.6 Population

Brunei Darussalam's population increased from 386,800 in 2010 to 450,500 in 2023, reflecting an average annual growth rate of approximately 1%. This estimate includes all people residing in Brunei Darussalam. Malay, which also included Brunei Indigenous communities of Malay, Kedayan, Tutong, Belait, Bisaya, Dusun and Murut, constitutes the major population group numbering at 332,100, Chinese at 43,400 persons and other races not specified at 75,000.

The official language is Malay, but English is widely understood and used in business. Other languages spoken are several Chinese dialects, Iban, and a number of native dialects. Islam is the official religion, but religious freedom is guaranteed under the Constitution.

1.7 Economy

1.7.1 Gross Domestic Product

Brunei's economy has traditionally relied heavily on its natural resources, especially in the oil and gas sector. However, in recent years, in line with the country's diversification efforts, the non-oil and gas sector contributed 53% to GDP in 2023, surpassing the oil and gas sector, which contributed 47%.

From 2011 to 2020, real GDP growth was modest, averaging only 0.3% *(Table 1.2)*. In 2023, the economy experienced positive growth by 1.4%, primarily driven by a sustained increase in the Non-Oil and Gas Sector, supported by positive growth recorded in several subsectors such as Finance, Transport and Logistics, Construction and Communication. On the contrary, the Oil and Gas Sector experienced a contraction by 2.0% owing to a decline in the production of crude oil, natural gas and liquified natural gas (LNG) production.

The trend in real GDP growth is also indicative of the consequence of production of oil and gas. As shown in *Figure 1.6*, the positive economic growth of the economy is heavily dependent on the level of oil and gas production, except when other sectors, such as the downstream sector, experience

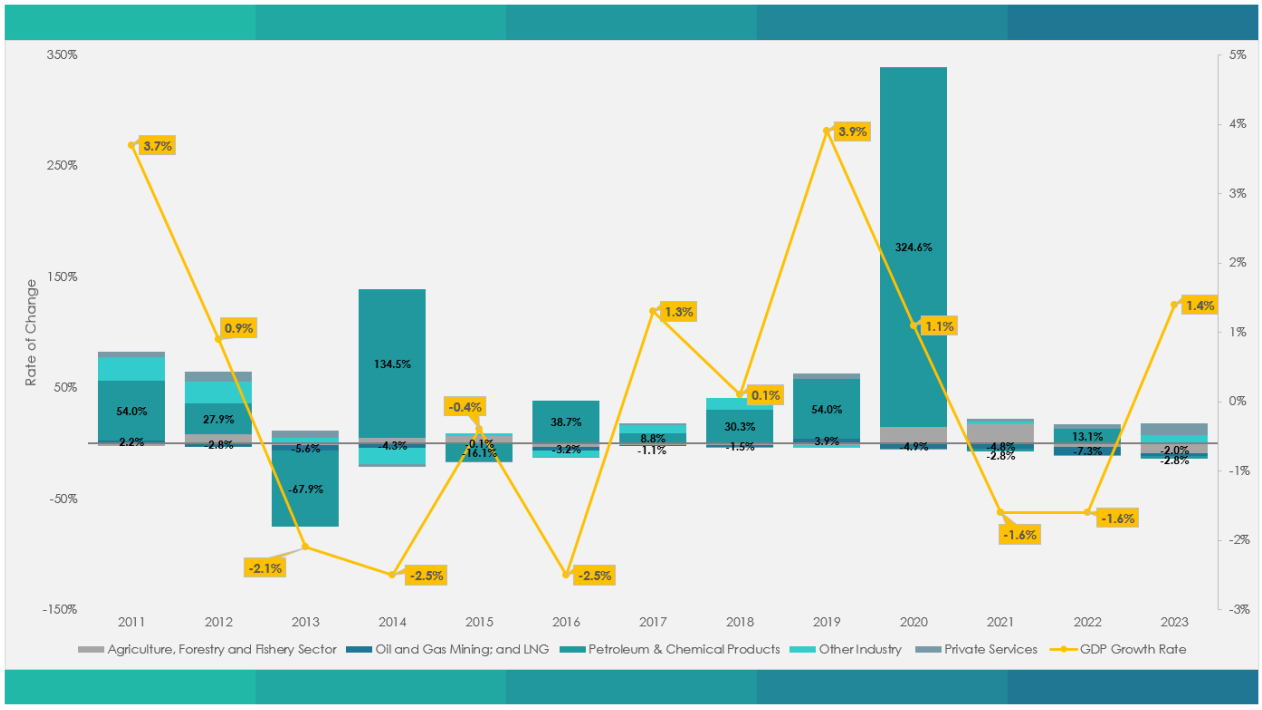
significant expansion. The effects of the dependence on oil and gas are not only limited to the structure of the economy, but also government finance. The Government relies primarily on revenue from taxes, incomes, and royalties from oil and gas companies, as shown in Table 1.2. Over the recent years, the country has experienced budget deficit except in 2018/1019 and 2022/2023, which were driven by high oil and gas prices during these periods.

Table 1.2 Key Economic Parameters, 2011-2023 (index 2010 =100)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
GDP AT CONSTANT PRICE													
Gross Domestic Product (GDP) (BND Billion)	19.4	19.6	19.2	18.7	18.6	18.1	18.4	18.4	19.1	19.3	19.0	18.7	19.0
GDP Growth Rate (%)	3.7	0.9	-2.1	-2.5	-0.4	-2.5	1.3	0.1	3.9	1.1	-1.6	-1.6	1.4
GDP Per Capita (BND)	49,291	49,076	47,486	45,806	45,095	43,466	43,099	42,114	42,347	43,719	43,129	41,981	42,090
GDP Per Capita Growth Rate (%)	2.0	-0.4	-3.2	-3.5	-1.6	-3.6	-0.8	-2.3	0.6	3.2	-1.3	-2.7	0.3
GDP GROWTH AT CONSTANT PRICE													
Agriculture, Forestry and Fishery	-2.6%	8.1%	-1.2%	4.7%	6.4%	-3.6%	-1.6%	-1.6%	-1.4%	14.4%	16.9%	-3.3%	-9.0%
Oil and Gas Mining; and LNG	2.2%	-2.8%	-5.6%	-4.3%	-0.1%	-3.2%	-1.1%	-1.5%	3.9%	-4.9%	-4.8%	-7.3%	-2.0%
Petroleum & Chemical Products	54.0%	27.9%	-67.9%	134.5%	-16.1%	38.7%	8.8%	30.3%	54.0%	324.6%	-2.8%	13.1%	-2.8%
Other Industry	21.7%	19.7%	4.8%	-14.8%	2.8%	-5.6%	7.7%	10.7%	-2.8%	-0.2%	2.5%	-0.7%	7.2%
Private Services	5.0%	8.8%	6.7%	-1.8%	-0.1%	-0.3%	1.9%	-0.3%	5.0%	-0.2%	3.0%	3.9%	11.0%
Inflation (Consumer Price Index)	0.10	0.10	0.40	-0.20	-0.42	-0.28	-1.26	1.03	-0.39	1.94	1.74	3.68	0.36
Current Account Balance (BND Billion)	8.1	7.1	4.7	6.6	2.9	2.0	2.7	1.3	1.2	0.7	2.1	4.5	2.6
Fiscal Balance (% of GDP)	25.6	15.8	13.0	3.6	-14.5	-21.7	-10.4	-3.6	-3.7	-15.8	-8.2	2.1	-11.1
Import (BND Billion)	4.5	4.5	4.5	4.6	4.4	3.7	4.3	5.6	7.0	7.3	9.7	12.7	10.0
Export (BND Billion)	15.7	16.2	14.3	13.4	8.7	6.8	7.7	8.9	9.9	9.1	14.1	19.6	14.8

Source: Department of Economic Planning and Statistics.

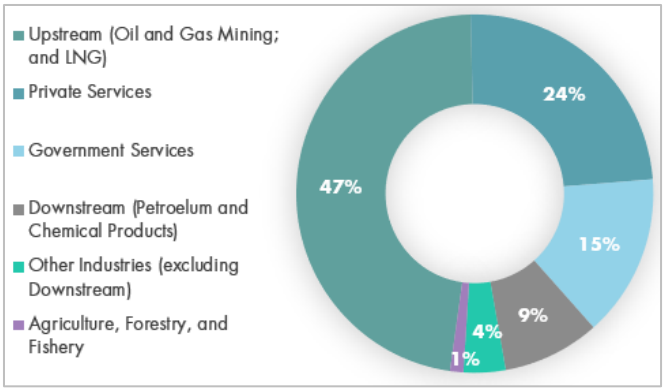
Figure 1.6 Real GDP and Sectoral Composition Annual Rate of Growth, 2011-2023



Source: Department of Economic Planning and Statistics.

Despite importing most consumer goods and food, Brunei maintains a positive trade balance due to its large oil and LNG exports, substantial foreign reserves, and minimal external debt, which help mitigate overall economic risks. Additionally, Brunei's political stability, low inflation rates, high standard of living, and affluent population create a conducive environment for sustained long-term economic growth.

Figure 1.7 Sectoral Share to GDP (%)



In its efforts to diversify away from oil and gas and promote sustainable economic growth, Brunei has implemented several long-term strategies. The Vision 2035 Strategy[2] focuses on diversifying the economy, enhancing private sector growth, and fostering investments in non-oil sectors. The Ministry of Finance and Economy (MOFE), in its 2021 Economic Blueprint[3] for Brunei, outlined five key areas for economic diversification: downstream oil and gas, food, tourism, information and communications technology (ICT), and services, indicating a strategic shift towards reducing economic dependency on hydrocarbons.

Nevertheless, diversification poses significant challenges, largely due to Brunei's small size. Foreign direct investment (FDI) continues to be heavily influenced by the petrochemical sector which remains closely tied to global oil price fluctuations. Additionally, in 2023, Brunei's non-oil and gas sector which makes up 53% of GDP, is predominantly concentrated in the private services sector at 24%, followed by government services at 15%, other industries (including downstream) at 13%, with the agricultural sector being negligible with the 1%.

1.7.2 Oil and Gas

In 2023, the oil and gas industry accounted for 47% of GDP, and about 40% of the nation's exports. The primary exports from this sector are crude oil, petroleum products, and LNG. While there has been progress in diversifying the economy away from oil and gas-with the share of activity outside of oil and gas extraction increasing steadily from 36% in 2010 to 53% in 2023 (Figure 1.8) – the wealth generated from this sector continues to play a crucial role in developing other areas of the economy. Additionally, Brunei's major downstream industries remain heavily tied to oil and gas. A significant portion of the country's economic activities also benefits from substantial subsidies funded by revenues from the oil and gas industry.

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[2] Brunei's long-term strategic plan known as *Wawasan Brunei 2035* aspires for Brunei Darussalam, by the year 2035, to be known worldwide as a country with: An Educated, Highly-Skilled and Accomplished People; a High Quality of Life; and a Dynamic and Sustainable Economy.

[3] Brunei Darussalam's Economic Blueprint: Towards a Dynamic and Sustainable Economy to plan the country's economic direction towards achieving the Third Goal of Brunei Vision 2035 which is a Dynamic and Sustainable Economy.

Figure 1.8 Oil and Gas Sector's Contribution to GDP (2010 and 2023 Comparison)

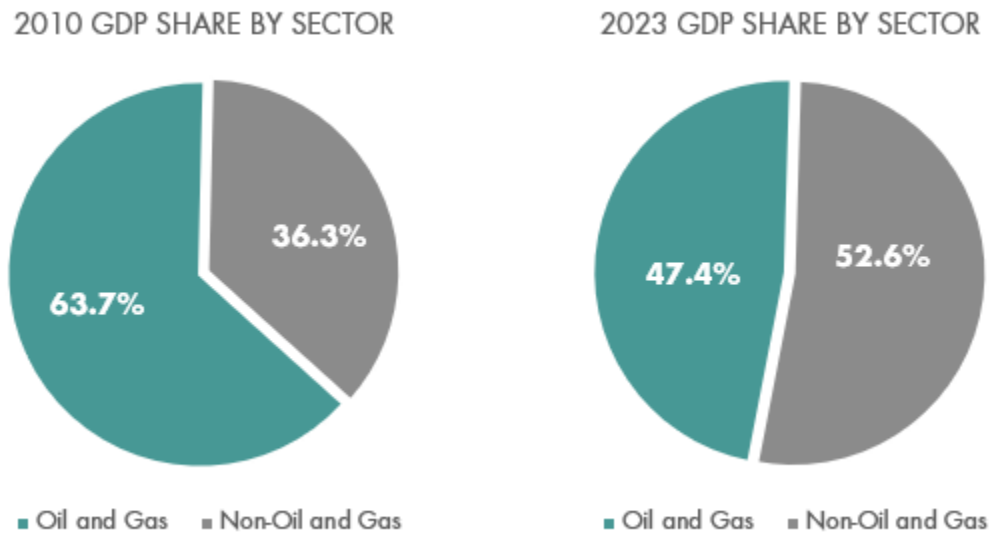


Table 1.3 Oil and Gas Production and Export

		2010	2022	2023
Oil	Production (Kbbl/day)	170	91.9	89
	Export (Kbbl/day)	162	55.2	57
Gas	Production (Kboe/day)	239	196.1	196
	LNG Export (MMbtu/day)	945,801	664,602	649,751

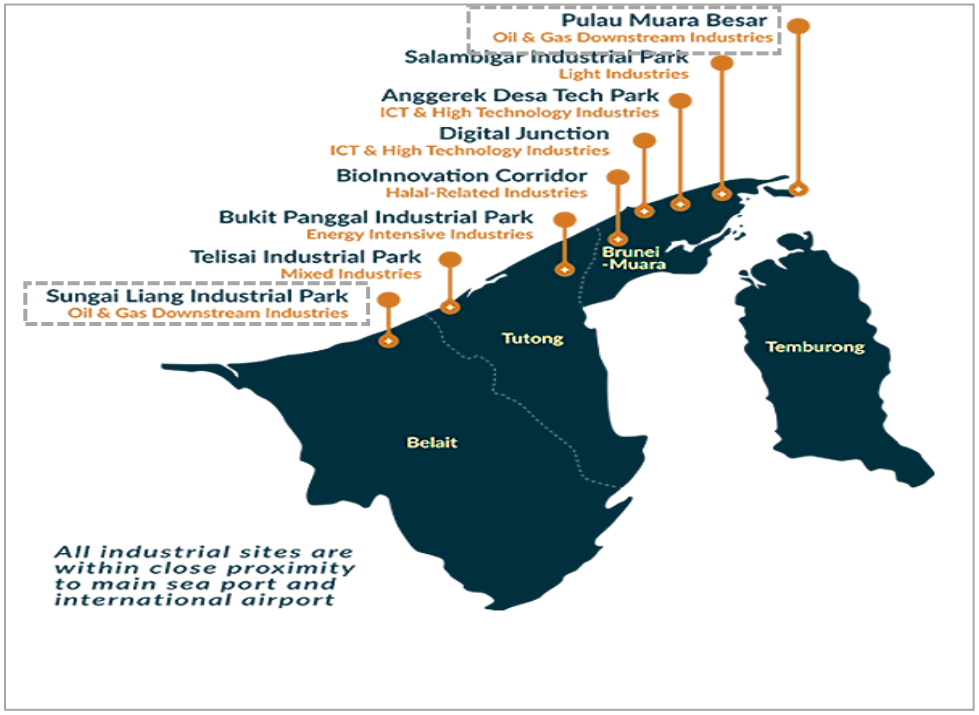
Source for Figure 1.7, Figure 1.8 and Table 1.3: Department of Economic Planning and Statistics.

Major trading partners of Brunei are mainly linked to its oil and gas exports. These include Japan, South Korea, the Association of Southeast Asian Nations (ASEAN), Australia and China. Revenue from oil and gas is crucial for funding Brunei's national development programs. With the exception of its diversification efforts in recent years, the country has continuously enhanced its upstream activities to ensure sustainable growth in the oil and gas sector and to maintain energy security. This includes considering the exploration of untapped deep-water fields. Additionally, rejuvenating existing upstream assets is a priority to improve recovery rates and maximize production from these fields. Furthermore, Brunei is focused on expanding its downstream energy industries, aiming to maximize the economic benefits derived from its upstream production and assets.

1.7.3 Downstream

Brunei has 8 industrial clusters *(Figure 1.9)* including 2 that currently houses energy-intensive heavy industries; Pulau Muara Besar and Sungai Liang Industrial Park (SPARK).

Figure 1.9 Industrial Clusters in Brunei



Source: Invest Brunei Darussalam

Pulau Muara Besar (PMB) hosts Hengyi Industries' Refinery and Petrochemical Plant, a cornerstone of Brunei's industrial sector, which began with its Phase 1 commercial operations in 2019. This phase brought an annual production capacity of 8 million tonnes of refined and petrochemical products, including paraxylene, benzene, and liquified petroleum gas, among others. By 2027, Hengyi anticipates launching Phase 2, increasing refining capacity by an additional 12 million tonnes per year. This expansion will optimise the use of petroleum resources through advanced processing techniques and more efficient crude utilisation, supporting Brunei Darussalam's downstream sector while prioritising resource efficiency and reducing waste.

In October 2024, Hengyi launched its Project SINAR, a significant initiative aligned with Brunei's renewable energy targets and climate change commitments. This project supports the nation's goal of achieving a 30% renewable energy share in installed capacity mix. Project SINAR also contributes to Brunei Climate Change Secretariat's strategies to increase renewable energy adoption and reduce carbon emissions. The solar energy generated will power Hengyi's Petrochemical Refinery and can also supply Brunei's national power grid as needed, fostering national energy sustainability.

The SPARK houses the Brunei Methanol Company (BMC) and Brunei Fertilizer Industries (BFI). BMC has a production capacity of up to 850,000 metric tonnes of methanol per year, while the BFI plant,

which began operations in mid-2021, has a production capacity of 1,365,000 metric tonnes of urea per year.

1.7.4 Manufacturing

Brunei's manufacturing sector is mostly concentrated at the Salambigar Industrial Park *(Figure 1.9*). The country's main industries include cement production, garment manufacturing, production of pre-cast concrete structures, mineral water, canned food, dairy products, as well as publishing and printing. At present, the manufacturing industries represent 1.3% of the country's GDP.

1.7.5 Financial Services

This sector, which includes banking, insurance, real estate and other financial and business services, plays a substantial role in the nation's economy contributing to 11.6% of its GDP in 2023. In lieu of a central bank, the Financial Institution Division and the Brunei Currency Board, both part of the MOFE, are responsible for most central banking services. The Brunei Currency Board issues the Brunei dollar. Several Islamic commercial banks, a number of foreign banks, and a few offshore banks all operate in the country.

1.8 Energy

Oil and natural gas remain Brunei's primary sources of total primary energy supply. In 2022, Brunei's primary energy supply was recorded at 12.66 million tonnes of oil equivalent (Mtoe) while the final consumption was recorded at 1.44 Mtoe *(Table 1.4)*. As depicted in Table 1.4, Brunei's energy mix comprises of both fossil fuels (coal, oil, natural gas) and RE sources (solar), however, this is very minimal. The country's energy supply is sourced from domestic resource exploitation and imports, particularly crude oil.

Table 1.4 Energy Supply and Consumption, 2022 (Mtoe)

Supply and Consumption	Oil	Petroleum Products	Natural Gas	Electricity	Coal	Solar	Total
Primary Energy Supplies							
Indigenous production	4.85		8.35	-	-	0.00013	13.20
Net imports and others	4.96	-8.04	-5.50	-	0.72	-	0.16
Total primary energy supply	9.81	-8.04	2.85	-	0.72	0.00013	13.36
Final Energy Consumption							
Industry	-	0.13	-	0.15	0.72	-	0.98
Transport	-	0.40	-	-	-	-	0.40
Others	-	0.02	0.02	0.27	-	-	0.31
Non-energy	-	0.00	0.45	-	-	-	0.45
Total final energy consumption	-	0.55	0.47	0.42	0.72	-	1.44

Source: Economic Research Institute for ASEAN and East Asia (ERIA)

1.8.1 Power

As of 2022, Brunei's electricity demand stands at 671.19 MW, and grows at average annual rate of 1% mainly from the residential sector. With and overall growth rate of approximately 3% across all sectors including government, residential and commercial sector.

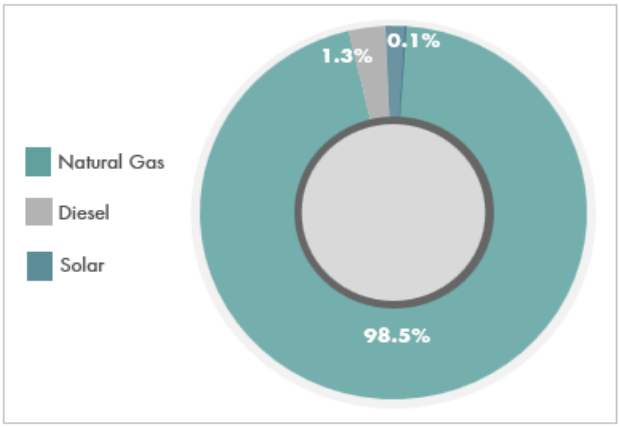
Table 1.5 Electricity Production and Supply, 2010-2022

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Generation Capacity (MW)	741.90	745.90	768.30	774.70	777.00	777.70	777.70	856.70	863.70	917.20	917.20	899.20	899.20
Peak Demand (MW)	581.51	573.06	595.29	600.74	642.59	642.19	656.54	627.19	655.81	691.29	676.83	686.66	671.19
Production (GWh)	3,792.23	3,722.98	3,928.67	3,961.81	4,054.60	4,198.79	4,269.85	4,157.35	4,293.57	4,449.48	4,508.60	4,450.77	4,389.52
Percentage	5.01	-1.83	5.52	0.84	2.34	3.56	1.69	-2.63	3.28	3.63	1.33	-1.28	-1.38
Consumption (GWh)	3,327.57	3,389.44	3,608.77	3,553.04	3,765.52	3,787.91	3,647.65	3,539.27	3,684.27	3,828.49	3,936.90	3,950.28	3,697.82
Residential	1,181.43	1,201.70	1,338.27	1,338.55	1,338.88	1,368.40	1,385.72	1,280.98	1,306.95	1,328.66	1,402.51	1,420.17	1,407.64
Commercial	831.45	877.97	967.87	970.71	1,015.50	971.10	905.66	896.12	985.02	1,082.90	1,091.05	1,210.92	1,026.37
Government	705.81	733.87	659.56	647.59	767.54	862.98	803.11	801.32	802.40	785.39	882.02	775.34	738.94
Others	608.88	575.90	643.08	596.18	643.61	585.43	553.17	560.85	589.90	631.53	561.33	543.85	524.88
Coverage in Electricity Supply (Percentage)	99.7	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9

Source: Department of Economic Planning and Statistics, Ministry of Finance and Economy.

On the supply side, Brunei's electricity sector is primarily driven by natural gas, with diesel being used to power the electric system in the Temburong district. Solar photovoltaic (PV) contributed less than 1% of the total share of generation in 2022. Brunei solar power are sourced from the Tenaga Suria Brunei (TSB) on-grid 1.2MW solar PV plant operated by DES (*Figure* 1.10). Additionally, there are two off-grid electric power systems for industrial captive use: a 254 MW coal power plant supplying electricity to Hengyi Industries' petrochemical and refinery project, as Brunei Shell Petroleum (BSP) and Brunei Liquified Natural Gas (BLNG) 100MW co-generation gas combustion turbines for oil and gas operations.

Figure 1.10 Total Installed Capacity by % Share

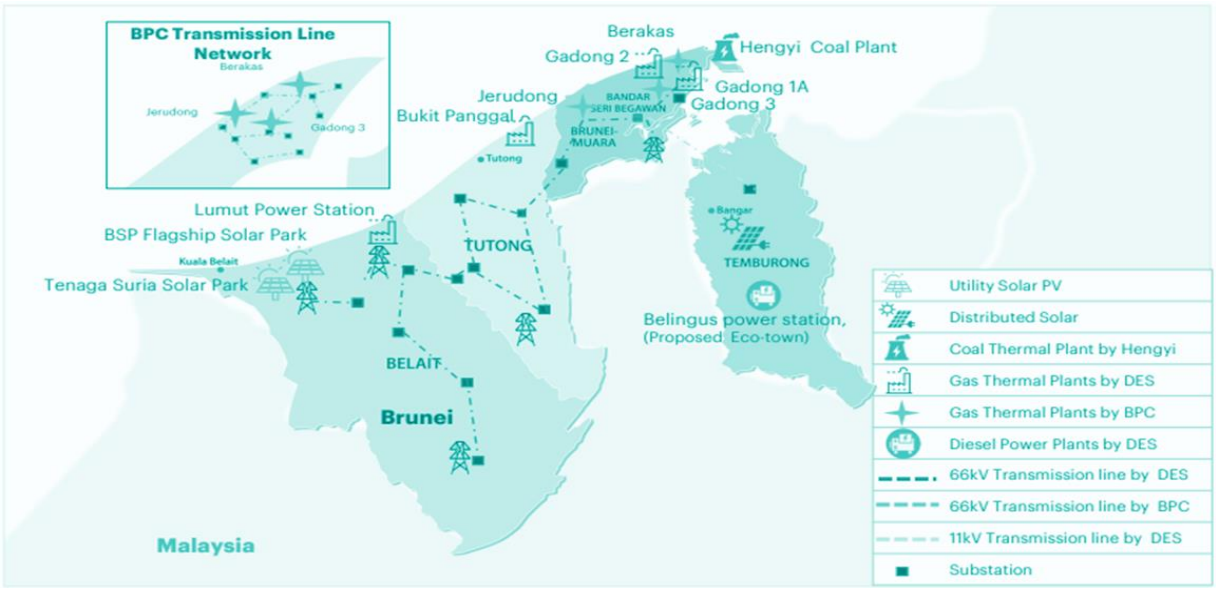


Source: Department of Economic Planning and Statistics.

Brunei's grid-connected capacity currently consists of seven natural gas power plants and one solar power plant, with a total installed capacity of 920 MW. Power sector in Brunei is primarily operated by the Department of Electrical Services (DES) and the Berakas Power Company (BPC). The DES power system covers the entire country and includes four natural gas-based power plants (Gadong 1A and 2, Sultan Omar 'Ali Saifuddien Sa'adul Khairi Waddien Lumut Power Station, and Bukit Panggal Power Station) and a diesel power plant (Belingus) located in the Temburong District, with a total generation capacity of approximately 600 MW. However, construction of a new power transmission line connecting Brunei-Muara to Temburong District via Sultan Haji Omar 'Ali Saifuddien Bridge is currently on-going and is expected to be completed by 2024. Once completed,

Belingus will be decommissioned. BPC, on the other hand, operates three natural gas-based power plants (Berakas, Jerudong, and Gadong) with an installed capacity of 280 MW. Brunei's current electrification rate is at 99.9%.

Figure 1.11 Brunei's Transmission Network



Source: ERIA (Economic Research Institute for ASEAN and East Asia)

1.8.1.1 Electricity Tariff

Electricity tariff rates in Brunei are notably lower compared to other Southeast Asian countries. DES has implemented a 4-tier tariff structure for the residential sector. This structure, however, differs from the rates applied to the government and commercial sectors. Refer table 1.6 to for a comparison of tariff rates across each sector.

Table 1.6 Brunei Electricity Tariff Structure

Sector		
Residential	Energy Usage (kWh)	Price (BN $)
	0001 to 0600	0.01
	0601 to 2000	0.08
	2001 to 4000	0.10
	4001 and above	0.12
	Energy Usage (Units)	Price (BN $)
Commercial	First 10 Units	0.20
	Second 100 Units	0.07
	Third 100 Units	0.06
	Remaining Units (if applicable)	0.05
Government	$0.10 fixed tariff	

Source: Department of Electrical Services, Prime Minister's Office.

1.8.2 Energy Policies

Brunei has the lowest electricity rate and the highest energy intensity of all ASEAN countries. As such, Brunei aims to reduce energy intensity by 45% by 2035 from the baseline year of 2005, in line with its regional commitment to the Asia-Pacific Economic Cooperation (APEC). To ensure the 45% reduction target is met, Brunei has identified a number of action plans for the generation, residential, industry, government and transport sector between 2010-2030.

On the consumption side, efforts to achieve Energy Efficiency and Conservation (EEC) targets include power efficiency improvement, implementation of standards and labelling for electrical appliances, deployment of electric vehicles, expansion of EEC building guidelines, and use of Light-Emitting Diode (LED) lighting systems for streetlights, amongst others. In terms of transportation, the Government and the industry are working hard to increase the number of electric vehicles and hybrids into the market.

On the supply side, the DES and BPC play major roles in improving power stations' efficiency, including by using combined-cycle turbines and co-generation power plants, whilst phasing out single-cycle power stations and carbon-intensive diesel-powered plants. In terms of RE Brunei's current targets are to increase the share of RE, particularly solar PV, in the power generation mix to at least 30% of the total installed capacity by 2035. The Government plans to introduce a more robust RE policy and regulatory frameworks that will stimulate public and private sector investment in developing and deploying RE.

1.9 Transport

Brunei's transport sector includes land, sea and air subsectors.

1.9.1 Land Transport

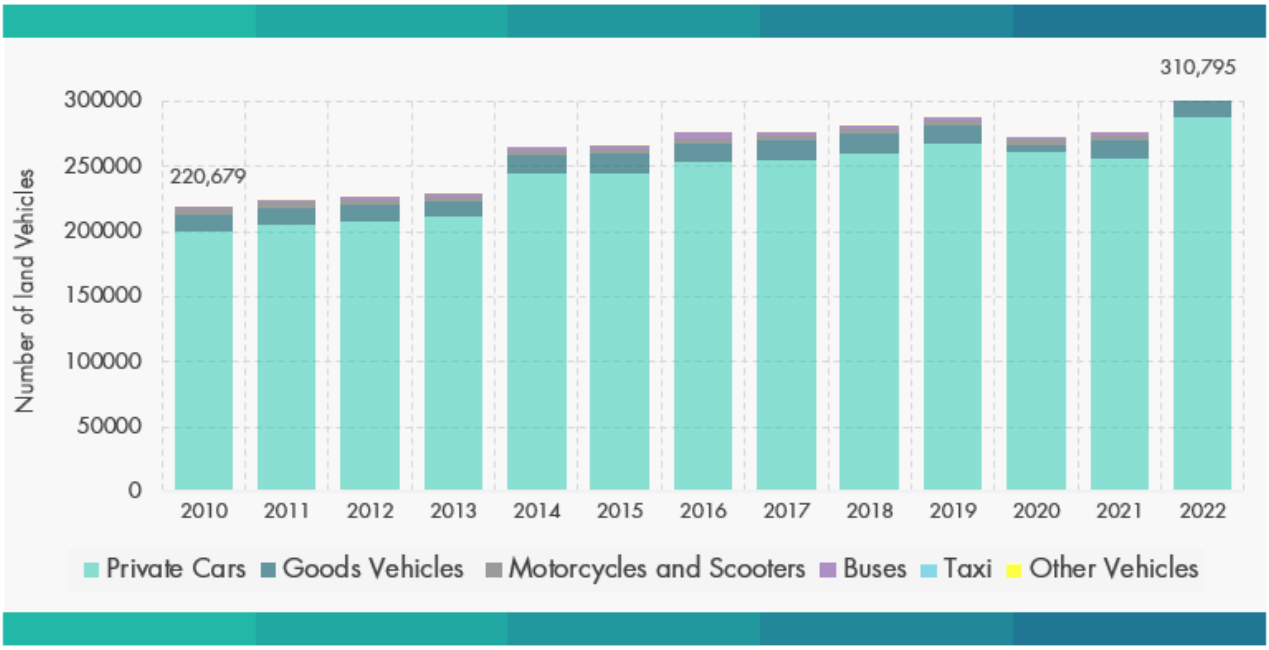
Brunei's road transport system is primarily centred around its extensive highway network, which covers 3,167 km across the country.

Brunei's land transport is primarily dominated by private vehicles[4]. This dominance is attributed to current lifestyle and transport infrastructure that places a strong reliance on vehicle ownership and usage, as well as the need for a more efficient and reliable public transport system that is currently in the pipeline. No policies are yet in place to curb private vehicle ownership and usage. However, an EV Pilot Project was launched in March 2021 that ran for two years, during which assessments

[4]Private Cars includes all types of vehicles used privately except motorcycles.
Goods Vehicles are motor vehicles ordinarily used for carriage of goods for hire or reward
Buses includes mini-buses
Other Vehicles includes automotive construction plant (road rollers, bulldozer, graders and others)
Source: Department of Economic Planning and Development.

was made on the public's response, infrastructure requirements and policy requirements. Since then, an interim EV vehicle license scheme has since been introduced as well as the adoption of EV vehicle safety standards. These has facilitated an increase in the number of EVs and their variety available in the Brunei market. As of 2022, there are 310,795 licensed motor vehicles, the vast majority being private cars. Every month, Brunei registers more than 1,200 new private vehicles, with an annual vehicle growth rate of 3%. Overall, Brunei exhibits a high levels of car ownership, use, and dependency.

Figure 1.12 Number of Registered Vehicles in Brunei, 2010-2022



Source: Department of Economic Planning and Statistics

Buses constitute the sole means of land public transport in Brunei – other than taxis, which are generally in short supply. Infrastructure for buses in Brunei comprises bus terminals in Bandar Seri Begawan, Kuala Belait and Seria, and bus lay-bys, stops and shelters throughout the country. There are a small number of local bus terminals, but these generally comprise only an area of hard standing for buses. International bus routes are provided on a commercial basis and link Brunei with towns and cities in Malaysia, for example Kuching, Miri and Kota Kinabalu.

1.9.2 Sea Transport

There are approximately 290 km of navigable waterways in Brunei with 273 licensed boats. However, current use of the network is largely limited to the proximity of the water village (*Kampong Ayer*). Water taxis currently operate for long periods of the day transferring passengers and low volumes of goods from the capital across to the water village.

At the same time there are at least 165 vessels comprising of passenger vessels, workboats, barges and tugboats operating within Brunei territorial waters that mainly serve the oil and gas industry as well as other coastal maritime services.

1.9.3 Air Transport

Brunei has a small but growing fleet of commercial aircraft. Royal Brunei Airlines (RBA) is the flag carrier of Brunei and is wholly government-owned. Based at Brunei International Airport in the capital Bandar Seri Begawan, RBA operate a network of services throughout Asia, the Middle East, Australia and the United Kingdom. In this regard, the Department of Civil Aviation, Ministry of Transport and Infocommunications has been working on producing a "Brunei Darussalam Action Plan on Reduction of Aviation Emissions" which will outline the strategies and initiatives to reduce CO_2 from international flights, including supplemental benefits from improvements made in airport operations. There are currently no domestic flight services in Brunei.

In addition, Brunei has a limited number of cycling routes and infrastructure exist across Brunei including some cycle lanes but these are not continuous.

1.10 Agriculture

Agriculture remains an important sector in the country's bid to achieve a progressive and productive economy and at the same time ensuring the security of food supply for Brunei. Output from the agricultural, forestry, and fishery sectors altogether contributes to about 1.0% of the country's total GDP. The official report of the agricultural development trend for 10 years shows the output value of the agriculture and agri-food sector growing at an average rate of 82.9% estimated at B$ 314.82 million in 2013 to B$575.71 million in 2022.

The agriculture sector comprises the production of main crops (rice, vegetables, fruits, ornamental plants, cut flowers, and miscellaneous) and livestock (buffaloes, cattle, goats, and poultry). The fisheries sector includes capture, aquaculture, and processing industries. The Government has emphasized the need to step up production in the agricultural sector, particularly to meet the local demand for rice and other commodities. In 2022, around 9,666.69 ha have been gazetted for citizens to utilize for agriculture, whether for growing crops or breeding livestock.

1.10.1 Agriculture Crops

In 2022, domestic rice production yield reached 2,316 metric tonnes across 890.79 ha of land. This represented only 8.38% of the total demand while the rest was supplied by imports.

Table 1.7 Production (Mt) of Selected Crops for 2010-2022

	2010	2022
Rice production	1,072	2,316

Source: Department of Economic Planning and Development.

1.10.2 Livestock

Livestock production is mainly on poultry farming, particularly in the production of chicken meat and eggs. The closed house system of farming in Brunei has contributed in raising the production efficiency of poultry farming. Brunei is now self-sufficient in chicken meat and eggs. Currently, ruminant (cattle, buffaloes, cows, goats, etc) production is still low and the bulk of the requirement is imported. The feed lot system offers an opportunity for intensive cattle and buffalo production in Brunei.

Table 1.8 Number of Locally Grown Livestock (Heads), 2010-2022

	2010	2022
Dairy Cows	2	0
Non-Dairy Cattle	852	367
Buffalo	4,124	1,209
Goats	6,806	4,160
Broiler Chickens (thousands)	13,757	20,472
Layer Chicken (thousands)	524	1,130

Source: Department of Economic Planning and Development.

1.10.3 Fisheries and Aquaculture

Fishery is one of the sustainable sectors that contribute to the country's economic diversification. The fisheries subsectors in Brunei include capture fisheries, aquaculture, and seafood processing. Capture fisheries are composed of small-scale and commercial fisheries.

Table 1.9 Production of Fisheries Production (MT), 2010-2022

	2010	2022
Capture	15,329.2	16,178.2
Aquaculture	423.8	5,018.5
Fish Processing	16,317.1	26,019.8

Source: Department of Economic Planning and Development.

1.11 Tourism

Brunei's travel and tourism industry offers local products with various themes such as community, culture, nature and activity-based, as well as gastronomy. Brunei also promotes Meetings, Incentives, Conventions and Exhibitions (MICE), such as the Brunei Mid-Year Conference and Exhibition (MYCE) and Brunei International Flower Show, to attract both local and international professionals, experts and special interest groups for purposes of knowledge-sharing, networking and opening business opportunities. In 2022, Brunei recorded a total of 35,700 tourists which contributed to 0.1% of its GDP.

1.12 Waste

The waste sector management in Brunei comprises municipal solid waste management at the engineered landfill and wastewater management, both of which are managed by the Department of Environment, Park and Recreation (DEPR) and the Department of Drainage and Sewerage (DDS), PWD respectively.

1.12.1 Municipal Solid Waste

Municipal Solid Waste (MSW) has been growing substantially due to population growth which gives rise to increasing demands and emergence of new business. In 2022, Brunei disposed of over 500 MT of MSW daily, amounting to 1.16 kilograms (kg) of waste per capita per day. Most of Brunei's solid waste are delivered to Sungai Paku Engineered Landfill, Brunei's main engineered landfill. Based on a waste composition study in 2019, the top four compositions of MSW disposed at Sungai Paku Engineered Landfill consist of food waste (32%), plastic waste (29%), green waste (11%), and paper (10%). The landfill covers an area of 110 ha whereby 16 ha is allotted for disposal sites. The waste sent here are buried within four excavated areas known as landfill cells. To ensure environmental compliance the landfill is equipped with a linear system to protect ground water, a leachate collection and treatment facility, dust control system, daily soil cover, methane collection and flaring system. The landfill also has a septic sludge system and a demolition waste facility to cater for septic sludge and construction waste respectively.

By 2035, the Government has set a target to recycle 30% of all solid waste. Currently, the recycling rate in Brunei stands at around 15%. Central to achieving this goal are the 3Rs - Reduce, Reuse, and Recycle. However, integrating 3Rs strategies into the existing waste management system has been challenging. Much of the waste still ends up being disposed at landfill, despite the evident potential and opportunities for such measures. A major challenge is the general public's certain degree of resistance to behavioural changes due to habitual behaviours.

Nevertheless, various awareness efforts have been conducted by both the Government and private sector to encourage changes. Presently, 20 recycling companies are registered with DEPR, and their services involves collection of recyclables for export and only a number of recyclables are recycled and processed within the country including papers and used tyres. Recycling infrastructure for

different types of recyclables are limited and certain factors may contribute to its limitation including availability of recyclable feedstock and financial feasibility. To provide convenience and encourage recycling habits, the Government has provided recycling bin for certain recyclables at strategic locations across the country.

1.12.2 Wastewater

DDS, PWD acts as the main regulatory authority for domestic wastewater from residential and commercial premises in Brunei. DDS operates 34 sewerage treatment plants (STPs), consisting of major and subsidiary treatment plants. Brunei has improved its sanitation infrastructure and currently has achieved 94% of improved sanitation (septic tank and centralised sewerage system) to the public of which 60% is of centralised sewerage system. Improvements to the system also include a sewerage vacuum system for the water village housing scheme in the capital.

1.12.3 Hazardous Waste

Legislation on hazardous waste in Brunei is limited to the control of the transboundary movement of hazardous waste through the Hazardous Waste Order 2013. This Order is also to enact the requirements of the Basel Convention.

Hazardous waste facilities in Brunei are able to treat only a fragment of the hazardous waste generated in the country including hydrocarbon waste, hazardous sludge waste, hazardous chemical waste, and clinical waste. Some of the hazardous waste generated are either disposed at the designated hazardous landfill designed for hazardous waste disposal or exported to be treated and disposed at hazardous waste disposal facilities through the Basel Convention procedures.

The oil and gas industry are significant generators of 'hazardous waste' that include oily sludge, waste oils, emulsions, waste drilling mud, produced waters, mercury, oxazolidine, spent catalyst, contaminated sludge and washings.

1.13 Institutional Arrangements

This section describes institutional arrangements relevant to the preparation of the national communications on a continuous basis.

1.13.1 National Entity and Focal Point

The Brunei Climate Change Office (BCCO)[5] serves as the government authority mandated to develop, implement, monitor, and evaluate Brunei's climate change policies, strategies, and actions. In addition, BCCO oversees all aspects of the National GHG Inventory Management System and is responsible for inventory planning, quality control, documentation, archiving, and inventory improvement planning.

[5] Previously known as Brunei Climate Change Secretariat (BCCS)

The designated national focal point (NFP) to the UNFCCC is:

Head of Brunei Climate Change Office,
Brunei Climate Change Office,
Prime Minister's Office,
Brunei Darussalam

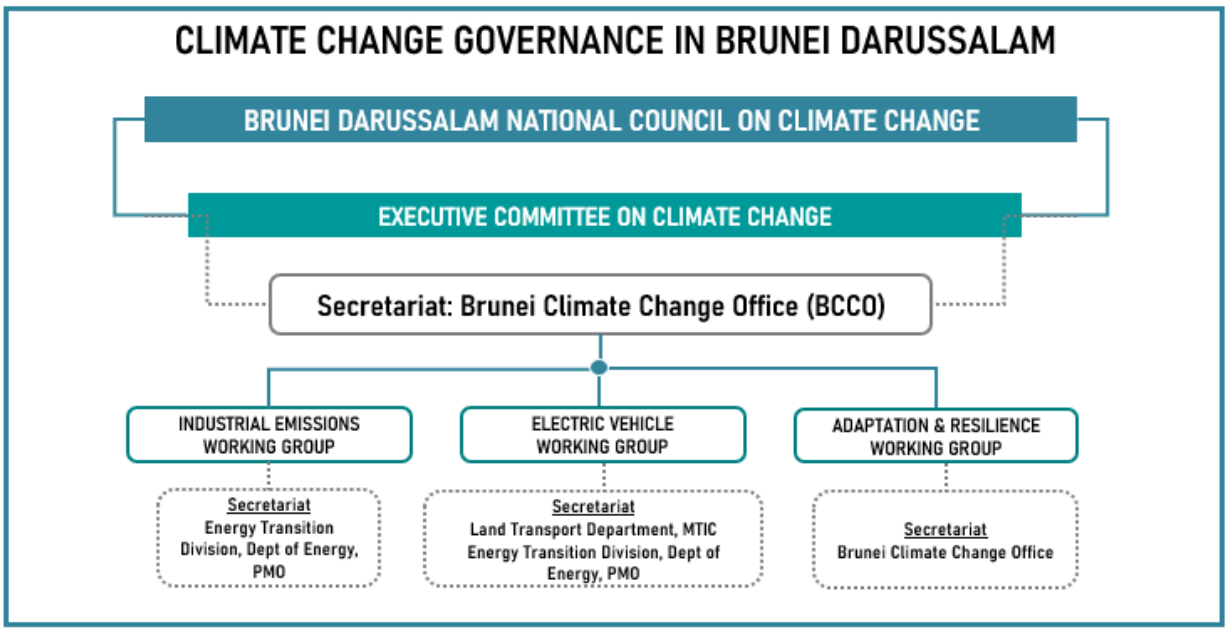
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BRUNEI CLIMATE CHANGE OFFICE

1.13.2 Climate Change Governance

The governance structure includes the Brunei Darussalam National Council on Climate Change (BNCCC), which provides the highest level of strategic direction in addressing climate change. Co-chaired by the Minister of Finance and Economy II and the Minister of Development, the BNCCC's members include representatives from various ministries.

Supporting the BNCCC is the Executive Committee on Climate Change (ExComm), chaired by the Deputy Minister (Energy), Prime Minister's Office and consist of Permanent Secretaries, Chief Executive Officers (CEOs), and Managing Directors (MDs) from relevant public, private, and non-governmental organizations (NGOs). BCCO serves as secretariat for both BNCCC and the ExComm. The ExComm oversees the Industrial Emissions Working Group (IEWG), Electric Vehicle Working Group (EVWG), and Adaptation and Resilience Working Group (ARWG). Membership in these committees spans across government, non-government, and academic bodies, ensuring a multi-sectoral approach to climate change mitigation and adaptation. Any decisions taken at ExComm and other bodies require endorsement by the BNCCC.

Figure 1.13 Institutional Arrangement and Thematic Working Groups for Climate Change

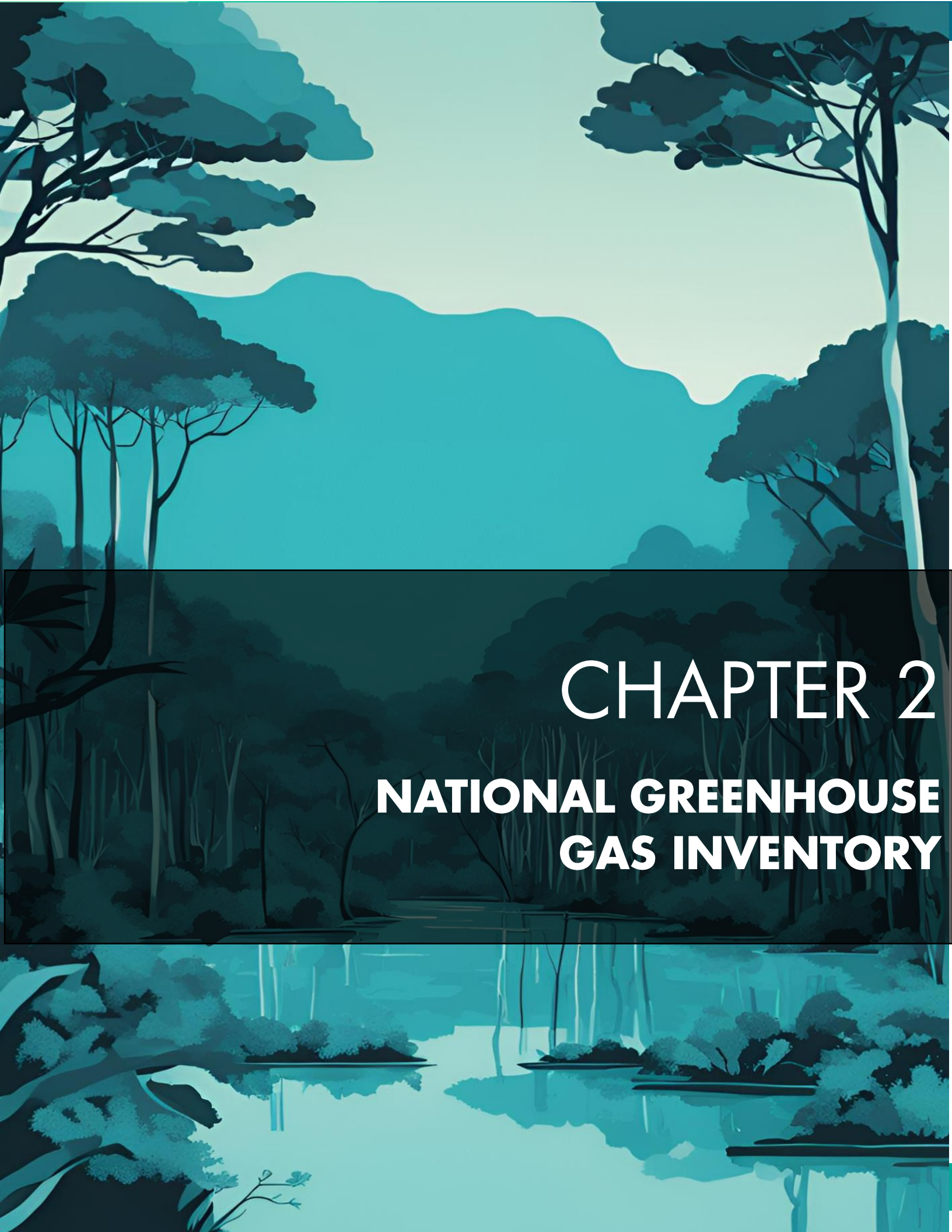


1.13.3 Climate Change Planning and Implementation

Climate change planning and implementation are led by climate change Lead Agencies, which consist of ministries designated to take primary responsibility for coordinating and implementing climate change policies, strategies, and actions within a country.

Table 1.10 Coordinating Ministries and Agencies Responsible for Climate Actions

AREA	SECTOR	MINISTRIES/GOVERNMENT AGENCIES
Greenhouse Inventory	All IPCC Sectors	• Brunei Climate Change Office, Prime Minister's Office • Department of Agriculture and Agrifood, Ministry of Primary Resources and Tourism • Department of Electrical Services, Prime Minister's Office • Department of Energy, Prime Minister's Office • Department of Environment, Park and Recreation, Ministry of Development • Forestry Department, Ministry of Primary Resources and Tourism • Ministry of Transport and Infocommunications
Mitigation	Energy	• Department of Energy, Prime Minister's Office
	Industrial Processes	• Department of Energy, Prime Minister's Office
	Transport	• Department of Energy, Prime Minister's Office • Land Transport Department, Ministry of Transport and Infocommunications
	Forestry	• Forestry Department, Ministry of Primary Resources and Tourism
	Land-Use Change	• Department of Town and Country Planning, Ministry of Development
	Agriculture	• Department of Agriculture and Agrifood, Ministry of Primary Resources and Tourism
	Waste	• Department of Environment, Parks and Recreation, Ministry of Development
Adaptation	Infrastructure & Urban Resilience	• Authority on Building Control and Construction Industry, Ministry of Development • Department of Town and Country Planning, Ministry of Development
	Health & Livelihood	• Ministry of Health • National Disaster Management Centre, Ministry of Home Affairs
	Biodiversity & Environment	• Department of Environment, Parks and Recreation, Ministry of Development • Forestry Department, Ministry of Primary Resources and Tourism
	Agriculture & Food Security	• Department of Agriculture and Agrifood, Ministry of Primary Resources and Tourism • Fisheries Department, Ministry of Primary Resources and Tourism
	Marine Protection & Coastal Resilience	• Department of Drainage and Sewerage, Ministry of Development • Survey Department, Ministry of Development
	Water Resources	• Department of Drainage and Sewerage, Ministry of Development • Department of Water Services, Ministry of Development



CHAPTER 2

NATIONAL GREENHOUSE GAS INVENTORY

2.0 NATIONAL GREENHOUSE GAS INVENTORY

2.1 Overview of Current Inventory Management System

As a signatory Party to the UNFCCC, Brunei is obligated to produce and regularly update its national greenhouse gas (GHG) according to the requirements in Decision 2/CP.17. This chapter provides an overview of Brunei's GHG emission levels, encompassing anthropogenic sources and removals by sinks, and the approaches used to estimate them. The reporting follows the accounting principles of Transparency, Accuracy, Consistency, Completeness, and Comparability (TACCC) as stated in Article 4.13 of the Paris Agreement.

The estimation of GHG emissions is categorized into four sectors: **energy, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU)[6], and waste.** The geographic coverage of the GHG inventory is complete. It covers Brunei's entire territorial boundary.

The greenhouse gases covered in the inventory included the following:

a) Carbon dioxide (CO_2)
b) Methane (CH_4)
c) Nitrous oxide (N_2O)

2.1.1 Inventory Preparation Process

The preparation of Brunei's national GHG inventory is a coordinated effort led by the BCCO as the National Inventory Coordinator (NIC). The NIC oversees the entire process of developing the national GHG inventories, from data collection to reporting, ensuring timely and high-quality delivery that meets international standards. This involves applying appropriate methodologies, emission factors, and activity data using IPCC software. Outputs from the IPCC software, such as sectoral tables, key category analysis, uncertainty analysis, and reference vs sectoral approach, are documented and archived in the database.

From the ad hoc nature of GHG inventory reporting and undefined institutional and procedural arrangement prior to 2023, the national GHG inventory reporting system in Brunei has greatly improved with the launch of a **Mandatory Reporting Directive on Greenhouse Gas** in April

[6] In the 2006 IPCC Guidelines, AFOLU covers GHG emissions and removals from land-based sectors, and it is divided into 1) Agriculture, and 2) Land Use, Land-Use Change, and Forestry (LULUCF). Agriculture focuses on emissions from activities like livestock, rice cultivation, and fertilizer use, while LULUCF addresses carbon emissions and removals from land management and land-use changes such as deforestation and reforestation. Both the terms AFOLU and LULUCF will be used in this report to differentiate the specific GHG sources and sinks within the AFOLU sector.

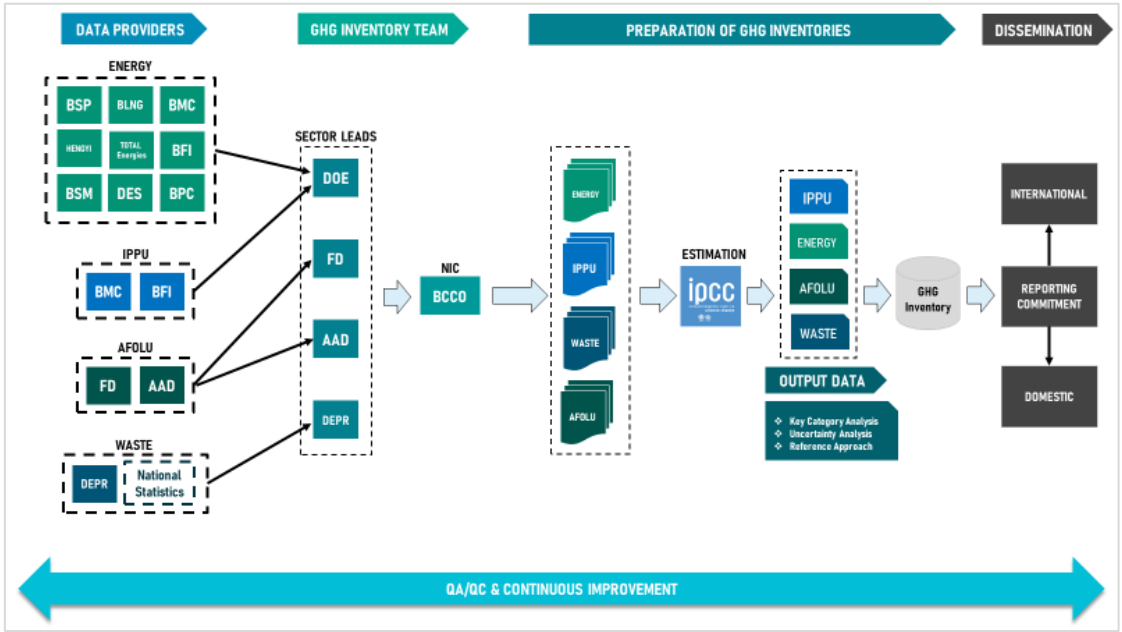
2023, requiring all facilities that emit and/or remove GHG—including government departments and private companies—to report their GHG emissions quarterly and annually starting in 2023. This directive aligns with Article 4, Paragraphs 13–14 of the Paris Agreement, which emphasizes the need for transparency, accuracy, and consistency in accounting and tracking progress toward Nationally Determined Contributions (NDCs). By mandating comprehensive GHG reporting, Brunei takes an important step in fulfilling its commitment to provide reliable and transparent data for monitoring emissions and removals.

Requiring companies to submit emissions reports is key to maintaining a transparent and reliable carbon inventory, which depends on a robust measuring, reporting, and verification (MRV) system, as outlined in the Modalities, Procedures, and Guidelines (MPGs) of the Paris Agreement. To support this effort, a centralized online reporting platform is being developed to standardize data reporting and provide a user-friendly overview of greenhouse gas data.

Under the Directive, Brunei adopted a Whole-of-Nation approach towards national GHG inventory preparation, which leverage on sectoral pool of expertise. The respective Sector Leads for Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land-Use, Land-Use Change and Forestry (LULUCF) and Waste sectors are responsible to consolidate GHG reports from all data providers and perform quality control and quality assurance activities, among others.

Data is primarily sourced from Government and private sectors and is submitted through reporting templates based on the 2006 IPCC Guidelines, tailored to specific needs. Sector Leads collect, compile, and consolidate this data, which undergoes initial quality checks by the NIC. Further validation, processing, and refinement are carried out as needed to ensure accuracy and reliability.

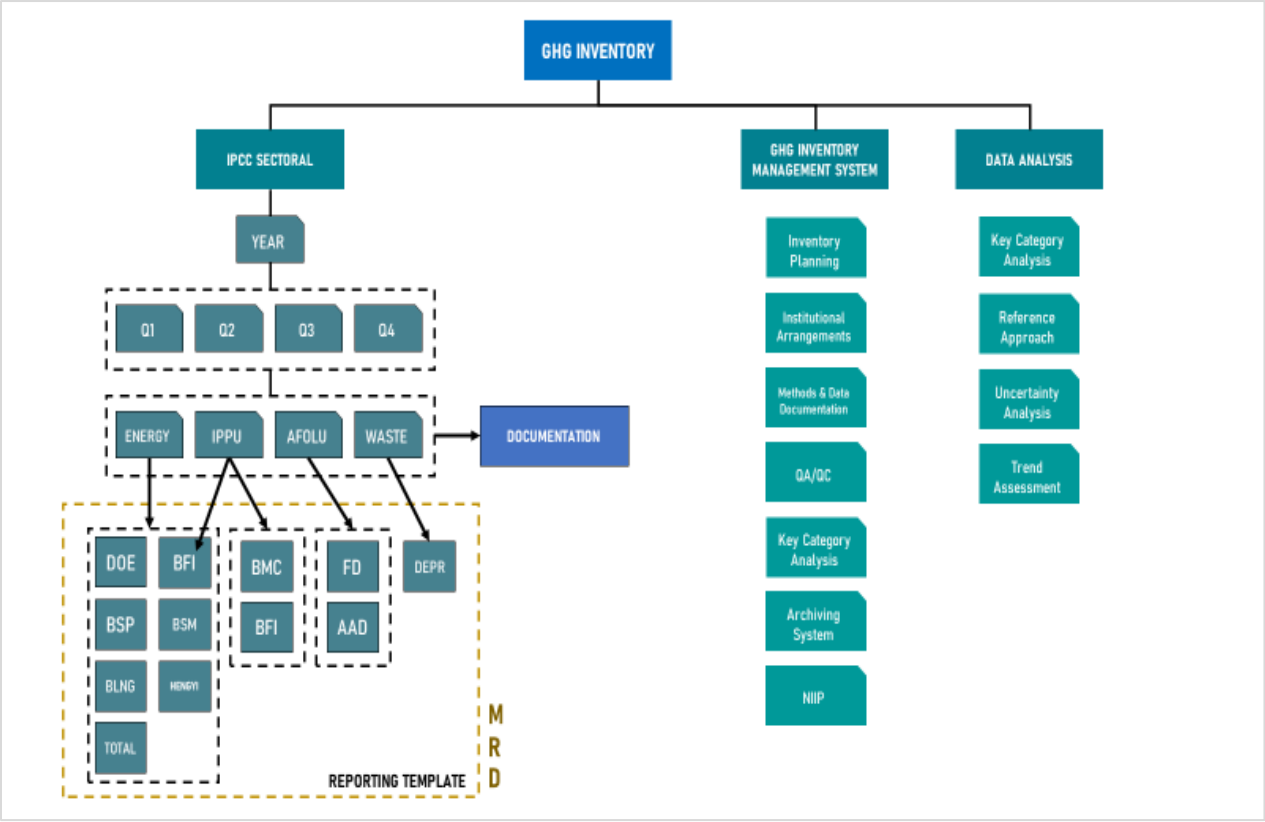
Figure 2.1 Brunei Darussalam's Data Flow and Inventory Preparation Process



2.1.2 Archiving of Information

All data and information pertaining to activity data and emission factors, along with methods and data documentation, including spreadsheets of GHG inventories for all sectors, are electronically stored in a centralised online storage facility and on the BCCO's computer network, as illustrated in Figure 2.2 below.

Figure 2.2 Brunei Darussalam's Archiving System



2.1.3. Processes for Official Consideration & Approval of Inventory

The approval process entails multiple reviews by officials from various Government Ministries before the report is forwarded to the Brunei's Climate Governance for endorsements. After approval, the National Focal Point submits BTR including Common Reporting Tables (CRT) electronically to the UNFCCC.

2.2 Methodologies & Data Sources

Brunei's GHG Inventory was prepared in accordance with the requirements of the UNFCCC using IPCC guidelines, supplemented by 2019 IPCC Refinement and utilises the associated IPCC software. The methodology and dataset used for BTR improve on the previous inventories. Some new datasets were used and period recalculations were performed, mostly for the new inventory years.

2.2.1 Estimation Methods

Generally, Tier 1[7] IPCC methodology was applied to most sectors, except in cases where available national data allowed us to adopt a higher tier. The Tier 2[8] method was used for calculating waste disposal combines default parameters alongside reliable country-specific activity data for both current and historical waste disposal at Solid Waste Disposal Sites (SWDS) and Tier 3[9] approaches are implemented for fuel combustion in Petroleum Refining and Other Energy Industries, as well as for fugitive emissions from oil and natural gas. In the IPPU sector, a hybrid approach combining Tier 1 and Tier 3 methods is applied.

Table 2.1a Methodological tiers and emission factors used in the inventory for emissions/removal categories

IPCC Code	Emission sources/removal categories	CO_2		CH_4		N_2O	
		Method	EF	Method	EF	Method	EF
1.A	Energy	T1, T3	D, PS	T1, T3	D, PS	T1, T3	D, PS
1.A.1.a. i	Electricity Generation	T1	D	T1	D	T1	D
1.A.1.a. ii	Combined Heat and Power Generation (CHP)	T1	D	T1	D	T1	D
1.A.2.m	Non-Specified Industry	T1	D	T1	D	T1	D
1.A.3.a. ii	Domestic Aviation	T1	D	T1	D	T1	D
1.A.3.b. i	Cars	T1	D	T1	D	T1	D
1.A.4.b	Residential	T1	D	T1	D	T1	D
1.A.1.b	Petroleum Refining	T3	PS	T3	PS	T3	PS
1.A.1.c. ii	Other Energy Industries	T3	PS	T3	PS	T3	PS
1.A.2.c	Chemicals	T3	PS	T3	PS	T3	PS
1.B.2.a	Oil	T3	PS	T3	PS	T3	PS
1.B.2.b	Natural Gas	T3	PS	T3	PS	T3	PS

[7] Tier 1 are default emission factors provided by the IPCC. It requires minimal country-specific data and is generally less accurate but often used when resources or data are limited.

[8] Tier 2 uses country-specific emission factors and activity data, which can provide more accurate estimates than Tier 1. It requires more detailed and higher quality data than Tier 1.

[9] Tier 3 method uses local emission factors and activity data, or actual activity-specific local carbon emissions data. It provides the most precise estimates.

2B	Industrial Processes & Product Use	T1, T3	D, PS	-	-	-	-
2.B.8.a	Methanol	T1, T3	D, PS	-	-	-	-

Table 2.1b Methodological tiers and emission factors used in the inventory for emissions/removal categories

3A	Agriculture	T1	D	T1	D	T1	D
3.A.1.a.ii	Other Cattle	-	-	T1	D	T1	D
3.A.1.b	Buffalo	-	-	T1	D	T1	D
3.A.1.d	Goats	-	-	T1	D	T1	D
3.A.2.a.ii	Other Cattle	-	-	T1	D	T1	D
3.A.2.b	Buffalo	-	-	T1	D	T1	D
3.A.2.d	Goats	-	-	T1	D	T1	D
3.A.2.i	Poultry	-	-	T1	D	T1	D
3.C.3	Urea Application	T1	D	-	-	-	-
3.C.4	Direct N_2O Emissions from Managed Soils	-	-	-	-	T1	D
3.C.5	Indirect N_2O Emissions from Managed Soils	-	-	-	-	T1	D
3.C.6	Indirect N_2O Emissions from Manure Management	-	-	-	-	T1	D
3.C.7	Rice Cultivation	-	-	T1	D	-	-
3B	Land-Use, Land-Use Change and Forestry (LULUCF)	T1, T3	D, CS	T1	D	T1	D
3.B.1.a	Forest Land Remaining Forest Land	T1, T3	D, CS	-	-	-	-
3.C.3	Cropland Remaining Cropland	T1	D	T1	D	T1	D
3.C.4	Settlements Remaining Settlements	T1	D	T1	D	T1	D
4A	Waste	-	-	T1, T2	D	T1	D
4.A.1	Managed Waste Disposal Sites	-	-	T2	D	-	-
4.D.1	Domestic Wastewater Treatment and Discharge	-	-	T1	D	T1	D
4.D.2	Industrial Wastewater Treatment and Discharge	-	-	T1	D	T1	D

CS = Country-Specific, PS = Plant-Specific, NE = Not Estimated, NO = Not Occurring, D = Default IPCC methodology and emission factor, EF = Emission Factor, Methods = Methods, T1, T2, T3 - Levels of Tiers

2.2.2 Global Warming Potentials

The 100-year time-horizon Global Warming Potential (GWP) values from the Fifth Assessment Report (AR5) were used to convert the estimated CH_4 and N_2O emissions to Carbon dioxide equivalent (CO_2e) for the time series 2010 to 2022.

Table 2.2 Global Warming Potential based on AR5

Greenhouse Gas	Global Warming Potential (AR5)
Carbon Dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	265

2.3 Quality Assurance and Quality Control (QA/QC)

Quality Assurance and Quality Control (QA/QC) are integral components of the IPCC 2006 guidelines since QA/QC practices contribute towards credible and reliable GHG inventories.

Brunei is in the midst of formulating a QA/QC plan that emphasises the principles of TACCC in accordance with the 2006 IPCC Guidelines. These procedures primarily focus on verifying activity data and emission factors, as well as archiving of reference materials:

Quality control was conducted at **three levels of the inventory process** as follows:

a) **Pre-inventory preparation:** This involved activity data compilation and cleaning of the data by sector teams prior to inventory compilation.
b) **Inventory preparation:** This involved checking and verification of activity data and emissions factors and ensuring correct entry of figures in the software.
c) **Post inventory preparation:** Further checks and verification are conducted on activity data, emission factors, and emission results.

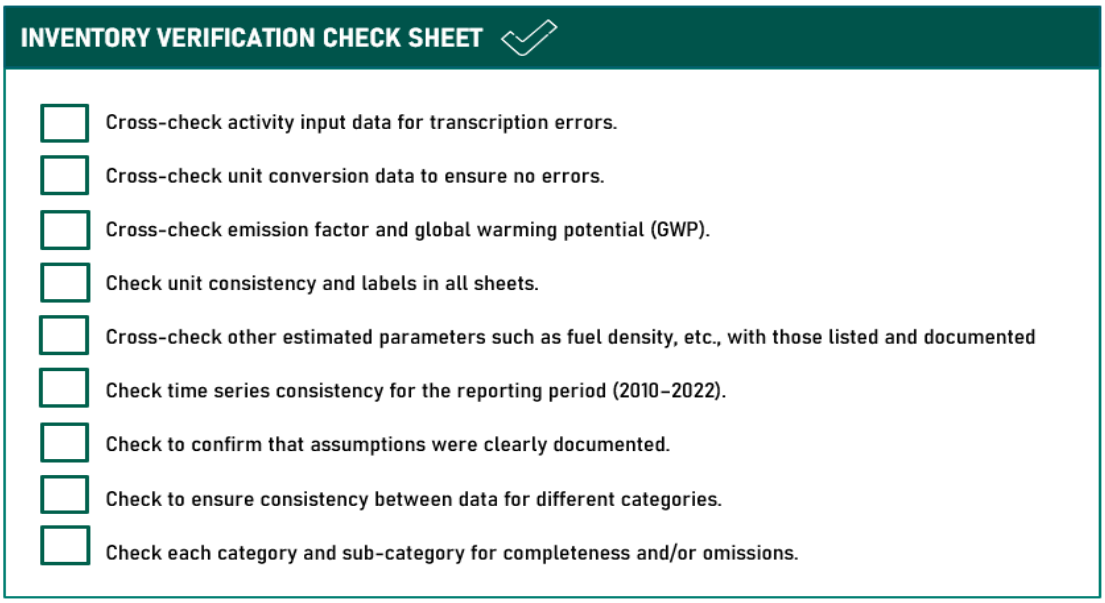
In adherence to this, the GHG Inventory report was submitted to a third-party verifier for quality assurance. Further, the report highlighted information gaps where estimations could not be undertaken and identifies information gaps and levels of uncertainties in areas where estimations could not be made.

Additionally, in 2022, a workshop on quality assurance of the national GHG Inventory Management System and national GHG Inventories of Brunei Darussalam was organised by the UNFCCC Secretariat and Food and Agriculture Organization (FAO) to strengthen the quality and transparency of the country's carbon inventory. Additionally, a series of workshop were conducted by Partnership to Strengthen Transparency for Co-Innovation by the Japan-ASEAN Integrated Fund (PASTI-JAIF) between 2023 and 2024 during which all the collected data and preliminary results

(up to that date) were analysed. This current inventory benefitted tremendously from the rigorous exercise. As such, the findings and recommendations of this report include outcomes and recommendations from the UNFCCC and FAO teams.

In addition to the team's recommendation, the following QA/QC activities were devised and used to further enhance the QA/QC of the national inventory;

Figure 2.3 Inventory Verification Check Sheet



2.4 General Uncertainty Assessment

The IPCC guidelines require that inventory estimates are reported with the uncertainty range using a Tier 1 uncertainty analysis across the sectors, which involves error propagation to assess uncertainties in individual categories and the overall inventory. Due to limited capacity to determine uncertainty, Brunei currently uses default uncertainty values at maximum range for both activity data and emission factors across all sectors, as per the 2006 IPCC Guidelines. However, the country committed to continuously improving our national GHG inventory by progressively developing country-specific data and refining its methodologies to reduce uncertainties in future assessments.

Applying the Tier 1 uncertainty method at an aggregate level, the overall uncertainty including LULUCF for Brunei's GHG inventory estimate for 2022 is estimated at ± 23.67%. The uncertainty reported for the trend (with base year of 2010) in total inventory emissions stands at approximately ±179.18%. Excluding the LULUCF sector from the analysis, the national inventory uncertainty is estimated at ± 6.71% for 2022 emissions and ± 72.77% for the emissions trend. Table 2.3 below presents the uncertainty assessment results of the inventory.

Table 2.3 Approach 1 Uncertainty analysis results, 2022

2022 GHG Inventory	Uncertainty of Total Inventory (%)		Uncertainty in Trend (%)	
	(-)	(+)	(-)	(+)
Total Inventory including LULUCF	23.67	23.67	179.18	179.18
Total Inventory excluding LULUCF	6.71	6.71	72.77	72.77

2.5 General Assessment of Completeness

Brunei's GHG inventory covers sectors and activities outlined in IPCC 2006 guidelines occurring in Brunei's territory during the inventory period, based on official records from relevant authorities. However, it may not capture unreported fuel use, certain household animals, and unaccounted harvested wood.

Since the reporting on indirect GHGs, such as non-metallic volatile organic compounds, is not mandatory, these were not included due to data limitations.

The time series reported in this inventory is the period 2010–2022. This fulfils the mandate that the latest inventory year of the time series be no more than four years earlier than the current reporting year. In this case, the latest reporting year (2022) is within four years of the current reporting year 2024.

As part of the good practice of ensuring time-series completeness, Brunei performs recalculation and uses notation to report emissions from all identified sources/removals and uses appropriate techniques to address gaps in data. Some emission categories either lack estimates or are combined with others due to lack of data limitations, methodological challenges, and insignificant or unknown estimates. These emissions categories are denoted as "NO (Not Occurring)" and "NE (Not Estimated)." These categories will undergo further assessment to determine emission potential and establish suitable estimation methodologies as per the QA/QC plan. Specific sector chapters will provide more insights into the inventory's completeness.

2.6 Summary of Flexibility Applied

Brunei demonstrates flexibility in its GHG inventory tailored to its capacities. Rather than adhering to the 1990 baseline, Brunei focuses on delivering quality data from 2010 onwards. This aligns with the flexibility for developing country Parties under Article 4 of the Paris Agreement.

Moreover, Brunei exercises flexibility in completeness, ensuring a comprehensive inventory by covering all relevant sources based on available data and enhances its credibility through detailed QC procedures following its QA/QC plan and the IPCC guidelines.

2.7 Key Categories

Brunei conducts Key Category Analysis (KCA) for 2022 through a level assessment using Approach 1 with the IPCC software, for all inventory categories, including and excluding the LULUCF sector. More detailed information is described in Annex II.

Including LULUCF sector, there are 9 key categories in the level assessment: 8 of these from the energy sector, followed by 1 from AFOLU sector.

Table 2.4 Key Category Analysis for 2022 Inventory - Approach 1 Level Assessment (Including LULUCF sector)

CRT Category code	IPCC Category	GHG	2022 Estimate ($MtCO_2e$)	Individual Contribution	Cumulative Contribution
1.A.1	Energy Industries - Gaseous Fuels	CO_2	5,374.09	28.95%	28.95%
3.B.1.a	Forest land Remaining Forest land	CO_2	5,302.74	28.57%	57.52%
1.A.1	Energy Industries - Solid Fuels	CO_2	2,515.74	13.55%	71.07%
1.A.1	Energy Industries - Liquid Fuels	CO_2	2,098.97	11.31%	82.38%
1.A.3.b	Road Transportation - Liquid Fuels	CO_2	1,176.01	6.34%	88.71%
1.A.2	Manufacturing Industries & Construction - Liquid Fuels	CO_2	402.18	2.17%	90.88%
1.B.2.b	Fugitive Emissions - Natural Gas	CO_2	301.90	1.63%	92.51%
1.B.2.a	Fugitive Emissions - Oil	CH_4	287.29	1.55%	94.06%
1.A.2	Manufacturing Industries & Construction - Gaseous Fuels	CO_2	264.72	1.43%	95.48%

The trend assessment was used to identify key categories for 2010 and 2022 emissions. There are 8 key categories: 7 from the energy sector and 1 from the AFOLU sector.

Table 2.5 Key Category Analysis for 2022 Inventory - Approach 1 Level Assessment (Including LULUCF sector)

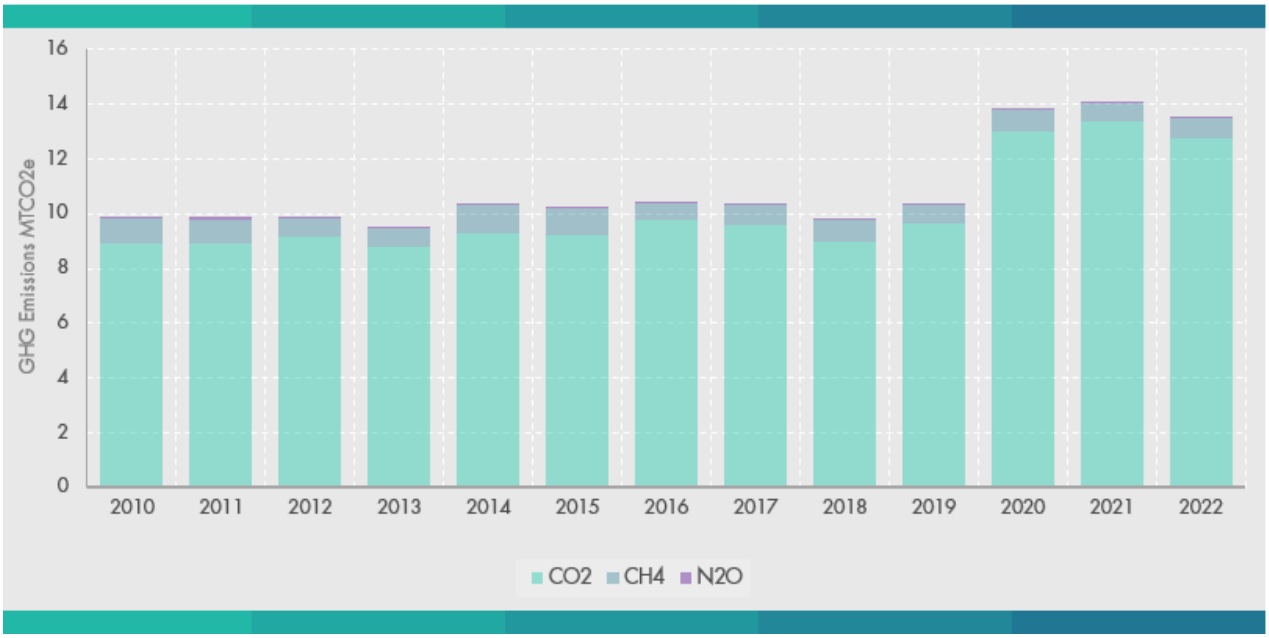
CRT Category code	IPCC Category	GHG	2010 Estimate ($MtCO_2e$)	2022 Estimate ($MtCO_2e$)	% Contribution to Trend	Cumulative Contribution
1.A.1	Energy Industries - Gaseous Fuels	CO_2	5,970.52	5,374.09	27.72%	27.72%
3.B.1.a	Forest land Remaining Forest land	CO_2	4,004.47	4,463.16	19.01%	46.73%
1.A.1	Energy Industries - Solid Fuels	CO_2	0.00	2,515.74	17.75%	64.48%
1.A.1	Energy Industries - Liquid Fuels	CO_2	32.86	2,098.97	14.45%	78.93%
1.B.2.b	Fugitive Emissions - Natural Gas	CO_2	846.71	301.90	7.18%	86.11%
1.A.3.b	Road Transportation - Liquid Fuels	CO_2	1,181.74	1,176.01	4.69%	90.80%
1.B.2.a	Fugitive Emissions - Oil	CH_4	411.17	287.29	2.49%	93.30%
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CO_2	14.76	264.72	1.71%	95.00%

2.8 Brunei GHG Emissions and Removals Profile

Brunei's total gross GHG emissions stood at 13.57 $MtCO_2e$ (million tonnes CO_2 equivalent) in 2022. As illustrated in Figure 2.4, emissions have steadily rose over a decade, from 9.88 MT CO_2e in 2010 at an annual growth rate of 2.68%. The Energy sector has consistently been the most significant emission source since 2010, driven by activities in the oil and gas, transport, and electricity generation. In 2022, 97.2% of total national emissions came from the Energy sector, followed by Waste (1.54%), IPPU (0.96%), and AFOLU (0.26%). The emission spikes for Energy sector 2020 was due to the commissioning of Brunei's first coal-fired powerplant for industrial purposes. The trends for other sectors, remained largely consistent.

When the net emissions from LULUCF are excluded from the national totals, the overall emissions amounted to 9.11 $MtCO_2e$ in 2022.

Figure 2.4 Trends of GHG Emissions and Removals, 2010 – 2022



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2	8.90	8.93	9.14	8.78	9.29	9.22	9.77	9.58	8.99	9.64	13.00	13.35	12.74
CH4	0.92	0.87	0.68	0.66	1.01	0.96	0.64	0.73	0.76	0.67	0.81	0.68	0.77
N2O	0.06	0.08	0.05	0.05	0.06	0.06	0.05	0.05	0.05	0.05	0.06	0.07	0.06
Waste Sector	0.14	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.20	0.20	0.21
Sink/Removals	-4.00	-4.34	-4.08	-4.24	-4.05	-3.52	-3.41	-4.56	-4.08	-3.40	-4.17	-4.45	-4.46

2.9 GHG Emissions by Gas

As illustrated in Figure 2.5, CO_2 remain the most dominant GHG gas in the overall inventory throughout the inventory period contributing to more than 95% of total overall emissions. This is followed by CH_4 and the least being N_2O at less than 1%.

Figure 2.5 Trends of GHG emissions by Gas, 2010 – 2022

2.10 GHG Emissions by Sectors

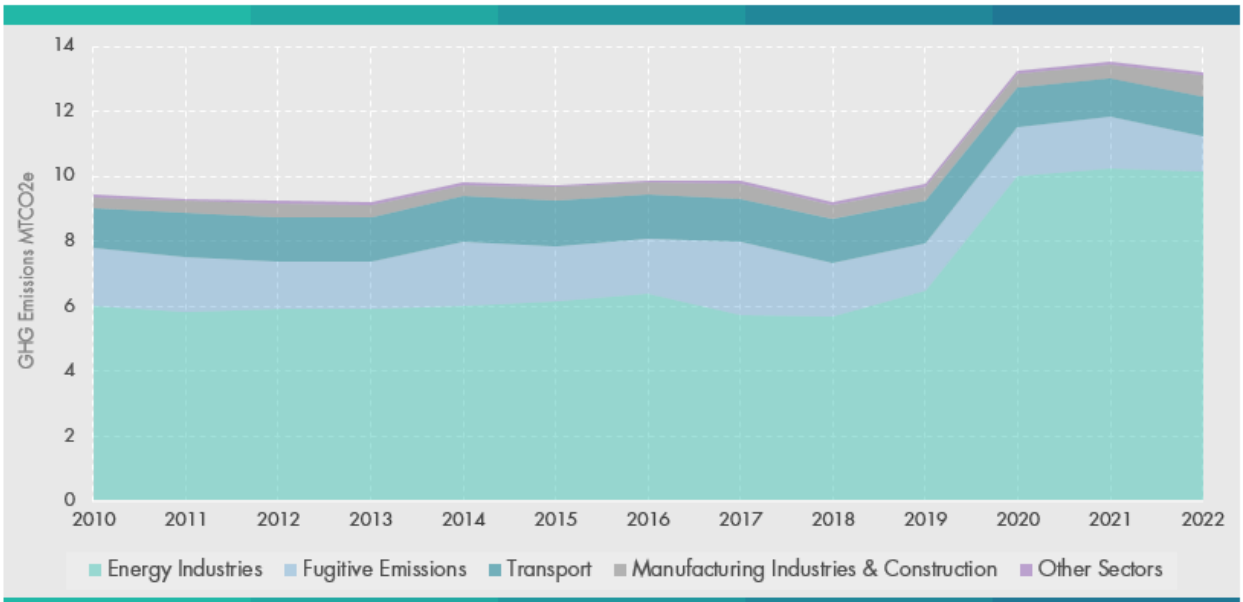
2.10.1 Energy

This section provides respective emissions, trends, activity data, emission factors, methodologies and plan improvements for categories under Energy.

2.10.1.1 Overview of Energy Emissions

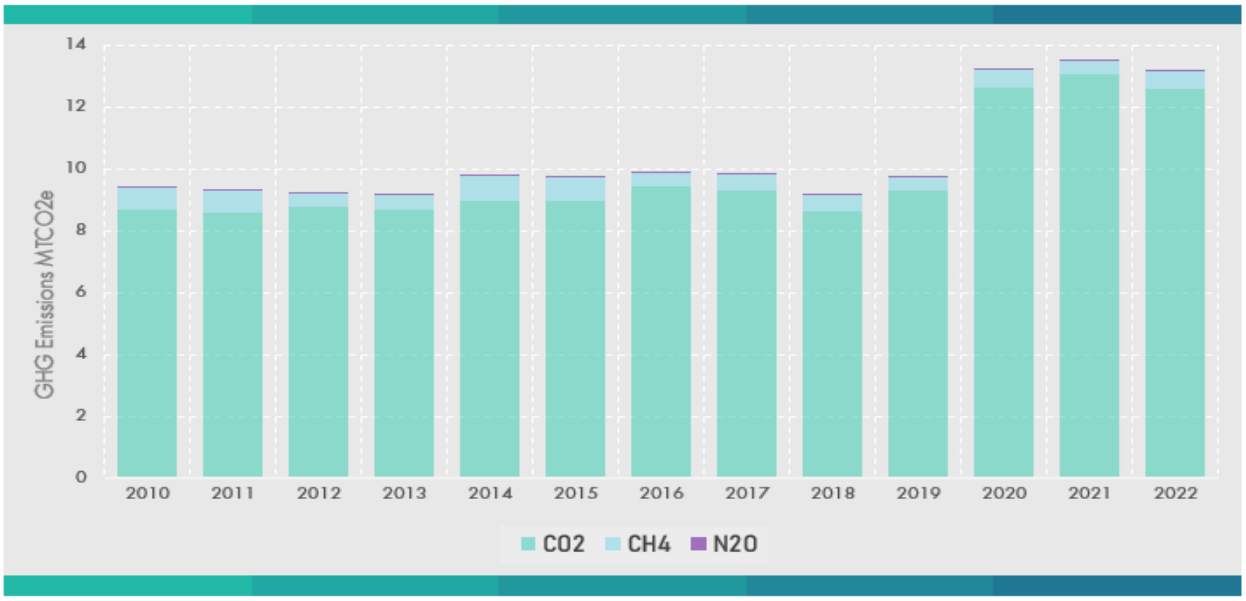
The Energy sector, which includes the consumption of fossil fuels in the country and their associated fugitive emissions, is the main GHG emitting sector in the country, contributing to 97% of the total GHG emissions in 2022 primarily from fossil fuel combustion activities, comprising of energy industries, manufacturing industries, transport and other sectors. Figure 2.6 illustrate the relative distribution of GHG emissions across the energy sector and emissions trend for the period 2010-2022. The total emissions from the energy sector were 9.44 $MtCO_2e$ in 2010, growing at an average rate of 8% to 13.20 $MtCO_2e$ in 2022 mainly due to the steady increase in the country's energy consumption and increase use of fossil fuel to generate power. The notable increase in emissions in 2020 onwards marked the start of Brunei's coal-fired powerplant for industrial purposes.

Figure 2.6 GHG Emissions from The Energy Sector By Category, 2010 – 2022



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Fugitive Emissions	1.78	1.71	1.44	1.45	1.99	1.71	1.71	2.21	1.64	1.46	1.51	1.60	1.11
Other Sectors	0.081	0.083	0.085	0.079	0.075	0.083	0.083	0.095	0.095	0.095	0.093	0.106	0.080
Transport	1.22	1.33	1.37	1.35	1.38	1.38	1.36	1.35	1.37	1.34	1.24	1.17	1.21
Manufacturing Ind & Const.	0.35	0.37	0.44	0.38	0.36	0.42	0.35	0.45	0.42	0.41	0.40	0.42	0.67
Energy Industries	6.01	5.83	5.93	5.93	6.01	6.15	6.39	5.75	5.68	6.47	10.00	10.23	10.13
Total	9.44	9.32	9.26	9.19	9.81	9.75	9.89	9.86	9.20	9.77	13.25	13.54	13.20

Figure 2.7 GHG Emissions from The Energy Sector By Gas, 2010 – 2022



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2	8.67	8.62	8.76	8.69	8.99	8.98	9.45	9.33	8.65	9.32	12.65	13.06	12.61
CH4	0.75	0.68	0.47	0.49	0.80	0.75	0.42	0.51	0.53	0.43	0.57	0.44	0.56
N2O	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03

Figure 2.7 shows CO_2 consistently remain the most significant gas in the energy sector representing more than 95% of total emissions followed by CH_4 and the least being N_2O at less than 1%.

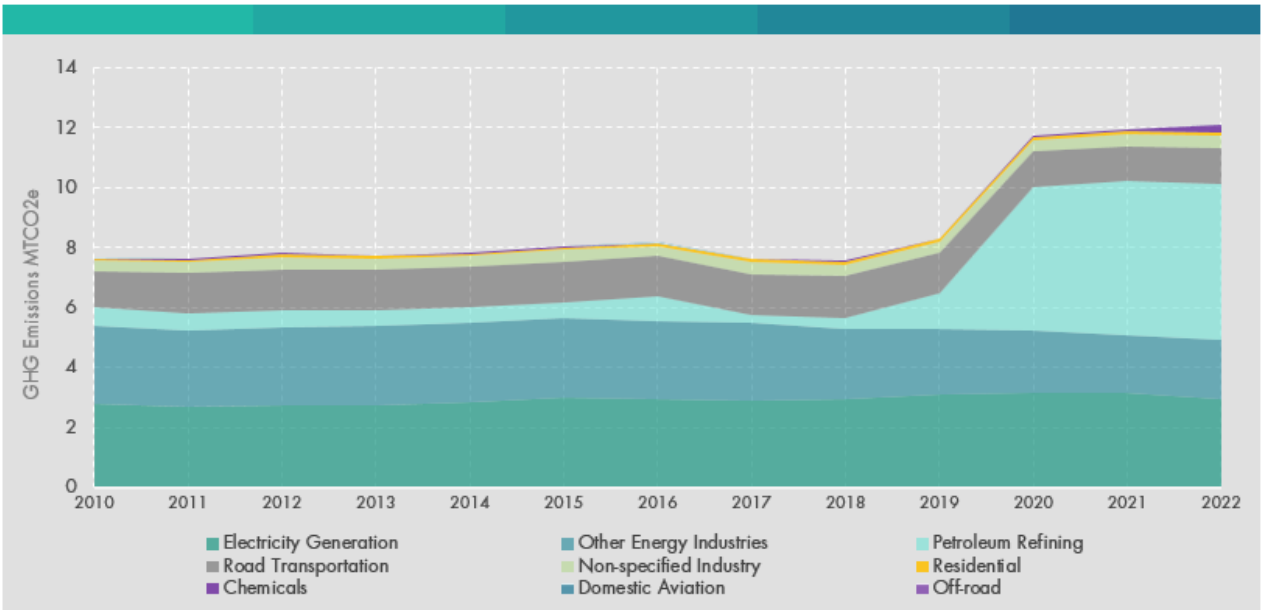
2.10.1.2 Emissions by Category

Following the 2006 IPCC Guidelines, Brunei's energy GHG Emissions are categorized into two relevant categories; 1A Fuel Combustion Activities and 1B Fugitive Emissions from Fuels. Table 2.6 provides a breakdown in energy sector GHG emissions for the year 2022 for these categories.

Table 2.6 GHG Emissions from Energy use in Brunei by Category and Gas, 2022

GHG Source Category	GHG Sources	CO2	CH4	N2O	TOTAL	% Energy Share	% Total Share
Fuel Combustion Activities (1A)	Energy Industries	10.11	0.00	0.02	10.13	76%	75%
	1.A.1.a.i – Electricity Generation	2.94	0.0015	0.00145	2.94	22.3%	21.7%
	1.A.1.b – Petroleum Refining	5.21	0.0021	0.0126	5.23	39.6%	38.5%
	1.A.1.c.ii -Other Energy Industries	1.96	0.0009	0.00100	1.96	14.9%	14.5%
	Manufacturing & Construction	0.67	0.0005	0.0009	0.67	5.0%	5.0%
	1.A.2.c – Chemicals	0.26	0	0	0.26	2.0%	2.0%
	1.A.2.m – Non-specified Industry	0.40	0.0005	0.000864	0.40	3.1%	3.0%
	Transport	1.18	0.0115	0.015	1.21	9.2%	8.9%
	1.A.3.a.ii – Domestic Aviation	0.086	0.00001	0.00002	1.21	0.1%	0.1%
	1.A.3.b.i – Cars	1.18	0.0115	0.015	0.00862	9.1%	8.9%
	1.A.3.e.ii – Off-roads	0.0002	0.00000023	0.000002	1.20	0.001%	0.00%
	Other Sectors	0.08	0.0002	0.00004	0.00015821	0.6%	0.6%
	1.A.4.b - Residential	0.08	0.0002	0.00004	0.08	0.6%	0.6%
	Total Fuel Combustion	12.04	0.02	0.03	12.09	91.6%	89%
Fugitive Emissions (1B)	Fugitive Emissions (Oil)	0.26	0.38	0.00		4.9%	4.8%
	1.B.2.a.i – Venting	0.00024	0.305	0	0.31	2.3%	2.3%
	1.B.2.a.ii – Flaring	0.263	0.038	0.0001	0.30	2.3%	2.2%
	1.B.2.a.iii.2 – Production & Upgrading	0.00003	0.038	0	0.04	0.3%	0.3%
	1.B.2.a.iii.4 – Refining	0	0.006	0	0.01	0.1%	0.1%
	Fugitive Emissions (Natural Gas)	0.30	0.16	0.0001	0.46	3.5%	3.4%
	1.B.2.b.i – Venting	0.10	0.09	0	0.19	1.4%	1.4%
	1.B.2.b.ii – Flaring	0.2	0.03	0.0001	0.23	1.8%	1.7%
	1.B.2.b.iii.2 – Production	0.000007	0.01	0	0.01	0.1%	0.1%
	1.B.2.b.iii.6 – Other	0.000009	0.03	0	0.03	0.2%	0.2%
	Total Fugitive Emissions	0.57	0.54	0.000108	1.11	1.1%	8.4%
Total Energy Emissions		**12.61**	**0.56**	**0.03**	**13.20**	**100%**	**97%**

Figure 2.8 GHG Emissions from Fuel Combustion, 2010 – 2022



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Electricity Generation	2.81	2.68	2.74	2.74	2.83	2.99	2.93	2.87	2.94	3.11	3.17	3.17	2.94
Petroleum Refining	0.61	0.59	0.57	0.55	0.53	0.52	0.83	0.27	0.38	1.21	4.75	5.13	5.23
Other Energy Industries	2.59	2.56	2.62	2.64	2.65	2.65	2.62	2.62	2.35	2.15	2.08	1.93	1.96
Chemicals	0.01	0.02	0.03	0.01	0.03	0.02	0.03	0.03	0.03	0.03	0.04	0.03	0.26
Non-specified Industry	0.34	0.35	0.41	0.38	0.33	0.40	0.32	0.42	0.39	0.38	0.36	0.39	0.40
Domestic Aviation	0.007	0.009	0.010	0.009	0.009	0.010	0.008	0.0003	0.0002	0.0003	0.007	0.009	0.009
Road Transportation	1.21	1.32	1.36	1.34	1.37	1.37	1.35	1.35	1.37	1.34	1.24	1.16	1.20
Off-road	0.0007	0.0005	0.0004	0.0004	0.0004	0.0003	0.0002	0.0003	0.0003	0.0004	0.0002	0.0002	0.0002
Residential	0.08	0.08	0.08	0.08	0.07	0.08	0.08	0.09	0.10	0.09	0.09	0.11	0.08
TOTAL	7.66	7.61	7.82	7.74	7.82	8.04	8.18	7.64	7.56	8.31	11.74	11.93	12.09

Fuel Combustion Activities (1A) include emissions from burning fossil fuels to produce energy for electricity, heating, transportation, and industrial activities. The total emissions from this category were 12.09 $MtCO_2e$ in the year 2022 (Table 2.5). As illustrated in Figure 2.8, it has been the largest contributor of total energy emissions throughout the inventory period, showing an increase of 32% from 7.66 $MtCO_2e$ in 2010. Fuel combustion is further sub-categorized into energy industries, manufacturing industries and construction, transport and other sectors.

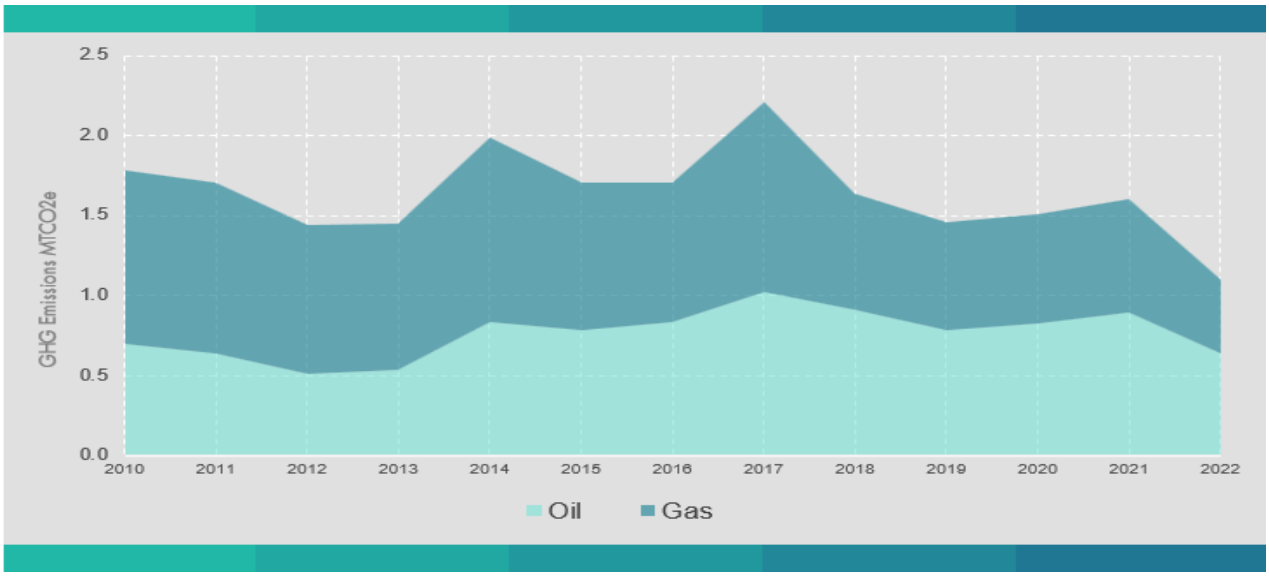
Energy industries (1.A.1) – this subcategory constitutes emissions from fossil fuels combustion for electricity generation by public utilities and energy production industries. In 2022, this sub-category accounted for 76% of energy emissions and 75% of total aggregate GHG emissions making it the highest source of emissions in Brunei. The sharp increase in 2020 for petroleum refining was due to the start of Brunei's coal-fired powerplant.

Manufacturing Industries and Construction (1.A.2) - This subcategory includes GHG emissions generated by fossil fuel combustion in industry, including burning for power and heat generation for in-house use. In 2022, it accounted for 5% of both energy and total aggregate emissions.

Transport (1.A.3) - This subcategory comprises the combustion of fossil fuels (gasoline and diesel oil) for road transport and domestic aviation (helicopters only). Emissions from international transport activities (bunker fuels) are estimated and reported separately. These estimates are excluded from the national totals as per the 2006 IPCC Guidelines. Emissions from the transport sector were 1.2 $MtCO_2e$ in 2022, accounting for around 9% of both energy and total aggregate emissions. The road transport sector accounted for 99% of total transport emissions and has remained somewhat constant throughout the inventory period.

Other sectors (1.A.4) - This subcategory includes GHG emissions from fossil fuels burned in commercial and institutional buildings, homes, and activities related to agriculture, forestry, fisheries, and the fishing industry. Cooking, lighting, space heating and cooling, refrigeration, and pumping characterize the residential, commercial, and agricultural sectors included in this category. In Brunei, this sector covers emissions from residential and commercial sources, such as LPG for cooking, town gas, kerosene, and gas/diesel oil, which together make up less than 1% of total emissions. Due to a lack of detailed data, emissions from fuel combustion in the commercial sector are aggregated with those from the residential sector.

Figure 2.9 GHG Emissions from Fugitive Emissions by Fuel Type, 2010 – 2022



Fugitive emissions (1B) refer to all intentional or unintentional GHG emissions released during the extraction, processing, storage and distribution of fossil fuels. The sources of **fugitive emissions (1B)** from oil and gas systems include, but are not limited to, equipment leaks, evaporation and flashing losses, venting, flaring, incineration and accidental releases. In 2022, fugitive emissions accounted for 9% of Brunei's total energy emissions, showing a downward trend compared to a decade ago. This improvement is attributed to several plant rejuvenation activities that have enhanced operational performance, leading to a reduction in unplanned venting and flaring.

2.10.1.3 Category Description, Activity Data, Emission Factor & Data Source

Principal sources of activity data used in Table 2.7 includes assumptions and treatment methods. To the extent possible, official country-specific activity data was used for inventory elaboration, first from official published statistics and secondly from published peer-reviewed or official publications. When such data was not available, default values were adopted primarily from the 2019 IPCC Refinement and secondly from the 2006 IPCC Guidelines.

Table 2.7a Category Description, Activity Data, Emission Factor and Data Source for Energy

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
1A1 ENERGY INDUSTRIES: Emissions from Energy Industries predominantly result from the combustion of fossil fuels for electricity generation and the industries' own operational use. This category is divided into three subcategories: Electricity Generation, Petroleum Refining, and Other Energy Industries.				
1A1a Public Electricity and Heat Generation	This subcategory includes GHG emissions associated with the production of electricity and heat from the combustion of fuel in public or privately-owned utility power plants. Brunei's electricity generation is predominantly fuelled by natural gas, with only one diesel power plant.	Natural gas (MMBTU); Diesel (litres)	Default EF values from Table 2.2 of Chapter 2: Stationary Combustion of Volume 2 (Energy) of the 2006 IPCC Guidelines	Department of Energy obtained from Department of Electrical Services (DES)
1A1b Petroleum Refining	This subcategory covers emissions from refining crude oil into various petroleum products. GHG emissions mainly arise from burning of natural gas and coal that support the refining processes. In recent years, there has been a notable increase in emissions, due to the commencement of a new refining capacity powered by coal, which began operations in 2019.	Natural gas (10^6 m^3); Diesel (TJ); Lignite (tonne); Refinery gas (tonne); Flexi gas (tonne)	Plant-specific EF from BSP, Total Energies Brunei and Hengyi Industries	BSP, Total Energies Brunei, Hengyi Industries
1A1c Other Energy Industries	Emissions comprise from electricity generation and own-use generated from natural gas combustion for the operation of LNG plant.	Natural gas (10^6 m^3)	Plant-specific EF from BLNG	BLNG

Table 2.7b Category Description, Activity Data, Emission Factor and Data Source for Energy

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
1A2 MANUFACTURING INDUSTRIES AND CONSTRUCTION: Emissions from Manufacturing Industries and Construction mainly originate from the Chemical Industry and Non-specified Industries.				
1A2c Chemicals	Emissions comprise from natural gas combusted for the operation of petrochemical plants (including electricity generation and own-use)	Natural gas (MMBtu, 10^3 Nm^3)	Default EF values from Table 2.3 of Chapter 2: Stationary Combustion of Volume 2 (Energy) of the 2006 IPCC Guidelines.	BMC

Table 2.7c Category Description, Activity Data, Emission Factor and Data Source for Energy

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
1A3 TRANSPORT: The transport sector category consists of three subcategories: Domestic Aviation, Road Transportation and Other Transportation (Off-Road). The primary contributor to GHG emissions from this sector is road transport, which accounts for the majority of transport emissions. Emission from the transport sector encompasses emissions resulting from the consumption of petrol (including motor gasoline and diesel) within road transport, which includes the utilisation of agricultural vehicles on paved roads.				
1A3a Domestic Aviation	Emissions from Domestic Aviation includes emissions only includes **Jet A1 combustion in helicopters**, excluding used for military	Jet A1 Kerosene (litres)	Default EF values from Table 3.2.1 of Chapter 3: Mobile Combustion of Volume 2 (Energy) of the 2006 IPCC Guidelines	Department of Energy obtained from Brunei Shell Marketing (BSM) and BSP
1A3b Road Transportation	Emission from the transport sector encompasses emissions resulting from the consumption of petrol (including motor gasoline and diesel) within road transport, which includes the utilisation of agricultural vehicles on paved roads.	Motor Gasoline (litres), Diesel (litres)		
1A4 OTHER SECTORS: Other sector consists of emissions from fuel combustion activities, including combustion of electricity generation (town gas) in the Residential sector.				
1A4b Residential	Includes all emissions from diesel, LPG, other kerosene and natural gas combustion in households.	Other Kerosene (m^3), Diesel (m^3), LPG (m^3), Natural Gas (1000 m^3)	Default EF values from Table 2.5 of Chapter 2: Stationary Combustion of Volume 2 (Energy) of the 2006 IPCC Guidelines	DOE obtained from BSM

Table 2.7d Category Description, Activity Data, Emission Factor and Data Source for Energy

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
1B2 FUGITIVE EMISSIONS – OIL AND NATURAL GAS: Intentional or unintentional release of emissions that occur during extraction of oil and natural gas from offshore fields, its transportation via pipelines to onshore facilities such as refineries and storage tanks, and eventual processing into refined products. The subcategories comprise of fugitive emissions from Oil mainly originated from Venting, Flaring, Production and Upgrading, Refining and fugitive emissions from Natural Gas which originated from Venting, Flaring, Production and Other.				
1B2a Oil	This subcategory includes emissions from venting, flaring and all other fugitive sources associated with the production of oil and refining.	Natural gas (MMBTU, 10^3 Nm^3)	Flow meters following American Petroleum Institute (API) Compendium; Mass-Balance & Air Emission Calculation by Shell Global Solution	BSP, BLNG Total Energies Brunei, Hengyi Industries
1B2b Natural Gas	This category comprises emissions from venting, flaring and all other fugitive sources associated with the production of natural gas (including both associated and non-associated) and others.	Associated and non-associated natural gas production, venting and flaring activities, other fugitive activity ($1O^6$ m^3)		

2.10.1.4 Inventory Gaps and Plan Improvements

In order to enhance future inventories for the energy sector, the following improvements were identified and recommended;

Table 2.8 Inventory gaps and plan improvements for Energy

Category	Inventory Gaps	Plan Improvements
1.A.2.c	Inconsistency across time periods when estimating emissions due to application of different methodologies i.e. Tier 1 for the period of 2010-2021 and Tier 3 for 2022.	1. Develop and implement a National GHG Inventory Improvement Plan for emission factors. 2. Ensure consistency in estimating emissions. standardised methodologies should be utilised.
1.B.2	Fugitive emissions from venting and flaring from processing, production, storage, and distribution, as accounted for by Hengyi Industries, were calculated based on the difference between input and output of material (mass balance check).	Enhance reporting controls to ensure that adequate transparency in the calculations is maintained.

2.10.1.5Comparison of the Sectoral Approach with the Reference Approach

A comparison between the reference approach and the sectoral approach for the energy sector was conducted. In 2022, CO_2 emissions under the reference approach resulted in emissions of 14.52 $MtCO_2e$, whereas Sectoral approach resulted in 11.92 $MtCO_2e$. This indicates that the sectoral approach resulted in 21% lower compared to the reference approach.

Table 2.9 Comparison of CO_2 emissions between Sectoral and Reference approach for 2022

	Reference Approach				Sectoral Approach		Difference	
Fuel	Apparent Consumption (TJ)	Excluded consumption (TJ)	Apparent Consumption (excluding non-energy use and feedstocks) (TJ)	CO_2 Emissions (Gg)	Energy Consumption (TJ)	CO_2 Emissions (Gg)	Energy Consumption (%)	CO_2 Emissions (%)
Crude Oil	410,490	-	410,490	30,102.6	-	-	100	100
Gas/Diesel Oil	-131,075	-	-131,075	-9,708.28	13,927.24	1,028.67	-1,041.14	-1,043.77
Jet Kerosene	-2,171	-	-2,171	-155.2	118.81	8.59	-1,927.24	-1,907.13
Liquefied Petroleum Gases	-25,500	-	-25,500	-1,608.2	749.36	47.28	-3,508.90	-3501.10
Motor Gasoline	-65,882	-	-65,882	-4,565.62	11,847.29	821.01	-656.09	-656.09
Naphtha	-34,662	-	-34,662	-2,541.88	140.42	10.09	-100	-100
Other Petroleum Products	-77,501	177	-77,678	-5,696.39	-	-	100	100
Refinery Gas	-	-	-	-	27,424.10	1,818.03	-100	-100
Lignite	30,098.2	-	30,098.2	3045.94	27,832.83	2,515.74	8.14	21.08
Natural Gas (Dry)	119,445	18,846	100,599	5,643.6	96,578.29	5,671.15	4.16	-0.49

Table 2.10 Comparison of the Reference and Sectoral Approach, 2010 and 2022

CO_2 Emissions (Mt)	2010	2022
Under Reference Approach	7.40	14.52
Under Sectoral Approach	7.63	11.92
Difference (%)	-3.02%	21%

2.10.1.6 International Bunker Fuels

Emissions from international aviation and marine bunker fuels are excluded from the national total emissions but reported as memo item.

2.10.2 Industrial Processes and Product Use (IPPU)

This section provides respective emissions, activity data and emission factors, methodologies and plan improvements for categories under IPPU.

Industrial products that potentially emit Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) such as freezers, fridge, and electronic appliance, etc. were imported and used in Brunei, but its quantity was possibly small. Importantly, it lacked data about the products and uses.

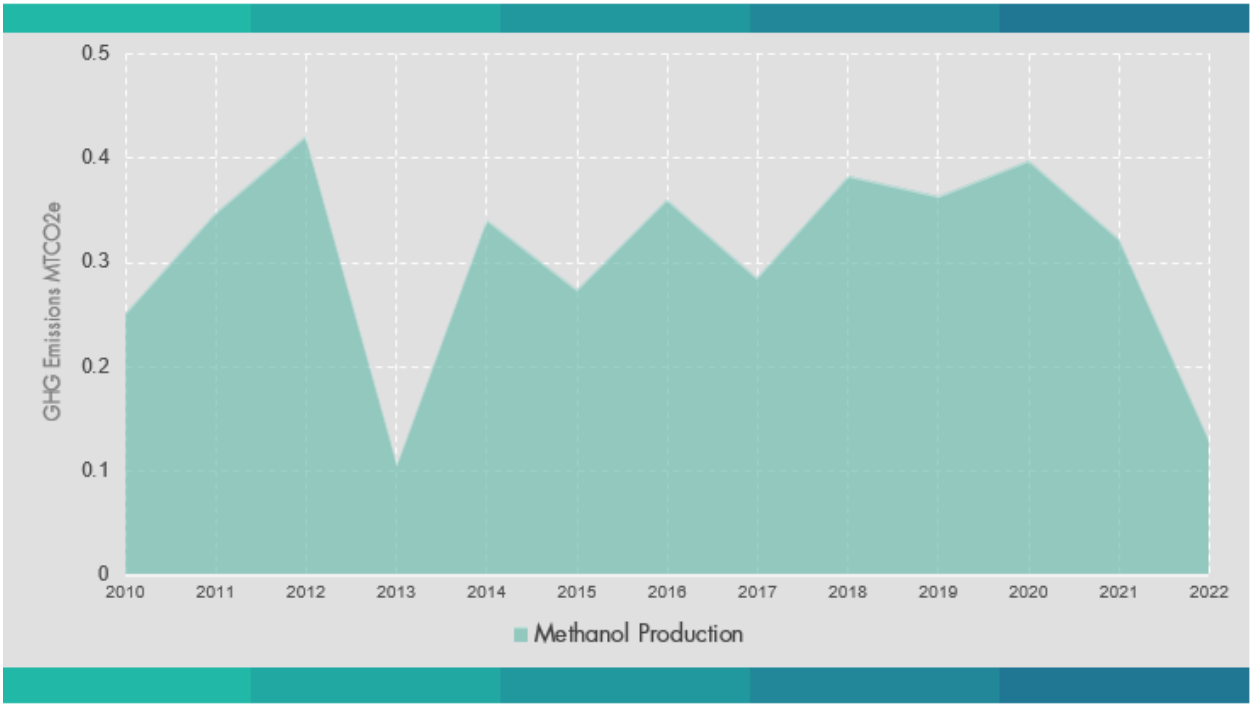
2.10.2.1 Overview of Emissions from IPPU

The IPPU sector includes non-energy related emissions from industrial processing plants. The main emission sources are releases from industrial processes that chemically or physically transform raw material, e.g., ammonia products manufactured from fossil fuels.

In 2022, the industrial process sector in Brunei emitted 0.13 $MtCO_2e$ which accounts for 1% of total aggregate GHG emissions. The chemical industries represent the sole source of emissions from industrial processes and product use from 2010 to 2022, and on average, accounts for only 3% of total aggregate GHG emissions. Although Brunei's chemical industry includes both methanol and ammonia production, only data from methanol has been included in the inventory for this period. BMC, operational since 2010, produces methanol through a process of natural gas pre-treatment, syngas production via catalytic reforming, methanol synthesis, and methanol distillation for final product purification.

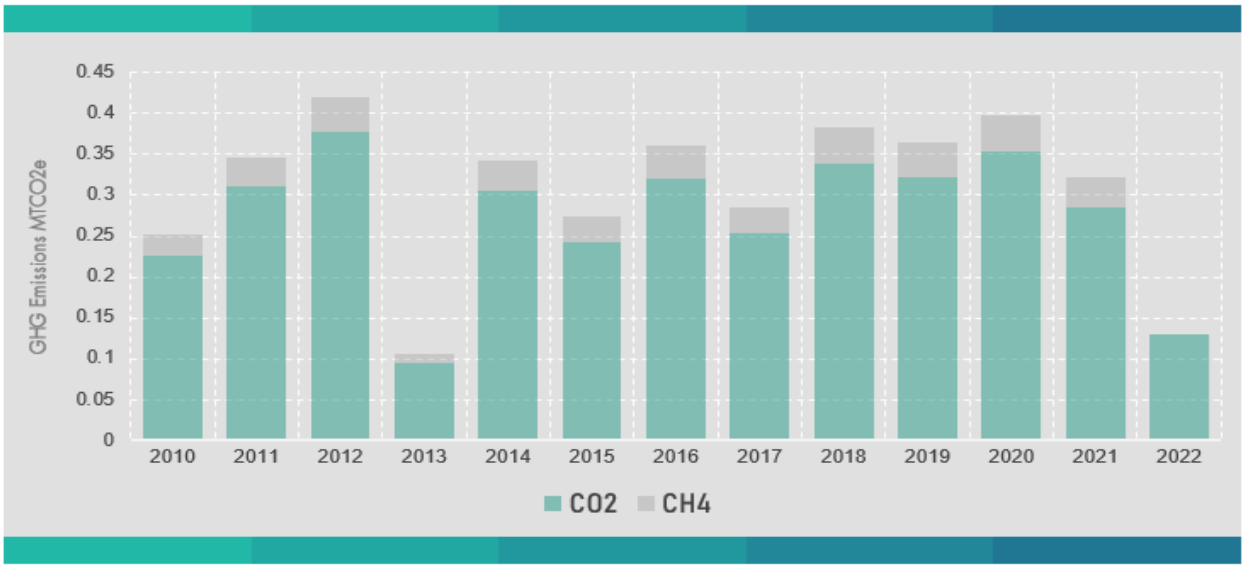
Figure 2.10 illustrates the associated emissions and trends for this sector over the inventory period. The trend inconsistency observed in the chart can be attributed to the irregular operation of the factory due to various operational constraints in its earlier years.

Figure 2.10 GHG Emissions from IPPU Sector, 2010 – 2022



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Methanol Production	0.25	0.35	0.42	0.11	0.34	0.27	0.36	0.29	0.38	0.36	0.40	0.32	0.13

Figure 2.11 GHG Emissions from IPPU Sector by Gas, 2010 – 2022



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2	0.23	0.31	0.38	0.10	0.31	0.24	0.32	0.25	0.34	0.32	0.35	0.29	0.13
CH4	0.03	0.036	0.044	0.011	0.035	0.031	0.041	0.033	0.044	0.042	0.046	0.037	0.000

2.9.2.2 Category Description, Activity Data, Emission Factor & Data Source

Principal sources of activity data used in Table 2.11 includes assumptions and treatment methods. To the extent possible, official country-specific activity data was used for inventory elaboration, first from official published statistics and secondly from published peer-reviewed or official publications. When such data was not available, default values were adopted primarily from the 2019 IPCC Refinement and secondly from the 2006 IPCC Guidelines.

Table 2.11 Category Description, Activity Data, Emission Factor and Data Source for IPPU

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
2B CHEMICAL INDUSTRY: Covers emissions from key processes in the petrochemical production i.e. methanol				
2.B.8.a Methanol	Comprise of emissions from natural gas combusted through the process of Conventional Steam Reforming, with primary reformer in the petrochemical for methanol production.	Volume of Natural Gas consumption (TJ, tonnes)	Tier 1 product-based EF from Table 3.12 of Chapter 3: Chemical Industry Emissions of Volume 3 (IPPU) (Used for 2010-2021) Tier 3 direct estimate of plant-specific emissions (Used 2022 onwards).	BMC

2.9.2.3 Inventory Gaps and Plan Improvements

In order to enhance future inventories for the IPPU sector, the following improvements were identified and recommended;

Table 2.12 Inventory Gaps and Plan Improvements for IPPU

Inventory Gaps	Plan Improvements
2.B – Chemical Industry Inconsistency across time periods when estimating emissions due to application of different methodologies i.e. Tier 1 for the period of 2010-2021 and Tier 3 for 2022. Unable to make changes to previous data due to difficulties in tracking back historical data.	Ensure consistency in estimating emissions, standardised methodologies should be utilised.
2.A – Mineral Industry Emissions from other industries were not estimated due to limited data. At present, GHG emissions reported in the IPPU sector include emissions from only one plant.	Identify and include other major industries that i.e., Cement Production, Food and beverage industry etc.
2.F – Product Uses as Substitutes for Ozone Depleting Substances Emissions from the usage of HFC and PFC are not estimated.	1. Enhance data collection efforts to gather information on the import, production and consumption of HFC and PFC, including refrigeration and air conditioning 2. Collaborate with the National Ozone Unit to evaluate potential use of the data they collect for estimating emissions

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

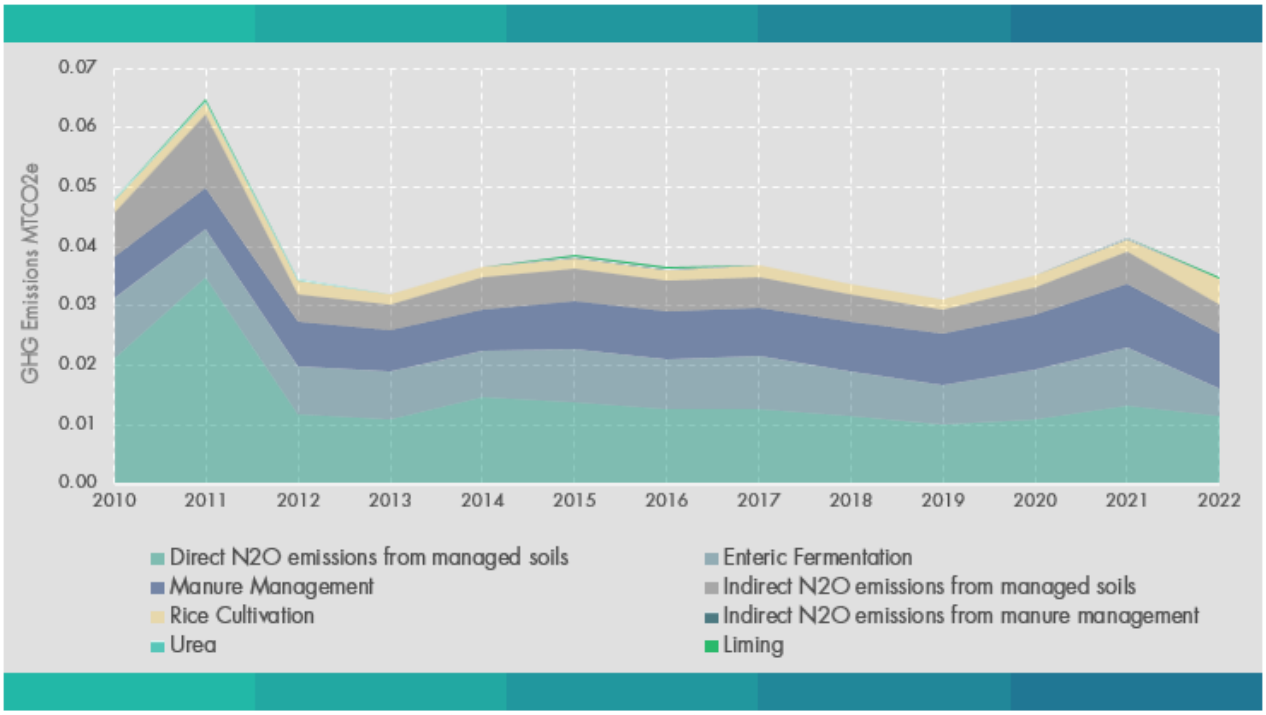
This section provides respective emissions, trends, activity data, emission factors, methodologies and plan improvements for categories under AFOLU.

The AFOLU Sector integrates agriculture, forestry and other land use emission and removal categories. This integration identifies that the underlying processes responsible for GHG emissions and removals, as well as the different forms of terrestrial carbon stocks, can occur across all types of land. This integration approach ensures consistency and completeness in the estimation and reporting of GHG emissions and removals (IPCC, 2006).

2.9.3.1 Overview of Emissions from Agriculture

In agriculture, GHG emissions were estimated from livestock, liming, urea application, direct and indirect emissions of N_2O from managed soils and manure management. Globally, this sector is a significant contributor to total GHG emissions, primarily through the release of CO_2, CH_4, and N_2O. In Brunei however, this sector is the smallest source of anthropogenic GHG emissions, accounting for on average, less than 1% of total national GHG emissions equivalent to 0.04 $MtCO_2e$. Figure 2.12 illustrates the associated emissions and trends from Agriculture sector over the inventory period. Compared to 2010, GHG emissions from the agriculture sector in 2022 was 40% lower.

Figure 2.12 GHG Emissions from Agriculture Sector, 2010 – 2022



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Direct N2O emissions from managed soils	0.0212	0.0348	0.0117	0.0108	0.0147	0.0137	0.0127	0.0127	0.0114	0.0099	0.0109	0.0131	0.0116
Enteric Fermentation	0.0101	0.0081	0.0081	0.0082	0.0077	0.0091	0.0082	0.0088	0.0076	0.0069	0.0085	0.0100	0.0045
Manure Management	0.0069	0.0071	0.0076	0.0069	0.0069	0.0082	0.0082	0.0083	0.0084	0.0085	0.0092	0.0106	0.0093
Indirect N2O emissions from managed soils	0.0077	0.0122	0.0047	0.0043	0.0056	0.0054	0.0051	0.0051	0.0047	0.0042	0.0046	0.0055	0.0049
Rice Cultivation	0.0019	0.0020	0.0023	0.0016	0.0017	0.0018	0.0019	0.0019	0.0016	0.0016	0.0019	0.0020	0.0042
Indirect N2O emissions from managed soils	0.0077	0.0122	0.0047	0.0043	0.0056	0.0054	0.0051	0.0051	0.0047	0.0042	0.0046	0.0055	0.0049
Urea	0.0002	0.0004	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Liming	0.0000	0.0004	0.0000	0.0001	0.0000	0.0003	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002

Following the 2006 IPCC Guidelines, the GHG Emissions from Brunei's Agriculture sector are categorized into two main sources; Livestock (3A) and Managed Soils on Land (3C). Table 2.13 provides a breakdown for the year 2022.

Table 2.13 GHG Emissions from Agriculture sector by Activity, 2022

GHG Sources	CO_2	CH_4	N_2O	Total
3A. Livestock				
3.A.1 Enteric Fermentation	0.0000	0.0045	0.0000	0.0045
3.A.2 Manure Management	0.0000	0.0023	0.0070	0.0093
Total Emissions from Livestock	0.0003	0.0110	0.0236	0.0139
3C. Aggregate Sources and non-CO_2 emissions sources on land				
3.C.2 Urea application	0.0002	0.0000	0.0000	0.0002
3.C.3 Liming	0.0001	0.0000	0.0000	0.0001
3.C.4 Direct N_2O Emissions from managed soils	0.0000	0.0000	0.0116	0.0116
3.C.5 Indirect N_2O Emissions from managed soils	0.0000	0.0000	0.0049	0.0049
3.C.6 Indirect N_2O Emissions from manure management	0.0000	0.0000	0.0000	0.0000
3.C.7 Rice cultivation	0.0000	0.0042	0.0000	0.0042
Total Emissions from Managed soils	0.0003	0.0042	0.0165	0.0210
TOTAL Emissions from Agriculture Sector				0.0349

Livestock (3A) covers emissions from livestock production systems, particularly those involving ruminants, which are significant sources of CH_4 emissions through enteric fermentation in their digestive systems. Manure management practices, including disposal and storage, also produce CH_4 and N_2O emissions due to decomposition processes such as methanogenesis and nitrification/denitrification, respectively. Additionally, volatilization and leaching from manure management can result in both direct and indirect N_2O losses. In Brunei, livestock types considered for GHG quantification include cattle and buffaloes for enteric fermentation, while poultry is considered for manure management. In 2022, emission estimates show that this sector emitted 0.0139 $MtCO_2e$, constituting 40% of total agriculture emissions, of which 0.0045 $MtCO_2e$, came from enteric fermentation and 0.0093 $MtCO_2e$, from manure management.

Managed Agricultural Soils (3C) refer to emissions from managed soils primarily arise from application of fertilizers, crop residues, manure, lime and urea in agricultural land. Managed Soils are a source of GHG emissions including direct & indirect N_2O emissions from additions of nitrogen to land due to deposition and leaching. Additions of liming materials and urea-containing fertilizer can result in release of CO_2. In 2022, emissions from managed soils amount to 0.0210 $MtCO_2e$. This includes emissions from rice cultivation (3C7) which releases CH_4 through anaerobic decomposition of organic material in flooded rice fields (methanogenesis process).

2.9.3.2 Category Description, Activity Data, Emission Factor and Data Source

Principal sources of activity data used in Table 2.14 includes assumptions and treatment methods. To the extent possible, official country-specific activity data was used for inventory elaboration, first from official published statistics and secondly from published peer-reviewed or official publications. When such data was not available, default values were adopted primarily from the 2019 IPCC Refinement and secondly from the 2006 IPCC Guidelines.

Table 2.14a Category Description, Activity Data, Emission Factor and Data Source for Agriculture

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
3A AGRICULTURE: encompasses various agricultural activities, focusing on emissions from enteric fermentation, manure management, rice cultivation, agricultural soils, and field burning of agricultural residues.				
3A1 Enteric Fermentation	This subcategory addresses CH_4 release during the digestive process of ruminant livestock, occurring in the rumen, where food breakdown releases CH_4 through burping or exhaling. In Brunei all livestock categories are included in the inventory except for a few of unknown ownership. The ruminant livestock includes non-dairy cattle, buffaloes, goats and sheep. Imported livestock are considered local because they undergo slaughter within its borders. The holding period in Brunei is 3 months.	Livestock population (number of heads), typical animal mass (kg) and number of days alive (days)	Default EF for Tier 1 method from Table 10.10 (Developing countries) and Table 10.11 (Asia) of Chapter 10: Emissions from Livestock and Manure Management of Volume 4 (AFOLU) of the 2006 IPCC Guidelines.	Department of Agriculture and Agrifood (DoAA), Ministry of Primary Resources and Tourism.
3A2 Manure Management	This subcategory refers to CH_4 and N_2O produced during the storage and treatment of manure, and from manure deposited on pasture. The types of animals currently inventoried include dairy cows, non-dairy cattle, buffaloes, goats, broiler chickens, and layer chickens. The DoAA has been consulted regarding the choice of the IPCC category for the Manure Management System (MMS) usage. All manure is handled through dry lot, liquid slurry, pit storage below animal confinement, composting-static pile and composting-passive windrow.		Default EF for Tier 1 method from Table 10.14 and 10.15 of Chapter 10 of Volume 4 (AFOLU) of the 2006 IPCC Guidelines and Table 10.13A (New), Table 10.14 (Updated) from 2019 IPCC Refinement	

Table 2.14b Category Description, Activity Data, Emission Factor and Data Source for Agriculture

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
3C2 Liming	Refers to CO_2 emissions from applying carbonates to soils in the form of limestone or dolomite.	Amount of limestone and dolomite (tonne).	Tier 1 Default EF are 0.12 (limestone) and 0.13 (dolomite) from Chapter 11.3.2 of Volume 4 (AFOLU).	Department of Agriculture and Agrifood (DoAA), Ministry of Primary Resources and Tourism.
3C3 Urea Application	Refers to CO_2 emissions from adding urea to soils	Amount of Urea (tonne)	Tier 1 Default EF is 0.20 for carbon emissions from Urea applications from Chapter 11.4.2 of Volume 4 (AFOLU)	
3C4 Direct N_2O emissions from managed soils	Refer to the release of N_2O directly from soil surfaces due to human activities and land management practices. Brunei's land use practices play a significant role in N_2O emissions from managed soils. The application of fertilizers where agriculture is practiced is common. Nitrogen-based fertilizers, such as urea and ammonium sulphate, are widely used to supplement soil nitrogen levels, especially in intensive cropping systems like rice cultivation.	Amount of Fertilizers (tonne)	Tier 1 Default EF from Table 10.23 and Table 11.1 from Chapter 10 and 11 of Volume 4 (AFOLU)	
3C5 Indirect N_2O emissions from managed soils	Indirect N_2O emissions from managed soils resulting from human activities in managed agricultural soils typically result from application of fertiliser, land use changes, tillage practices.	Amount of Fertilizers (tonne)	Tier 1 Default EF from Table 11.3 from Chapter 11 of Volume 4 (AFOLU)	
3C6 Indirect N_2O emissions from manure management	Refers to release of N_2O into the atmosphere as a result of processes indirectly related to, handling and storage of manure, which arise from the subsequent interactions of nitrogen compounds in the manure with soil, water and atmosphere.	Livestock population (number of heads)	Default values from Table 10.22 and Table 11.3 from Chapter 10 and 11 of Volume 4 (AFOLU)	

3C7 Rice Cultivation	Refers to CH_4 emissions occur during rice cultivation, particularly in flooded rice paddies caused by anaerobic decomposition of organic material. Water management practices before and during cultivation, use of organic and inorganic soil additives, soil type, temperature and type of rice variety play a role in influencing CH_4 emissions. Rice is a staple food crop in Brunei, and paddy fields are prevalent in various parts of the country. Farmers typically practice both rainfed and irrigated rice cultivation, with traditional methods still being used in many areas. Cultivation periods last 90 days and 180 days, for rainfed and irrigated respectively. The inventory includes all types of rice water management systems found in the country.	Harvested area (hectare), cultivation period (days)	Default EF and scaling factors values from Table 5.11, 5.12 and 5.13 from Chapter 5: Cropland of Volume 4 (AFOLU)	

2.9.3.3 Land-Use Changes & Its Corresponding LULUCF categories

Land-use changes, such as deforestation, reforestation, and the conversion of land for agriculture or urban development, can significantly impact GHG emissions. However, Brunei is currently unable to estimate these emissions due to a lack of sufficient and reliable data on the different types of land use in the country, the specific activities taking place on the land, and the extent of land-use changes over time.

Table 2.15 Brunei Darussalam's Land-Use Management

IPCC		National Context		
Type of Land	IPCC Definition	Responsible Agency	Responsibility	Area (ha)
Forest land	Land that is primarily covered by forests and is used for forestry activities, including timber production, conservation, and habitat preservation. Forestland plays a crucial role in carbon sequestration, biodiversity conservation, and regulating the water cycle.	Forestry Department	Responsible for forest land management and monitoring changes such as deforestation or reforestation as per Brunei's Forest Act.	380,000
Cropland	Land used for growing crops, including cereals, vegetables, fruits, and other agricultural products. Cropland management practices can vary widely, from traditional farming to intensive agriculture.	DoAA	Responsible for all agricultural land and oversees its use for farming and related activities.	4,751.45
Grassland	Land that is primarily used for grazing livestock or left in its natural state as grasslands. Grassland management includes activities like grazing, hay production, and conservation.	N/A	Dependent upon land gazette.	157,392
Wetland	Brunei Darussalam's Wetland falls under the definition of Forest land category	Forestry Department	Responsible for forest land management and monitoring changes such as deforestation or reforestation as per Brunei's Forest Act.	-
Settlement	Land areas that are developed for residential and industrial infrastructure, including villages, towns and cities, road and transport networks.	Department of Town and Country Planning (TCP)	Regulates land development, including the conversion of forest land to non-forest uses such as agriculture or urban areas.	34,356.01
Total land area				576,500

There is currently no data available to track land-use conversion, making it challenging to accurately record changes for emission estimation. Areas under each land-use without conversion are reported for 2022 in the table 2.15.

2.9.3.4 Inventory Gaps and Plan Improvements

In order to enhance future inventories for AFOLU sector, the following improvements were identified and recommended;

Table 2.16 Inventory Gaps and Plan Improvements for Agriculture

Category	Inventory Gaps	Plan Improvements
-	Imprecise emission estimates due to use of tier 1 emission factors.	Develop and implement a National GHG Inventory Improvement Plan for emission factors.
-	Absence of robust QA/QC processes to verify data for agricultural emissions.	Implement QA/QC procedures to verify the accuracy and reliability of agriculture collected
3A2	**Manure Management:** Challenges associated with manure as landfills in terms of tracking and categorization.	Improve national data on Manure Management by working with DoAA to develop a mechanism to collect and track manure management practices from data providers (farmers/small businesses etc).
3C2 & 3C3	**Liming and Urea application:** Methodological issues in calculating emissions, including whether to base it on the production of fertiliser batches or when they are used.	Refine definitions and assumptions to improve accuracy and reduce uncertainty of activity data. Push for improved technology i.e. satellite imagery and Geographical Information System (GIS) to assist with monitoring. Support research and development on effects of different application rates, timing, and methods on GHG emissions.
3B	**Land Use Changes:** Insufficient data to estimate emissions/removals from land use changes hence is not reported in this BTR. • Inadequate historical data to establish baseline and track changes. • Limited data on soil carbon stocks and changes, particularly in different soil types and management regimes. • Gaps in Data on Land Degradation and Restoration such as Incomplete information on forest growth rates, biomass density, and species composition.	Support research initiatives focused on land use change and its impacts on GHG emissions and carbon stocks. Push for improved technology i.e. satellite imagery and remote sensing. Work with relevant agencies to standardized protocols for data collection and mapping to ensure consistency and comparability.

2.9.4 Waste

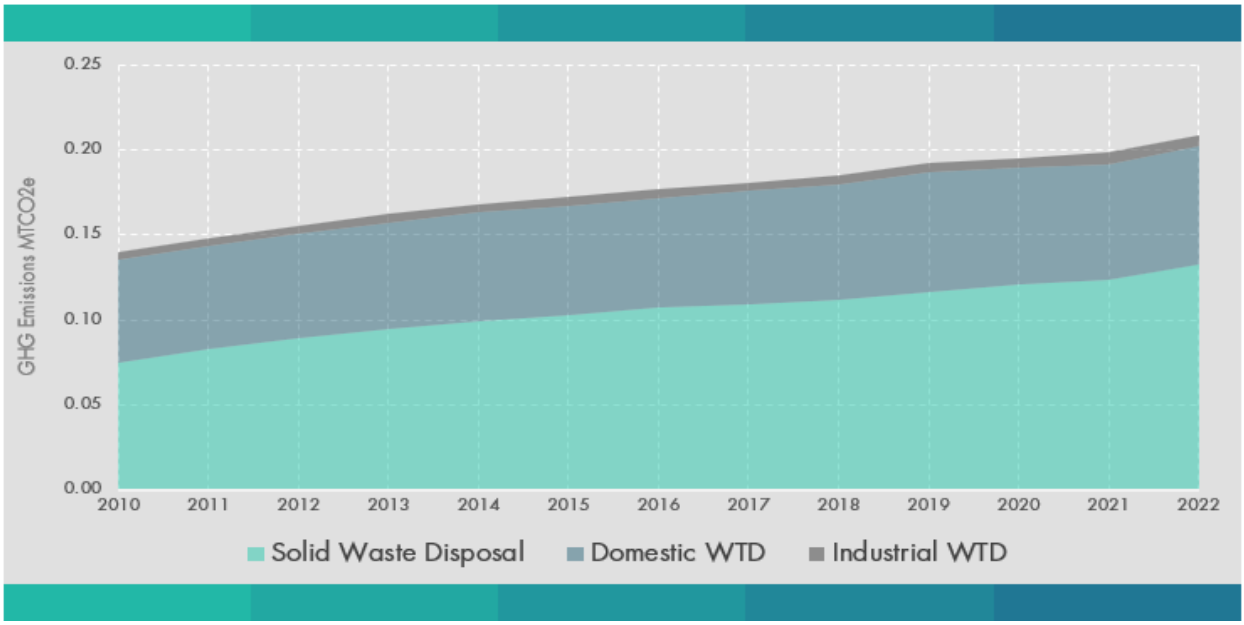
This section provides respective emissions, activity data and emission factors and methodologies for categories under waste.

2.9.4.1 Overview of Waste Emissions

The waste sector consists of emissions from solid waste disposal as well as wastewater treatment and discharge which is further categorized into domestic and industrial. The waste sector constitutes around 1.6% of total national GHG emissions. In Brunei, 85% of solid waste goes directly to Brunei's landfill, 15% are recycled. These landfills are the main source of CH_4 generation and emissions through anaerobic decomposition of solid waste. Domestic and commercial wastewater are either treated by centralized sewage treatment facility or septic tanks.

Figure 2.13 illustrates the associated emissions and trends for this sector over the inventory period. Between 2010 and 2022, the waste sector emissions had increased by 49.3%. Emissions from the decomposition of solid waste had increased by 76.5% while that from wastewater treatment and discharge increased by 17.6%. The growth in emissions was contributed by the increase in population, domestic and commercial wastewater generation as well as the increase in the processing of meat and fish products (industrial).

Figure 2.13 GHG Emissions from Waste Sector by Category, 2010 – 2022



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Solid Waste Disposal	0.08	0.08	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.13
Domestic WTD	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Industrial WTD	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	0.14	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.20	0.20	0.21

The total emissions in 2022 amounted to 0.21 $MtCO_2e$, of which about 64% (0.13 $MtCO_2e$) came from solid waste disposal. Domestic wastewater and discharge (WTD) were responsible for emitting 0.07 $MtCO_2e$ (33% of total waste emissions), while the remainder is made up of industrial emissions, which were minimal (Table 2.17). CH_4 constitutes more than 98% of the total emissions from waste.

Table 2.17 GHG Emissions from Waste Sector, 2010-2022

GHG Sources	CO_2	CH_4	N_2O	TOTAL	% of Total Waste	% of Total Emission
Solid Waste Disposal	0	0.13	0.00	0.13	64%	0.96%
Domestic Waste Water Treatment	0	0.06	0.01	0.07	33%	0.52%
Industrial Waste Water Treatment	0	0.01	0	0.01	3%	0.07%
TOTAL	0	0.20	0.01	0.21	100%	1.6%

2.9.4.2 Category Description, Activity Data, Emission Factor & Data Source

Principal sources of activity data used in Table 2.18 includes assumptions and treatment methods. To the extent possible, official country-specific activity data was used for inventory elaboration, first from official published statistics and secondly from published peer-reviewed or official publications. When such data was not available, default values were adopted primarily from the 2019 IPCC Refinement and secondly from the 2006 IPCC Guidelines.

Table 2.18a Category Description, Activity Data, Emission Factor and Data Source for Waste

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
4A SOLID WASTE DISPOSAL: Covers CH_4 emissions from a well-managed landfill site (semi-aerobic condition)				
4.A.1 Managed Waste Disposal Sites	CH_4 emissions generated from solid waste that are disposed at an Engineered Landfill sites. This includes Municipal Solid Waste (MSW), industrial waste and sludge. MSW is composed of food waste, plastics, paper, garden waste, nappies, textile, abattoir and wood.	Amount of solid waste by category (tonne) and its percentage distribution	Default EFs and parameters[10] from Table 3.1 (Updated), Table 3.2, Table 3.3 and Table 3.4 of Chapter 3: Solid Waste Disposal of Volume 5 (Waste) from the 2019 IPCC Refinement.	DEPR

[10] Methane Correction Factors (MCF), Degradable Organic Carbon (DOC), Fraction of DOC disseminated (DOCf), CH_4 generation rate constant (k), Delay time, Fraction of CH_4 in developed gas (F), Oxidation factor (OX)

Table 2.18b Category Description, Activity Data, Emission Factor and Data Source for Waste

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Emission Factor (EF)	
4D WASTEWATER TREATMENT AND DISCHARGE: Covers CH_4 emissions from domestic and industrial wastewater treatment and discharge as well as N_2O emissions from decomposition of nitrogen compounds in domestic wastewater effluent.				
4.D.1 Domestic Wastewater Treatment and Discharge.	Domestic wastewater is defined as wastewater from household and commercial water use. Types of treatment or discharge involved are centralized, aerobic treatment plant and anaerobic reactor, septic tank, and vacuum system. Wastewater treatments in Brunei are managed by the DDS, PWD. All sewage that passes through the sewage treatment plant/septic tank are considered treated effluent except old Kg Ayer houses directly discharge to the river/sea which are not treated at the moment.	Total Population for Brunei, Per capita protein consumption, Degree of Utilisation of wastewater treatment system	Default EFs and parameters[11] from Tables 6.1, 6.2, 6.3 (updated), 6.4 & 6.6 from Chapter 6: Wastewater Treatment and Discharge of Volume 5 (Waste) from 2019 Refinement	DEPR Department of Economic Planning and Statistics (DEPS)
4.D.2 Industrial Wastewater Treatment and Discharge.	This subcategory refers to CH_4 emissions from Industrial effluent discharged from plants/facilities (fish processing, meat & poultry and petroleum refineries only). Industrial wastewater in Brunei is discharged directly into bodies of water. Chemical Oxygen Demand (COD) is not available because wastewater (influent) that enter into public sewer system typically from residential and commercial buildings including light industrial area, and not heavy industry like oil and gas industry, and power generation.	Total industrial product from fish processing, meat and poultry, and petroleum refineries (tonnes)	Default EFs and parameters[12] from Table 6.8 (Updated) from Chapter 6: Wastewater Treatment and Discharge of Volume 5 (Waste) from 2019 Refinement	DOE DEPS

[11] Degradable organic component (BOD), Correction factor for industrial BOD discharged in sewers, Maximum CH_4 Producing Capacity (B_O) for Domestic Wastewater, Methane Correction Factor for each treatment system (MCF) and CH_4 emission factor by type of treatment system and discharge pathway, Degrees of Treatment Utilisation (T) by income groups, Fraction of Nitrogen in protein (FNPR), Factor for non-consumed protein added to wastewater (FNON-CON), N_2O emissions factor from effluent

12 Default MCF values for Industrial wastewater, Maximum CH_4 producing capacity (COD), CH_4 emission factor for each treatment/discharge pathway

2.9.4.3 Inventory Gaps and Plan Improvements

In order to enhance future inventories for waste sector, the following improvements were identified and recommended;

Table 2.19 Inventory Gaps and Plan Improvements for Waste

Inventory Gaps	Plan Improvements
4A – Solid Waste Disposal Current inventory includes waste collection and disposal data obtained from the 3 operating landfills (Sungai Paku, Rubada and Anduki). Data from other waste disposal entities are not considered.	To include other companies and contractors that are processing waste which are hazardous in nature i.e. chemical, oil sludge and clinical.
4D2 – Industrial Wastewater Treatment & Discharge Industries beyond fish processing, meat and poultry and petroleum refineries have not been considered. The chosen waste treatment method for calculating emissions in 4D2 requires reassessment, as its presence in the country is unknown.	To include other industries in the estimation for completeness and review type of waste treatment selected for calculation

2.11 GHG Removals

This section provides information on methodologies, trends, activity data, carbon stock change factors, and plan improvements associated with the emissions and removals of GHG from the land category under LULUCF.

The six land-use categories under the IPCC are Forest Lands, Croplands, Grasslands, Wetlands, Settlements, and Other Lands. Each land-use category has been further subcategorized into land under the categories i.e. Forest Land Remaining Forest Land, Forest Land Remaining Croplands etc.

Due to limited data on land use change in Brunei, only Forest Lands – Forest Remaining Forest Land is considered in the inventory preparation.

2.11.1 Overview of GHG Removals

The forestry sector plays an important role in Brunei's national GHG inventory profile. Forestland under this sector is the only sector in Brunei that consistently absorbs CO_2 making it highly relevant for its mitigation potential. GHG removals and emissions are estimated based on changes in above and below ground biomass, dead organic matter, and soil organic carbon on Brunei's forestland. Emissions from forestland were estimated from carbon loss due to human activities such as deforestation and forest fires. GHG removals for the period of 2010-2022 is illustrated in Figure 2.14, indicating fairly constant net removals in the sector throughout the inventory period. Forest sector in Brunei is a net sink.

Figure 2.14 Emissions and Removals from Forestland, 2010-2022



2.11.2 Category Description, Activity Data, Carbon Stock Change Factors (SCF) and Data Source

Table 2.20 Category Description, Activity Data, Carbon Stock Change Factors (SCF) and Data Source

Category	Description	Type of Data		Data Source
		Activity Data (AD)	Carbon stock change factors (SCF)	
3B1 FOREST LAND: All managed land under the jurisdiction of the Forest Act. Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10% of trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.				
3B1a Forest Land Remaining Forest Land	This subcategory deals with managed forests which have remained forested without conversion for the past 20 years, which covers approximately 380,000 ha of Brunei's total land area.	Area of managed forest land (ha), wood removal (m^3), forest disturbance area (ha)	Default factors[13] for Tier 1 method from Table 4.3, Table 4.4, Table 4.5, Table 4.7 and Table 4.9 of Chapter 4: Forest Land of Volume 4 (AFOLU) of the 2006 IPCC Guidelines	Forestry Department

2.11.3 Methods and Data

The IPCC Gain-Loss Method (Tier 1) was used to estimate carbon removals from forest land remaining forest land, guided by the decision tree outlined in Figure 2.2 of Chapter 2, Volume 4 of the 2006 IPCC Guidelines. The activity data are derived from forest cover assessment and national forest inventory[14].

IPCC default factors combines with region-specific biomass growth rates across various forest types and climatic zones are applied to estimate the annual biomass carbon stock. Carbon losses are estimated using data on wood and fuelwood removals and disturbances such as forest fires. The annual change in carbon stocks in biomass is then estimated by considering the net CO_2 removals, which involves adding up the annual carbon gain with carbon loss in biomass.

[13] Above-Ground Biomass (AGB), Average annual above-ground biomass growth, the ratio of above-ground to below-ground biomass (BGB), and the carbon fraction of dry matter, Biomass conversion and expansion factor for wood and fuelwood removal

[14]Based on Forest Resources Assessment (FRA) 2015 Country Report. Brunei's forest inventory is expected to be updated by Mid-2025 which also includes data on biomass carbon stock.

GHG emissions and removals per hectare vary according to forest types as depicted in Table 2.21.

Table 2.21 Forest Classification by Type and Hectare with corresponding parameters for estimation, 2022

Forest Type	Area (HA)	Average annual AGB Growth (tonnes dm/ha)	Ratio of BGB to AGB	Carbon fraction of dry matter	Carbon Stock (Tonne C)	Removals Estimates ($MTCO_2e$)	Annual Biomass loss ($MTCO_2e$)	Net removal	% share of total removal
Beach / Mixed	15,988	3.4	0.37 (IPCC default value for tropical rainforest, Table 4.4)	0.47 (IPCC default value for all Table 4.5)	35,001.89	-0.13	114,554.61 tonne carbon equiv to 0.42 $MTCO_2e$		3%
Freshwater Swamp	12,668	9*			73,412.33	-0.27			6%
Kerangas	3,455	3.4			7,563.89	-0.03			1%
Mangrove	18,418	11*			136,143.83	-0.50			10%
Mixed Dipterocarp	192,575	3.4			421,596.74	-1.55			32%
Montane	7,196	10*			46,335.04	-0.17			3%
Peat Swamp	90,884	9*			526,681.87	-1.93			40%
Secondary/ Others	38,816	3.4			84,978.32	-0.31			6%
TOTAL					1,331,713.91	-4.88	0.42	-4.46	

** Based on Growth rate for Borneo (Sabah, Sarawak and Brunei) from REDD+ report and values suggested by UNFCCC/FAO LULUCF experts*

Peat Swamp forest is ranked highest for CO_2 sequestration at 40%, followed by Mixed Dipterocarp (32%) and Mangrove (10%).

2.11.4 Methodological issues/limitations on Assumptions

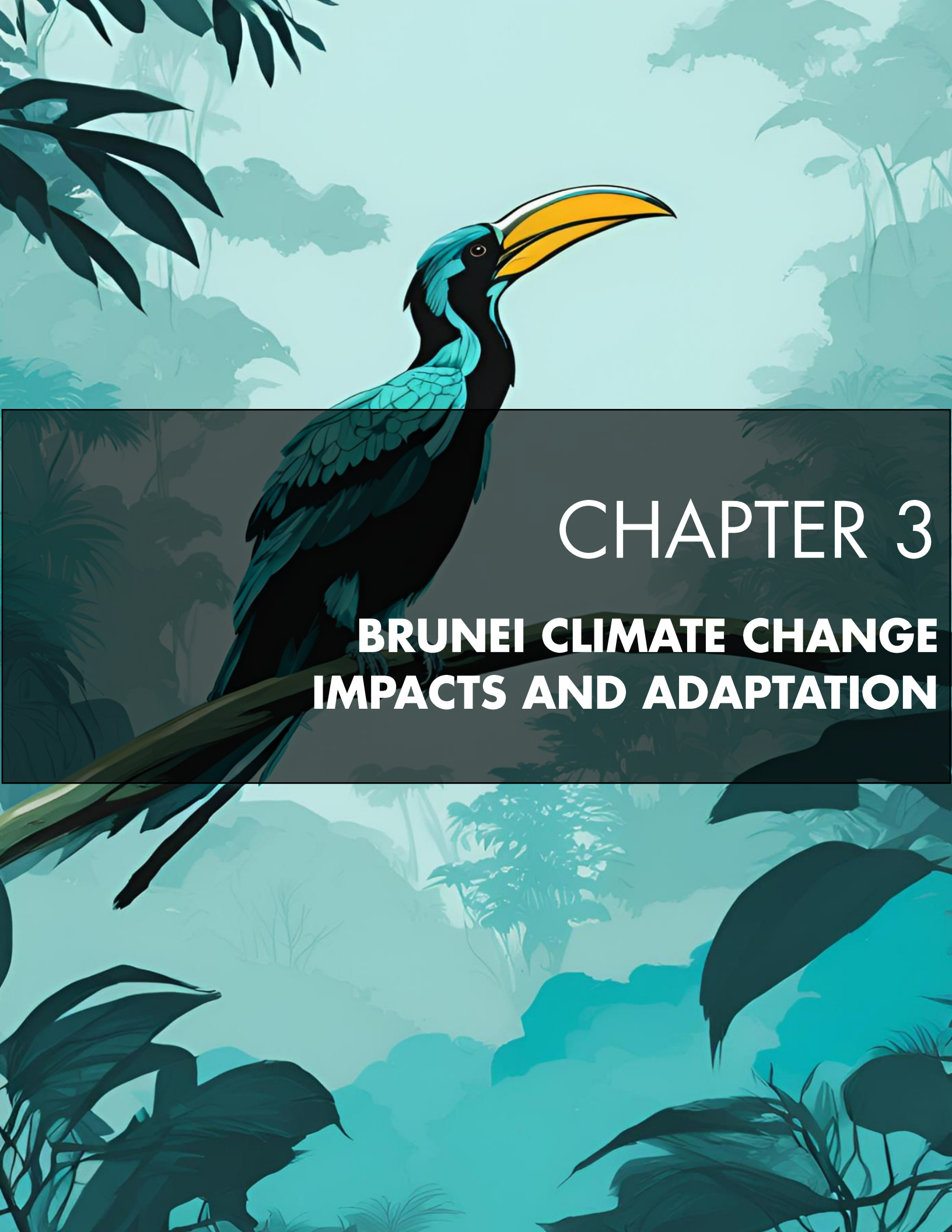
There has been a significant increase in land conversion since 1984 due to development projects in the last 40 years. Using Tier 1 method to estimate CO_2 removal reveals several key issues that require attention. Firstly, the reliance on outdated data, sourced from a 1984 report for forest area measurements, poses a significant challenge in terms of accuracy. The consistency in the land area data fails to reflect recent developments such as the expansion of Pulau Muara Besar, leading to potential inaccuracies in estimations. Similarly, the secondary/other forest data, based on 2010 records, lacks the nuance provided by current field assessments. Furthermore, the assessment of disturbances only accounts for forest fire events, disregarding other developmental factors that could impact carbon stock.

2.11.5 Inventory Gaps and Plan Improvements

In order to enhance future inventories for LULUCF, the following improvements were identified and recommended;

Table 2.22 Inventory Gaps and Plan Improvements for Removals

Inventory Gaps	Plan Improvements
Limited data with the Tier 1 method being predominantly used leading to overestimation or under estimation of emissions and removals.	On-going Forest Inventory Project to update forest data and adopt Tier 2 using country-specific biomass data and stock change factor.
Reliable Land use and Land use change data were not available.	To set a monitoring system and report emissions/removals separately for Forest Land-Forest Land (FL-FL) and land converted to FL.
Biomass loss estimation not available for different type of forests. Limited information from provider on how losses for different reasons are derived. Limited data on afforestation or reforestation activities.	Collect data on hectares of land reforested or afforested if they occur. Ensure all data and information used for calculations are referenced correctly to enhance transparency in reporting.



CHAPTER 3

BRUNEI CLIMATE CHANGE IMPACTS AND ADAPTATION

3.0 CLIMATE CHANGE IMPACTS AND ADAPTATION

3.1 Overview of Brunei's National Adaptation Plan (NAP)

Brunei Darussalam is not exempted from the impacts of climate change such as extreme weather events, flooding, and sea level rise despite its relatively low contribution to global GHG emissions, amounting to less than 0.02%. This demonstrates that climate change impacts have no boundaries, affecting even those who contribute least to it.

As a small developing nation where the majority of its economic hubs and settlements are located along the coastal areas, Brunei recognises and is committed to taking proactive adaptation measures to build resilience and safeguard its livelihoods, environment and economy and ultimately, its future.

In 2022, Brunei began developing its first iteration of the NAP which was completed in 2023. This initial NAP focuses on two key hazards that Brunei is highly exposed to. These hazards were identified based on their prominence in the assessment matrix, guiding the country's climate adaptation strategies. In the next iteration of Brunei's NAP, the hazards identified will be categorised into six key sectoral areas: **marine protection, biodiversity and environment, water resources, agriculture and food security, infrastructure and urban resilience, and health and livelihood.** Brunei is currently developing its second iteration of the NAP, which will include the six sectors mentioned earlier. In addition, the country is set to begin the National Climate Vulnerabilities Assessment (NCVA) to better understand how Brunei is exposed to the effects of the changing climate. This assessment will be crucial in informing future adaptation strategies and ensuring that the NAP effectively addresses the country's vulnerabilities.

As a fundamental principle, the NAP emphasizes the essential incorporation of adaptation across all levels of governance through a Whole-of-Nation approach, while also coordinating national efforts towards an integrated ecosystem-based management. It is designed to be an open and dynamic document, updated periodically to reflect and align with the latest climate science and projections. This ensures an on-going, forward-moving and iterative approach to medium and long-term climate adaptation requirements.

The objectives of the NAP are three-fold:

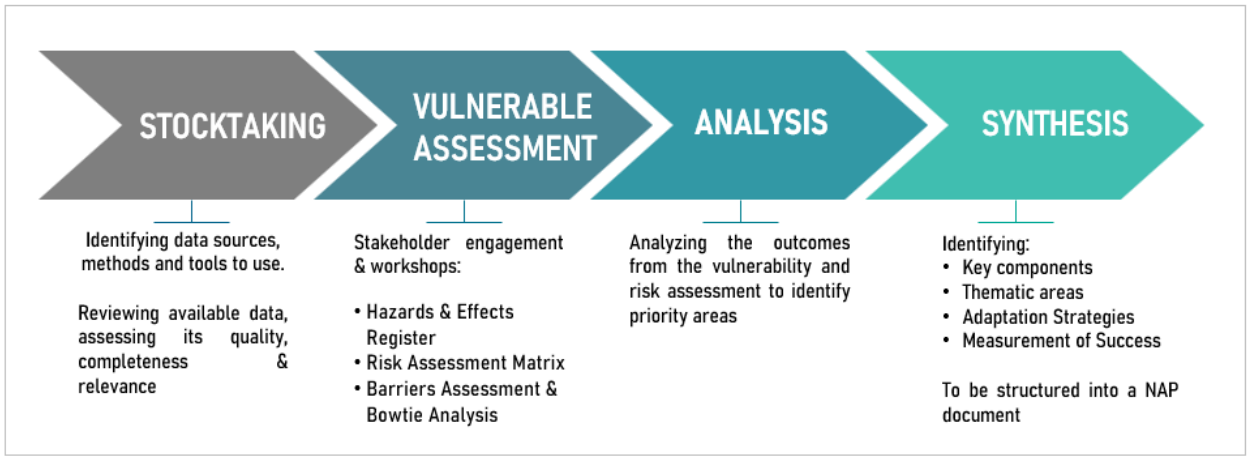
1) Reduce vulnerability to climate change impacts by building adaptive capacity and resilience.
2) Enhance climate resilience with comprehensive adaptation strategies and projects.
3) Facilitate the integration of climate change adaptation, through a Whole-of-Nation approach, into new and existing policies and programmes, especially in socio-economic development planning processes and strategies.

3.2 NAP Framework

The first iteration of the NAP was developed based on a NAP Framework (*Figure* 3.1), which incorporated Element A: Lay the groundwork and address Gaps and Element B: Preparatory elements from UNFCCC's NAP Technical Guidelines (Least Developed Countries Expert Group (LEG), 2012).

The NAP Framework is a dynamic and structured process which comprises four elements to guide Brunei in formulating and implementing adaptation strategies that are fit to its unique national circumstances. Through this process, Brunei can systematically assess risks, set clear priorities, engage relevant stakeholders, and implement adaptation strategies, ultimately building a climate-resilient and sustainable future.

Figure 3.1 NAP Framework



3.3 NAP Development Process

3.3.1 Element 1: Stock-Taking (Data Gathering)

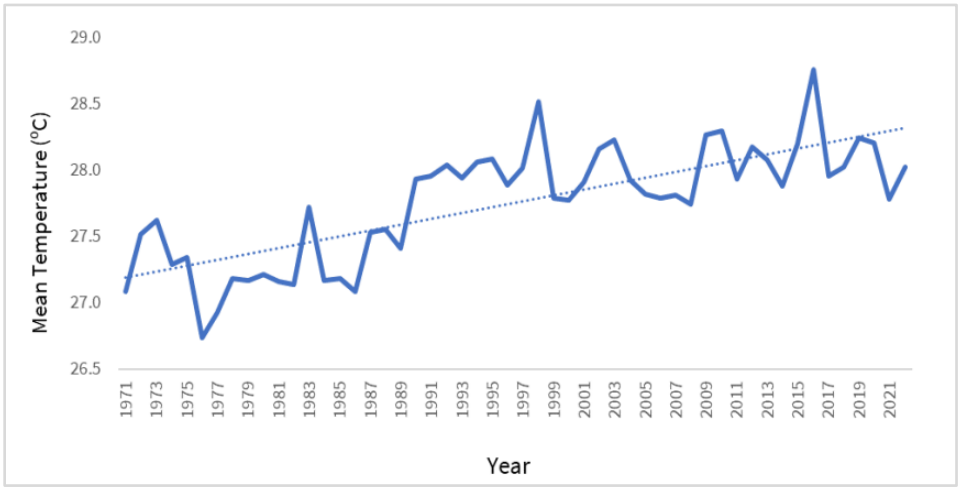
Data gathering is crucial to understand Brunei's current climate situation for better decision making, informed by the latest climate science. It can also help to identify and address any existing gaps and inconsistencies which can lead to unreliable data and low confidence climate projections.

3.3.1.1 Observed Climate Change Trends

The climate trends of Brunei Darussalam can be represented by temperature and rainfall trends, observed at the Brunei Darussalam Meteorological Department (BDMD)'s Meteorological Station located at the Brunei International Airport.

Brunei's annual mean temperature has increased by 0.22°C per decade from the years 1971 to 2022 (*Figure* 3.2). Across Brunei, there is an observed rise in mean surface temperature, daily minimum and maximum temperatures. Whereas for relative humidity, it varies between 80-90% on average since 1979 to 2022.

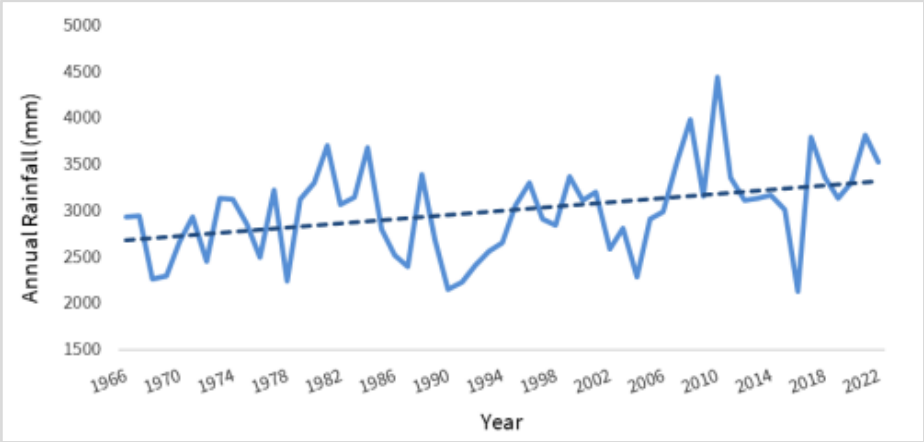
Figure 3.2 Annual Mean Temperature Trend, 1971-2022



Source: Brunei Darussalam Meteorological Department

Brunei's annual rainfall has increased by 114mm per decade from 1966 to 2022 (*Figure* 3.3), but with large year-to-year variations associated with natural climate phenomena such as the El-Niño Southern Oscillation (ENSO). It is important to note that ENSO has a substantial impact on Brunei's rainfall patterns, which generally results in increased rainfall during La Niña years and decrease during El Niño years. The occurrences of Excessive Hot Weather (EHW), i.e., when maximum temperature is at least 35°C for three consecutive days, is more common during El Niño episodes.

Figure 3.3 Annual Rainfall Trend, 1966-2022



Source: Brunei Darussalam Meteorological Department

3.3.1.2 Historical Climate-Induced Disaster Trends

Flooding

Figure 3.4 shows a flood mapping in Brunei, whereby it is categorized into 2: flood plain (blue) and tidal flood (red).

Flood plain is a naturally caused flood when water exceeds the river capacity and flows at the surrounding area, which commonly occurs at low lying areas. On the other hand, tidal flood occurs during high tide that coincides with heavy rainfall and/or strong wind conditions, where the water will inundate the surrounding low-lying areas close to coastal bays or at rivers subjected to tide.

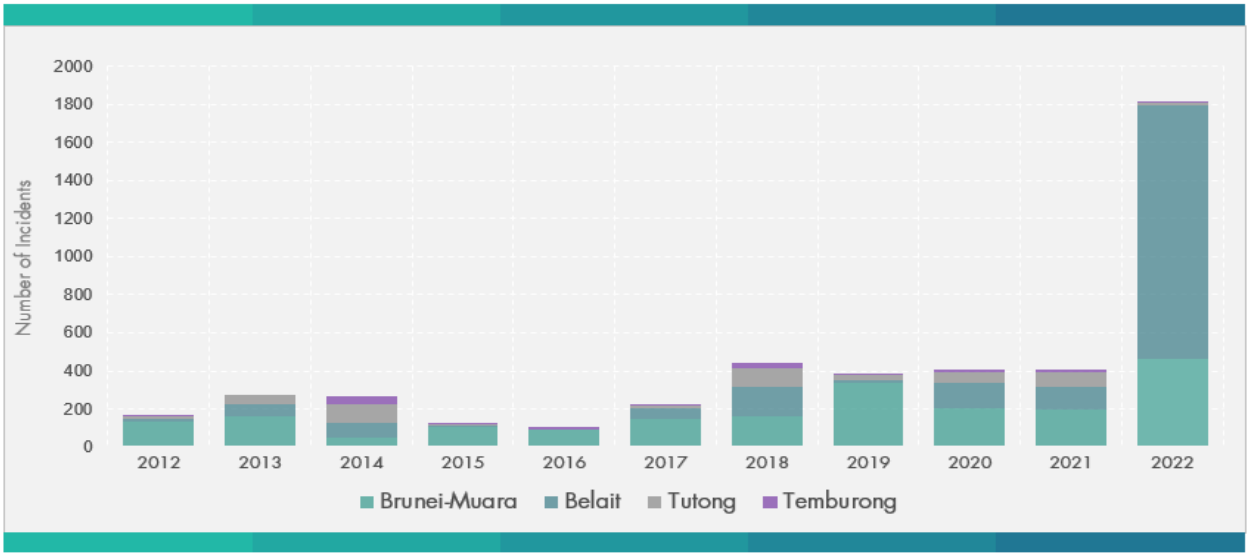
Figure 3.4 Flood Mapping in Brunei



Source: Department of Drainage and Sewerage, Public Works Department

As recorded by DDS, the number of flooding incidents have increased from 2018, with the highest number of incidents taking place in 2022 at the low-lying areas of Belait District (*Figure* 3.5). Although the annual rainfall in 2022 was relatively low (3,533 mm) compared to 2021 (3,815 mm), the 2022 high flood incident may be due to extreme and prolonged rainfall which were further exacerbated by the flood plain vicinity.

Figure 3.5 Number of Flooding Incidents, 2012-2022

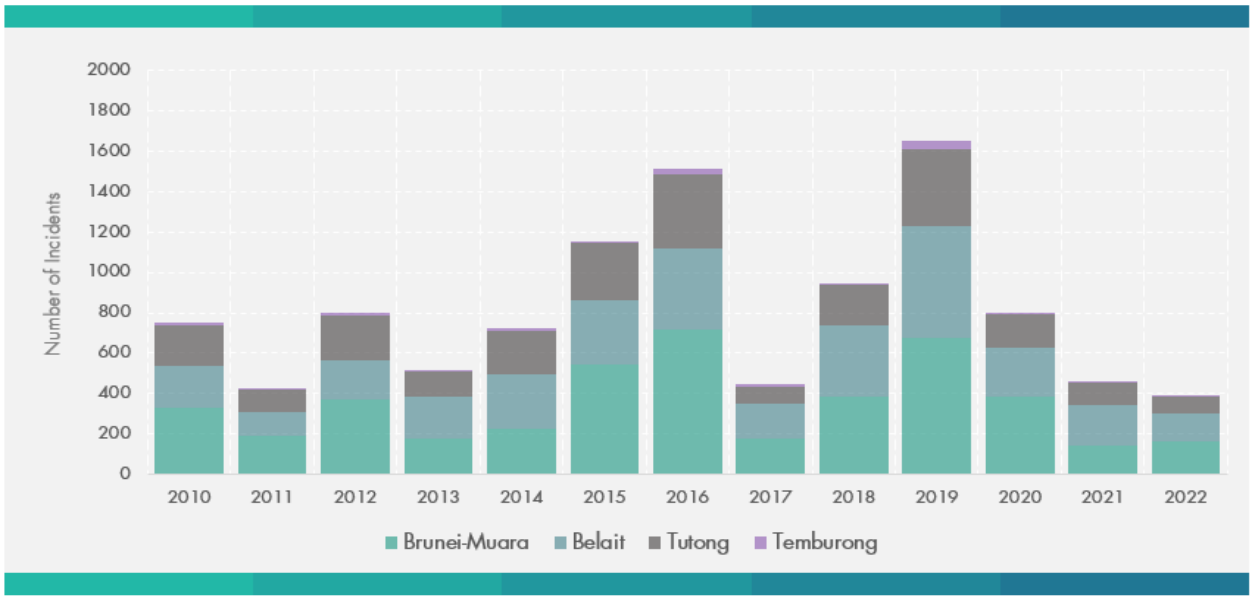


Source: Department of Drainage and Sewerage, Public Works Department

Forest Fire

Figure 3.6 below shows the total number of forest fire incidents for both forest and grassland from 2010 until 2022, as reported by Brunei Fire and Rescue Department (BFRD). The high number of forest fire incidents in 2016 and 2019 coincided with the El-Niño episode which brings higher temperatures and drier conditions.

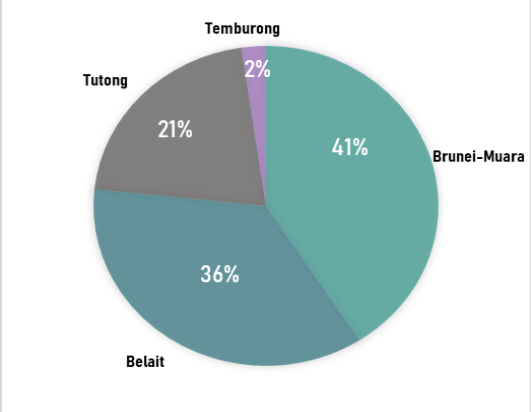
Figure 3.6 Total Number of Forest Fire Incidents for Both Forest and Grassland, 2010-2022



Source: Brunei Fire and Rescue Department

According to BFRD, the forest fire hotspots in Belait District (*Figure* 3.7) are commonly located at forests along the highway, which may cause disruptions of transportation, passers-by and road visibility.

Figure 3.7 Percentage of Districts Affected by Forest Fire In 2022

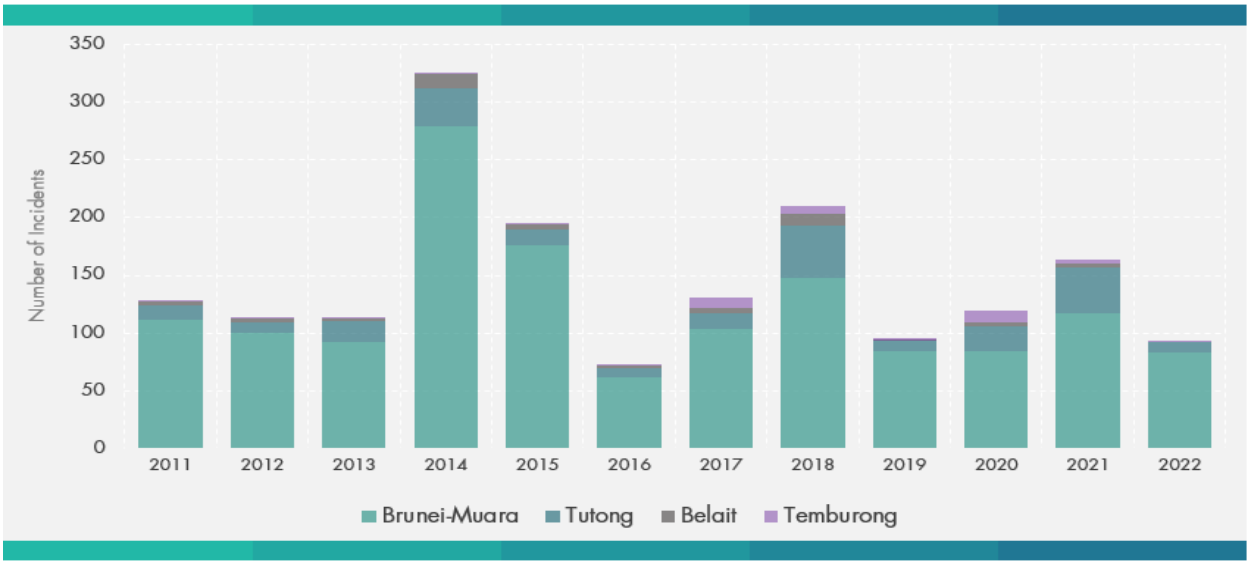


Source: Brunei Fire and Rescue Department

Landslide

Figure 3.8 below shows the number of landslide incidents from 2011 until 2022, as recorded by the Department of Technical Services (DTS), PWD. It shows fluctuating landslide incidents over the period, where Brunei was hit with the highest landslide incidents in 2014, with 325 events on both government and private lands.

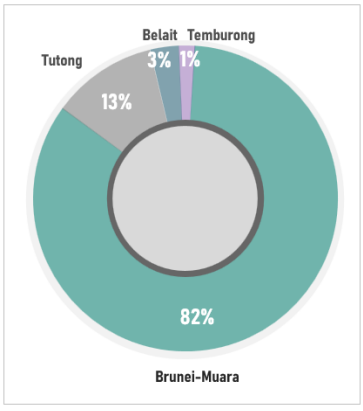
Figure 3.8 Number of Landslide Incidents, 2011-2022



Source: Department of Technical Services, Public Works Department

As the annual rainfall amount in 2014 is relatively low, this high landslide incident may be caused by the monsoon season which usually brings wetter conditions. As also evident in the Figure 3.9 below, Brunei-Muara district is significantly most affected by landslides.

Figure 3.9 Percentage Chart of Districts Affected by Landslide in 2022

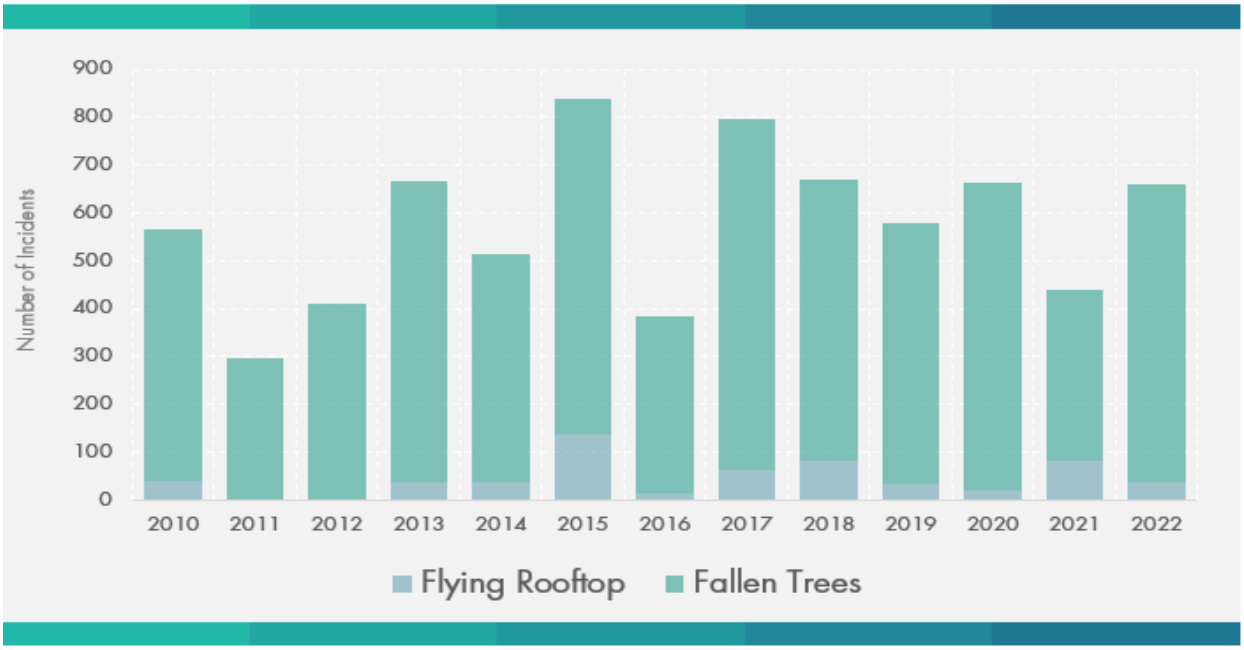


Source: Department of Technical Services, Public Works Department

Strong Winds

Brunei also experienced strong winds, especially during monsoon season. This can lead to incidents of fallen trees and rooftops being blown away. According to the BFRD, the number of fallen trees incidents has increased over the period 2010 to 2022 (*Figure* 3.10). This means that the weather during the monsoon seasons has become more extreme.

Figure 3.10 Number of Incidents of Fallen Trees and Rooftops Blown Away, 2010-2022



Source: Brunei Fire and Rescue Department

3.3.1.3 Future Climate Change Projection Trends

The projections of future climate trends and hazards are carried out by BDMD using climate models under the CORDEX (Co-ordinated Regional Climate Downscaling Experiment) project. It is a WCRP (World Climate Research Programme) framework to evaluate regional climate model performance through a set of experiments aiming at producing regional climate projections as shown in Table 3.1 below. These projections are consistent with the projections for the region presented in the IPCC AR5.

Table 3.1 Projection Trends on Rainfall and Temperature, 2006-2099

Variables	Scenario RCP4.5	Scenario RCP8.5
Annual Rainfall Projections	-23 mm/decade to +63 mm/decade	-166 mm/decade to +133 mm/decade
Mean Multi-Model Ensemble for Rainfall Projections	-2.8 mm/decade	-11.4 mm/decade
Annual Temperature Projections	+0.13°C/decade to +0.22°C/decade	+0.29°C/decade to +0.47°C/decade
Mean Multi-Model Ensemble for Temperature Projections	+0.17°C/decade	+0.38°C/decade

Source: Brunei Darussalam Meteorological Department

3.3.2 Element 2: Conducting Vulnerability Assessments

Several Risk and Vulnerability Assessments were conducted as a foundation for the development of NAP such as Hazards and Effects Register (HER), Risk Assessment Matrix (RAM), Barriers Assessment (or Swiss Cheese Model) and Bowtie Analysis.

3.3.2.1 Hazards and Effects Register (HER)

The HER is a list of all climate-induced hazards in Brunei that was identified by each member of the ARWG. It is a process to identify and assess hazards, and the risks they pose to People, Environment, Asset, Reputation and Legal (PEARL). It aims to provide an overview and detailed information on how these hazards can be managed in the next stages of risk assessments.

3.3.2.2 Risk Assessment Matrix (RAM)

The RAM is a visual medium that provides insight into the risks of climate-induced disasters by categorizing them according to likelihood of occurrence and impact severity. It helps to identify and prioritize potential risks while considering both internal and external factors. It can also be used to strategize action plans and allocate resources to manage and/or reduce potential risk impacts. The RAM was completed through a workshop, where the ARWG members set the criteria and scale for likelihood of occurrence and impact severity of risks based on PEARL. The first iteration of NAP identified the top two climate-induced hazards as pilot.

3.3.2.3 Barriers Assessment (Swiss Cheese Model) and Bowtie Analysis

The Barriers Assessment (or Swiss Cheese Model) aims to evaluate and outline strategies to mitigate and prevent worst-case scenario of climate-induced disaster impacts from happening.

Subsequently, the Bowtie Analysis aims to assess and outline response and recovery measures in the event of an occurrence of climate-induced disasters in Brunei. This approach will also involve evaluating gaps and providing recommendations to improve both existing and new adaptation strategies, with the goal of increasing resilience to the consequences of climate-induced disasters.

3.3.3 Element 3: Outcomes Analysis of the Assessments and Workshops

3.3.3.1 Potential Impacts Using HER

An inventory of climate-related threats and its potential impacts to Brunei was completed by using HER. They are later categorized based on four main climate factors: temperature, rainfall patterns, sea level rise, and prolonged El Niño or La Niña events. A summary of some hazards and their impacts can be found in Table 3.2.

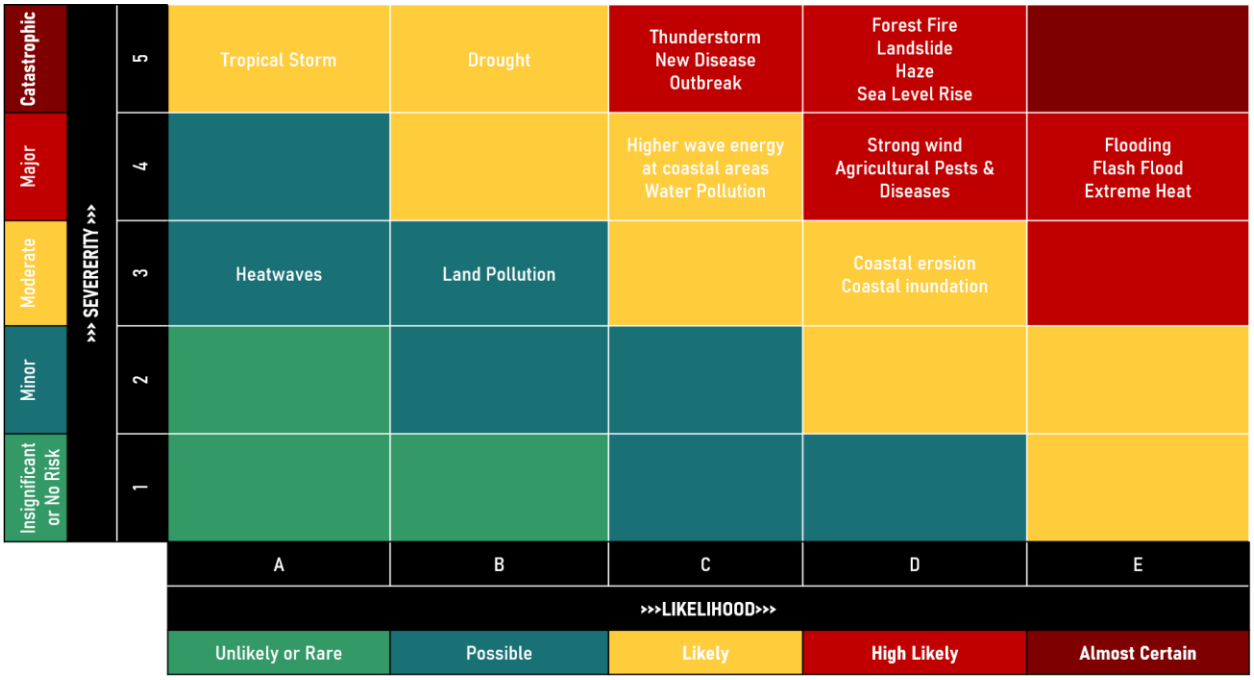
Table 3.2 Climate Hazards, Linked to Effects Due to That Hazards, Categorised Into PEARL

Climate Risk Driver	Hazards	Impact				
		People	Environment	Asset	Reputation	Legal
Increase in temperature	•Forest Fire •Haze •Drought	•Dehydration •Heat-related illnesses •Cardiovascular diseases •Adverse mental health	•Poor air quality •Loss of forests	•Damages to buildings •Agricultural pest and disease outbreak •Damage to crops	•Inflation •Unreliable utilities	•Infrastructure and building design
Decrease in temperature	•Dry condition	•Health issues: Respiratory diseases	•Food insecurity	•Power outage	•Decrease in agricultural productivity	
Increase in rainfall	•Flood •Landslides •Disease Outbreak	•Respiratory issues •Vector & Water-borne diseases •Injuries •Fatalities	•Mold growth •Soil erosion	•Damages to buildings •Agricultural pest and disease outbreak •Damage to crops	•Inflation •Unreliable utilities	•Infrastructure and building design
Decrease in rainfall	•Forest Fire •Haze •Drought	•Dehydration •Malnutrition	•Poor air quality •Groundwater depletion	•Water scarcity	•Decrease in agricultural productivity	
Sea level rise	•High coastal wave energy •Coastal Erosion •Inundation •Coastal Flooding	•Adverse mental health •Limited mobility and access to resources •Migration of people due to loss of land	•Food insecurity •Loss of wildlife •Salt water intrusion •Poor water quality	•Coastal erosion and inundation •Loss of property and land •Damage to crops	•Increase in infrastructure spending •Inflation of land prices	•Potential for new Health, Safety and Environment (HSE) •New policies •Infrastructure and building design
Prolonged El Niño	•Forest Fire •Haze •Drought •New Disease Outbreak	•Health problems •Human-wildlife conflict •Loss of lives	•Poor air quality •Biodiversity loss •Loss of habitat •Loss of carbon sinks	•Damages to buildings, government roads, private properties •Low fisheries production	•Supplier disruption (for Micro, Small and Medium Enterprise (MSME) under agricultural and fisheries sector) •Inflation •Decrease in incoming tourists	•Transboundary haze •Transboundary disease outbreak
Prolonged La Niña	•Flood •Landslides •Typhoon •Storm Surges •New Disease Outbreak	•Injuries •Fatalities •Lower food supply •Health problems •Malnutrition	•Biodiversity loss •Loss of habitat •Loss of carbon sinks	•High stress on budget allocation for healthcare and emergency response •Damages to buildings, government roads, private properties •Low agricultural production	•Supplier disruption (for MSME under agricultural and fisheries sector) •Inflation •Decrease in incoming tourists	•Transboundary disease outbreak

3.3.3.2 Probability of Potential Hazards using RAM

Figure 3.11 shows the consequence scale includes five severity levels: catastrophic, major, moderate, minor, and insignificant or no risk. It considers the likelihood of top frequent hazards which are flooding and forest fire.

Figure 3.11 RAM likelihood scale



3.3.3.3 National Climate Vulnerability Assessment (NCVA)

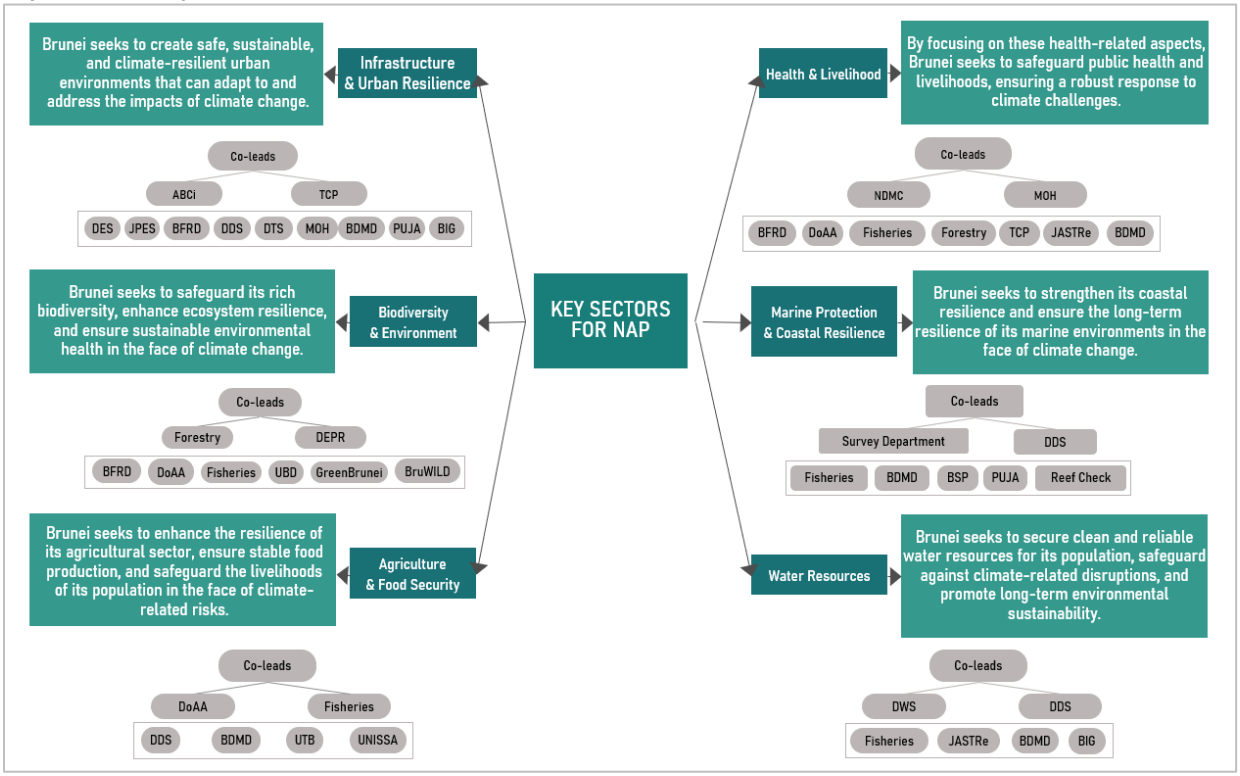
Brunei is currently developing an NCVA that will serve as the foundational assessment of the nation's climate vulnerabilities and risks. This assessment will inform the development of effective, tailored, and responsive adaptation strategies in the NAP to ensure Brunei's resilience and adaptive capacity to climate change impacts.

The hazards identified in the RAM are subsequently analysed and categorized into various sectors. Each sector is responsible for identifying the specific hazards to which they are most exposed. By breaking down the hazards into sector-specific categories, this approach allows for a more focused and detailed examination of vulnerabilities within each key sector.

This method not only highlights the areas of greatest concern but also facilitates the development of targeted mitigation strategies. Figure 3.12 provides a visual representation of these key sectors, along with a breakdown of the agencies associated to those sectors. Upon the completion of the NCVA, it will be incorporated into Brunei's finalised NAP submission to UNFCCC in 2025.

3.3.4 Element 4: Synthesis of the NAP Development

Figure 3.12 Key Sectors for NAP



This element focuses on outlining and addressing any gaps, risks and challenges during the formulation of the NAP, implementation of adaptation strategies and measurement of success which is elaborated further under Section 5.4.2. These can help in aligning and prioritising any adaptation initiatives and projects, and clarifying the roles and responsibilities of the relevant stakeholders.

3.4 Adaptation Priorities and Barriers

3.4.1 Domestic priorities and their progress

The first iteration of NAP was not inclusive of Element C: Implementation Strategies and Element D: Reporting, Monitoring and Review from the UNFCCC's NAP Technical Guidelines due to time constraints. Further elaboration is provided under Section 5.5.

3.4.2 Gaps and Challenges Identified

Several gaps and challenges arose during the NAP formulation process which can be classified into six key themes as shown in Table 3.3. Addressing these gaps and challenges requires a combination of both national and international efforts, adequate resources and capacity building,

and commitment from all stakeholders as well as the need for a centralised data repository. It also involves a process of learning and improvement, with adaptations made over time as more data becomes available and accessible and as climate impacts continue to evolve.

Table 3.3 Gaps and Challenges in the NAP Formulation Process

Classifications	Gaps, Risks and Challenges Identified
Incomprehensive NAP	• Only two climate-induced hazards (flooding and forest fire) were focused during the first iteration of NAP. • Lack of initiatives and engagements for external support during the NAP formulation process.
Data and Information Gaps	• Lack of understanding and knowledge on climate change adaptation • Lack of accurate and comprehensive data, leading to low data confidence • Absence of a centralised data repository, leasing to scattered data among agencies • Inconsistent existing historical data on climate-induced disasters, as not all data is available in the same year. • Lack of historical data for climate projections, specifically sea level rise. • Imposition of charges for data access.
Limited Technical Capacity	• Lack of experts in managing climate science, adaptation and the economic costs of loss, damage and recovery. • Lack of clarity in available resources during the NAP development process, especially international experts.
Ineffective Stakeholder Engagements	• Limited stakeholder engagements and collaborations • Lack of commitment and prioritization for adaptation • Lack of clarity in scope of work, as well as roles and responsibilities for adaptation measures.
Resource Constraints	• Lack of financial resources to hire technical experts for comprehensive assessments. • Absence of access to financial support/assistance from international organisations. • Lack of resources/external parties to perform QA/QC processes for data, information acquired and the NAP development process.

3.5 Monitoring and Evaluation of Implementation Progress for Adaptation Measures

In terms of measurement of monitoring and evaluating the effectiveness of Brunei's climate adaptation measures, there is a difficulty in determining realistic and measurable key performance indicators (KPIs). This is due to the lack of available data and adaptation knowledge.

Furthermore, there are also government agencies involved in the ARWG who are actively tracking specific climate drivers. But their efforts are currently independent and data is fragment among agencies, such as data collection on overall temperature and rainfall patterns by BDMD, forest fire and strong wind incidents by BFRD and flooding incidents by DDS, PWD. Due to the absence of a unified platform which can ease data access and enable data transparency, it is difficult to ascertain and monitor the implementation actions and the performance of adaptation strategies.

3.6 Information Related to Averting, Minimizing and Addressing Loss and Damage

The definition of loss and damage has not been established yet, and therefore it is difficult to determine the economic impacts of climate change, including losses, damages and recoveries. This is further exacerbated by the limited technical capacity and lack of monitoring and evaluation of adaptation strategies.

3.7 Cooperation, Good Practices, Experience and Lessons Learned

The development of the first iteration of NAP has enabled Brunei to identify several priority areas that can be addressed and improved in the next iteration, such as:

3.7.1 Revising and Updating the NAP

The subsequent iterations of the NAP shall comprise all other climate-induced hazards and future climate risks such as sea level rise. This is to accomplish a more comprehensive NAP that provides medium and long-term adaptation plans, strategies and projects.

The NAP shall be revised every five years to consider the evolving consequences of climate change. It will also be regularly reviewed, revised and updated in an iterative way, considering the progress and addressing the current and past adaptation barriers and new findings on climate change, risks and vulnerabilities. This is to ensure the effectiveness of the NAP and barriers, and minimize any uncertainties.

3.7.2 Socialising the NAP

The NAP shall be socialised throughout various agencies and communities, such as through awareness programs, forums, workshops and stakeholder engagements. This is to ensure a comprehensive and holistic approach of the NAP development, while also increasing awareness on adaptation. This can help with realigning all key sectors in adaptation in terms of information, roles and adaptation needs.

3.7.3 Impacts on Economy

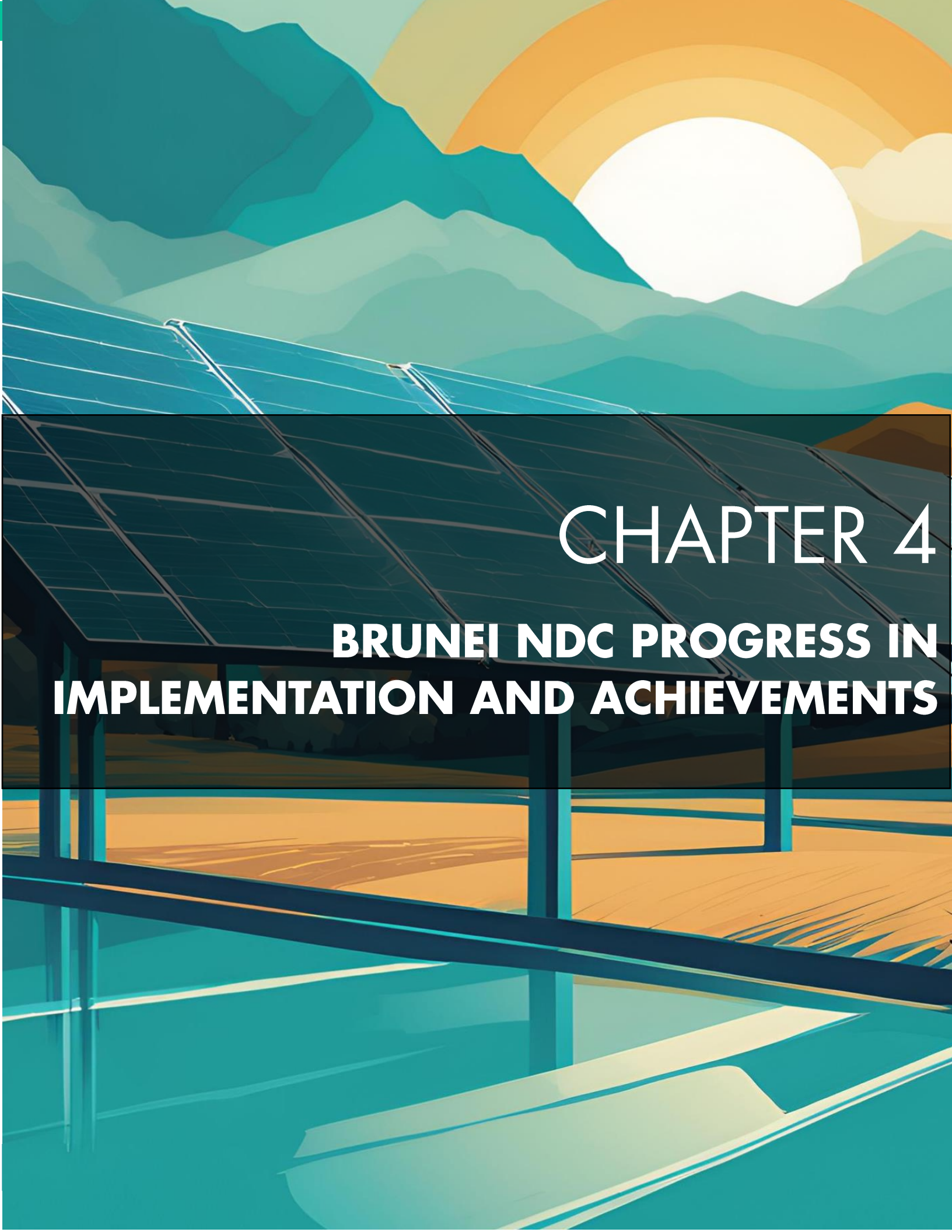
The next iteration of the NAP shall also consider the economic impacts of climate change adaptation, when quantifying how much losses from disasters and the costs needed to respond and recover. This also includes the costs of adaptation projects to be implemented in order to build adaptive capacity and resilience. This can help to assess and prioritize the adaptation projects that are low cost, low economic impacts and effective.

3.7.4 Enhance stakeholder coordination and engagement

Stakeholder coordination and engagement is crucial to keep up-to-date with current adaptation initiatives, strategies and projects. This is to avoid any mis clarification and misalignment of adaptation information and data.

3.7.5 Align NAP with current and future National Development Plan

The NAP and adaptation projects shall align with the current and future National Development Plans (NDP). Reliable data and information on adaptation can help mobilize resources and financing mechanisms when proposing any adaptation projects. A cost-benefit analysis shall be performed to support the prioritization of these projects



CHAPTER 4

BRUNEI NDC PROGRESS IN IMPLEMENTATION AND ACHIEVEMENTS

4.0 BRUNEI DARUSSALAM'S NDC PROGRESS

This chapter provides information on the progress of the implementation of Brunei's mitigation policies and programmes and their impacts on GHG emissions reductions in the context of achieving its NDCs as stipulated under Article 4 of the Paris Agreement. specifically, those occurring between 2020 and 2022.

Due to resource and time constraints, **the assessment was limited to GHG reductions only (i.e., costs were not considered).**

4.1 Target

In 2020, Brunei Darussalam submitted the Nationally Determined Contributions (NDC), under the Paris Agreement with a commitment to **reduce emissions by 20 per cent by 2030**, relative to 2015 Business-as-Usual (BAU) levels.

Brunei's contribution is considered in the context of other countries' mitigation actions, especially those of the Annex-I Parties of the UNFCCC. **This aligns with Article 3.1 of the Convention, which calls for climate action based on equity and common but differentiated responsibilities and capabilities**. As a developing country, meeting its needs will require scaling up infrastructure and energy use. Brunei's commitments under the Convention and the Paris Agreement aim to ensure efficient growth that allows for development while contributing to mitigating GHG emissions.

Emissions are tracked in terms of **absolute GHG**. These emissions are compared against a Business as Usual (BAU) scenario, which represents the projected emissions trajectory in the absence of any additional mitigation measures or policy interventions, and integrated into the overall NDC target. This approach helps to quantify the impact of implemented actions, assess progress toward emission reduction targets, and highlight the deviation from the baseline trajectory. Base year (2015) emission level: 11.6 Mt CO2e Business-As-Usual (2030) emission level: approximately 29.5 Mt CO2e.

Table 4.1 Quantitative Information on Brunei's NDC

Target	GHG emissions by 20% relative to Business-As-Usual (BAU) levels by 2030 (Single Year Target)
Reference Points.	Reference indicator quantified based on national total GHG emissions in 2015. Emission level: 11.6 $MtCO_2e$ Business as Usual: 2030, Emission level: 29.5 $MtCO_2e$
Implementation Timeline	1 January 2021 – 31 December 2030 (10-year period).
Gases Covered	Carbon dioxide (CO_2), Methane (CH_4) and Nitrous oxide (N_2O).
Sectors Covered	Industry, transport, power management, AFOLU and waste
Alignment with Paris Agreement paragraphs 31(c)[15] and (d)[16] of decision 1/CP.21	Assessment considered for all categories of anthropogenic emissions and removals included.

4.2 Information Needed to Track NDC Progress

Brunei Darussalam intends to achieve its emissions targets through the implementation of 10 strategic approaches outlined in the **Brunei Darussalam National Climate Change Policy (BNCCP).** The 10 strategies are comprised of 6 mitigation strategies, 3 enabling strategies, and 1 adaptation strategy. The 6 strategies listed in table 4.2 **form the core of BNCCP mitigation measures.** The table below classifies the policies and measures in terms of the four IPCC reporting categories: Energy, AFOLU, IPPU and Waste.

Table 4.2 BNCCP Mitigation Strategies, 2020-2035

Strategy	Description	Target	Implementing Agencies	IPCC Sector
Reduce Industrial Emissions	This strategy seeks to reduce industrial emissions from the industries. Industrial emissions refer to flaring, venting, other fugitives, and combustion (from auto producers) from upstream and downstream oil and gas operations.	18% GHG reduction by 2030	DOE, PMO	Energy and IPPU sector.

[15] Paragraph 31(c): Assessment of mitigation action's contribution to the global goal of limiting temperature rise to well below 2°C, with efforts to further limit it to 1.5°C above pre-industrial levels.

[16] Paragraph 31(d): Assessment of potential social and economic impacts of proposed climate actions.

Increase Forest Carbon Sink	This strategy seeks to increase Brunei Darussalam's forest carbon sink through afforestation and reforestation programmes.	Plant 500,000 trees by 2035. Increase forest cover not less than 55% of total land area.	Forestry Department, MPRT	AFOLU
Reduce Emissions from Land Transportation.	This strategy seeks to reduce GHG emissions from land transportation through increase sales of low carbon vehicles such as electrical vehicles, hybrid cars and improving public transportation.	20% GHG reduction by 2030	Land Transport Department (LTD), Ministry of Transport and Infocommunications (MTIC) DOE, PMO	Energy
Increase share of RE	This strategy seeks to increase the share of RE in the Power Generation Mix.	Increase RE share to at least 30% of the total installed capacity by 2035.	DOE, PMO	Energy
Reduce Emissions from Power Generation.	This strategy aims to reduce GHG emissions from power generation through the implementation of energy efficiency and conservation measures in both supply and demand side management.	30% GHG reduction from power generation by 2030. Enhance efficiency of public utilities power plants to exceed 45%.	DOE, PMO	Energy
Reduce Emissions from Solid Waste Landfills.	This strategy seeks to reduce GHG emissions by minimizing the amount of waste going to the landfill.	Reduce the waste disposal rate to 1 kg/person/day by 2035. 6% GHG reduction by 2030.	DEPR, MOD	Waste

Brunei's adaptation strategies are as explained in Chapter 3 of this BTR.

Enabling strategies (Table 4.3) are vital for creating a supportive environment to achieve climate goals, helping ensure that efforts across different areas are coordinated and mutually reinforcing, enhancing the overall effectiveness of Brunei's climate actions and providing a comprehensive response to the challenges of climate change.

Table 4.3 BNCCP Enabling Strategies, 2020-2035

Strategy	Description Target	Implementing Agencies
Carbon Pricing	To explore carbon pricing as an option to further reduce carbon intensity from all industrial sectors in Brunei Darussalam.	BCCO, PMO
Carbon Inventory	This strategy aims to improve Brunei's national GHG inventory by strengthening the institutional framework and enhancing data quality in line with the principles of Transparency, Consistency, Comparability, Completeness, and Accuracy (TCCCA).	BCCO, PMO
Climate Awareness and Education	This strategy seeks to foster awareness and increase education by integrating climate education into school activities, conducting public awareness campaigns, and fostering a culture of sustainability among citizens.	BCCO, PMO STEP Centre, Ministry of Education DOE, PMO

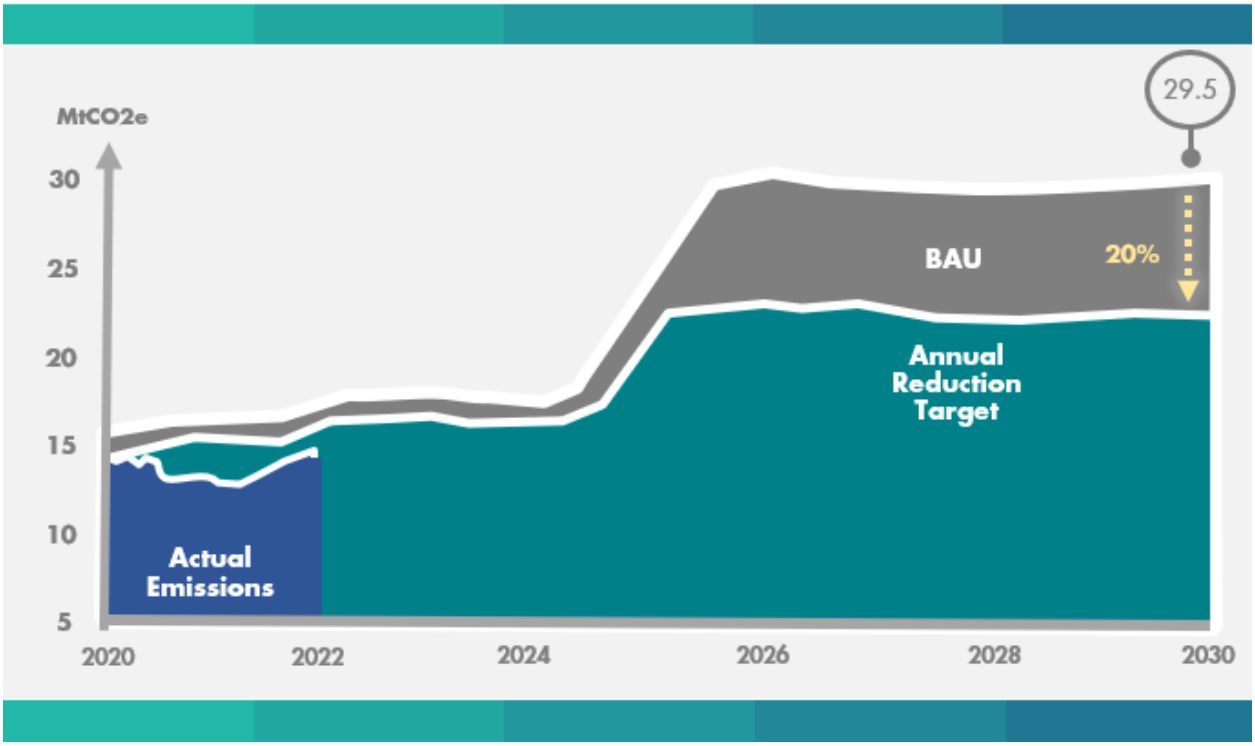
Brunei is also currently working **to update the strategies under the BNCCP** in response to the evolving challenges of climate change, new trends in climate science, changes in national socio-economic factors, and the need to align with updated international and national strategies. This exercise is expected to be completed by early 2025.

In addition, Brunei has also begun the **development of its long-term strategy**. Projections to 2050 are currently being developed for the major emitting sectors (power generation and industry), and discussions are ongoing to develop long-term projections for transportation, waste, and agriculture. Mitigation intervention options are also currently being identified to support Brunei's net-zero ambition by 2050.

As shown in figure 4.1, Brunei's GHG emissions are tracked in terms of absolute GHG. These emissions are compared against a Business as Usual (BAU) scenario, which represents the projected emissions trajectory in the absence of any additional mitigation measures or policy interventions. This approach helps to quantify the impact of implemented actions, assess progress toward emission reduction targets, and highlight the deviation from the baseline trajectory. Base year (2015) emission level: 11.6 Mt CO2e Business-As-Usual (2030) emission level: approximately 29.5 Mt CO2e

In the two years following the BNCCP, successful execution of pivotal strategies has ensured that Brunei consistently meets its annual targets and objectives, contributing to an average reduction of 11.1% in emissions between 2020 and 2022. This progress positions the nation well on its path to achieving its NDC.

Figure 4.1 Brunei's Current Progress Towards Achieving its NDC, 2020-2030



In April 2023, Brunei Darussalam issued a directive on mandatory greenhouse gas (GHG) reporting, requiring all facilities that emit and/or remove GHG—including government departments and private companies—to report their GHG emissions quarterly and annually starting in 2023. This directive aligns with **Article 4, Paragraphs 13–14 of the Paris Agreement**, which emphasizes the need for transparency, accuracy, and consistency in accounting and tracking progress toward Nationally Determined Contributions (NDCs). By mandating comprehensive GHG reporting, Brunei takes an important step in fulfilling its commitment to provide reliable and transparent data for monitoring emissions and removals.

This mandatory requirement for companies/other emitting agencies to submit emissions reports is key to maintaining a transparent and reliable carbon inventory, which depends on a robust measuring, reporting, and verification (MRV) system, as outlined in the Modalities, Procedures, and Guidelines (MPGs) of the Paris Agreement. To support this effort, a centralized online reporting platform is being developed to standardize data reporting and provide a user-friendly overview of greenhouse gas data.

Additionally, in 2022, an independent team **conducted a quality assurance exercise to strengthen the quality and transparency of the country's carbon inventory.** This initiative further ensures adherence to the principles of transparency and environmental integrity as stipulated under the Paris Agreement, enabling Brunei to track its progress toward national pledges and commitments to reducing GHG emissions.

Updates on the progress of each of these strategies are explained in sections 4.2.1 to 4.2.5.

4.2.1 Reduce Emissions from Industry

This strategy seeks to reduce industrial emissions from the industries**. Industrial emissions refer to emissions from combustions of fossil fuels to produce electricity for autoproducers, fugitive emissions and industrial processes.** Emissions from industrial processes comes primarily from the production of methanol (by BMC and urea by BFI). Additional emissions, categorized as 'others', come from the combustion of fossil fuels in commercial and institutional buildings and various economic activities. Emissions in the industry sector are projected to double by 2030 to 23.1 MtCO2e from ~9 MtCO2e in 2020 due to increasing activities in the oil and gas downstream sector.

The BAU projections assume that emissions from existing autoproducers will follow historical trends, fugitive emissions will remain constant based on historical averages, no abatement activities (in both upstream and downstream sectors) will be implemented, production for all utilities included in industrial processes will be sustained, and no expansion in the downstream sector will occur. Additionally, the BAU scenario assumes no deployment of new technologies, such as carbon capture and storage (CCS) or methane recovery.

Currently, there are no specific emission reduction targets for individual companies. **To achieve the targeted 18% reduction by 2030 from BAU levels,** Brunei Darussalam has adopted a policy-driven, sector-wide approach, focusing on general measures and policies to achieve collective reductions across all entities within the sector.

Abatement activities are guided by the 5- to 10-year business plans of upstream and downstream industry operators. GHG abatement plans are reported and monitored annually by the Department of Energy and Petroleum Authority, as part of company scorecards. Progress on GHG abatement is discussed annually, with updates consolidated and tracked on a quarterly basis.

Brunei's NDC tracking of industrial emissions encompasses emissions from the following sources; combustion of fossil fuels (natural gas, diesel, and coal) by autoproducers, fugitive emissions,

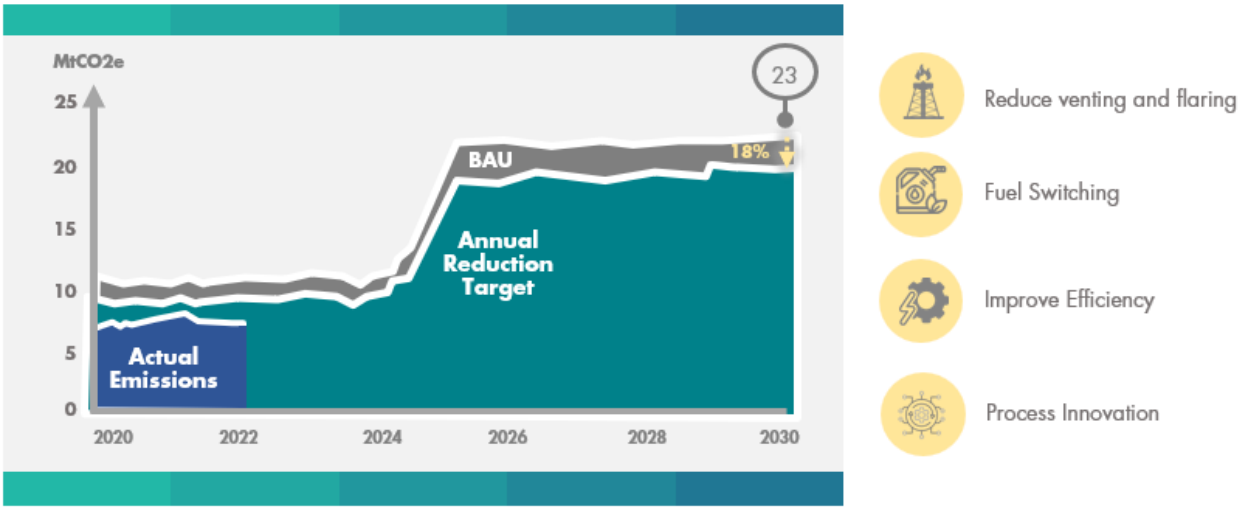
petroleum refining, industrial processes, combustion of fossil fuels in commercial and institutional buildings, and other economic activities.

Emissions are estimated using the Tier 3 IPCC methodology. Further details can be found under *chapter 2 of the BTR - Table 2.7a, 2.7b, 2.7c and 2.7d.*

Emission factors are aligned with IPCC recommendations, and production data is sourced from verified national and facility-level reports. To avoid double counting, data is cross-checked to ensure emissions reductions are not double-counted across agencies. Tracking is performed in terms of absolute GHG emissions relative to a Business-As-Usual (BAU) scenario and is integrated into Brunei's overall NDC target. This approach ensures robust monitoring of emissions reductions and supports the country's climate commitments. As shown in figure 4.2, emissions are tracked in terms of absolute GHG emissions compared to BAU scenario and integrated into the overall NDC target.

Over the past four years, Brunei has successfully reduced emission levels relative to the BAU scenario through the implementation of various rejuvenation projects. These initiatives demonstrate the country's commitment to meeting its climate goals through collaborative efforts across the industry.

Figure 4.2 Emissions from the Industry Sector, 2020-2030



The information on mitigation actions for industry includes the following;

PROJECT	Zero Routine Flaring and As Low as Reasonably Practicable (ALARP) Policy				
SECTORS AFFECTED	**GASES AFFECTED**	**STATUS**	**IMPLEMENTATION TIMELINE**	**IMPLEMENTATION AGENCIES**	**TYPE OF INSTRUMENTS**
Energy Sector Industrial Emissions	CO_2, CH_4	Developing	TBC	DOE, PMO	Regulatory
DESCRIPTION & OBJECTIVES	Minimize/eliminate the practice of routinely burning off excess gas in flares at oil and gas operations to reduce GHG Emissions while ensuring safety to reduce GHG emissions.				
ACTION PLAN	Develop comprehensive policies that incorporate Zero Routine Flaring by a target date and apply ALARP principles to achieve minimal flaring levels. Work with oil and gas operators to upgrade infrastructure to capture and utilize gas that would otherwise be flared. Establish a fine or penalty system for operations that exceed permitted flaring volumes, especially for non-emergency situations.				
EST. OUTCOME	Significant reduction in GHG emissions, particularly CH_4.				
EST. GHG EMISSIONS REDUCTION	~1.2 $MtCO_2e$ by 2030				
PROGRESS INDICATORS	Measurable decrease in annual flaring volumes and associated emissions reported ($MtCO_2e$)				
CURRENT PROGRESS	In Development				
CHALLENGES	High initial costs, technological limitations, operational challenges, economic viability, infrastructure constraints, stakeholder's resistance and regulatory compliance.				
MITIGATING ACTIONS	• Work with operators to develop and implement robust operational procedures that minimize the need for flaring. • Stakeholder engagements to address concerns. • Implement rigorous safety standards and monitoring systems.				

PROJECT	Develop Carbon Capture, Utilisation and Storage (CCUS) Framework				
SECTORS AFFECTED	**GASES AFFECTED**	**STATUS**	**IMPLEMENTATION TIMELINE**	**IMPLEMENTATION AGENCIES**	**TYPE OF INSTRUMENTS**
Energy Sector Industrial Emissions	CO_2, CH_4	Developing framework	TBC	DOE, PMO	Regulatory
DESCRIPTION & OBJECTIVES	Reduce GHG emissions by capturing carbon from industrial and energy-related sources, utilizing it in various applications, and securely storing excess carbon underground. Support the continued use of fossil fuels in a cleaner manner while transitioning to a low-carbon economy.				
ACTION PLAN	It involves reviewing and analyzing existing environmental and energy policies to identify gaps and opportunities for integrating Carbon Capture, Utilization, and Storage (CCUS). Additionally,				

	a feasibility study will be conducted to assess the potential and scalability of various CCUS technologies in Brunei, followed by a cost-benefit analysis.
EST. OUTCOME	Reduce GHG emissions from industrial sources and power plants. Long-term sustainability in industrial practices, ensuring continued economic activities without compromising environmental quality. Development of new infrastructure for the transport and storage of CO_2
EST. GHG EMISSIONS REDUCTION	N/A
PROGRESS INDICATORS	Amount of CO_2 captured annually ($MtCO_2e$) Number of new technologies or improvements in existing technologies related to CCUS.
CURRENT PROGRESS	Framework development
CHALLENGES	High costs and economic viability, technological challenges, storage and leakages risks, infrastructure development, regulatory environment for CCUS is still in its infancy, acceptance, scale of deployment, integration with existing operations and utilization opportunities.
MITIGATING ACTIONS	coordinated action between governments, industries, and financial institutions. Governments need to establish clear, supportive regulatory frameworks that define property rights, liability, and safety standards for CCUS. Rigorous site selection, combined with advanced monitoring and verification technologies, can help manage and mitigate leakage risks. Continuous research into safe storage techniques and real-time monitoring systems is necessary.

4.2.2 Power Management

This strategy aims to **reduce emissions from power generation by at least 30% by 2030** through the implementation of energy efficiency and conservation measures in both supply and demand side management.

On the supply side, the objective also includes to 1) **increase the overall energy efficiency of all public utility power plants to more than 48% by 2035** through comprehensive technological upgrades and operational improvements to achieve a more efficient system, and 2) **increase the renewable energy (RE) share to at least 30% of the total installed capacity by 2035.**

However, only the supply-side emissions are accounted for in both the National GHG inventory and NDC tracking, and as shown in figure 4.3, they are measured in terms of absolute GHG emissions compared to the BAU scenario and integrated into the overall NDC target.

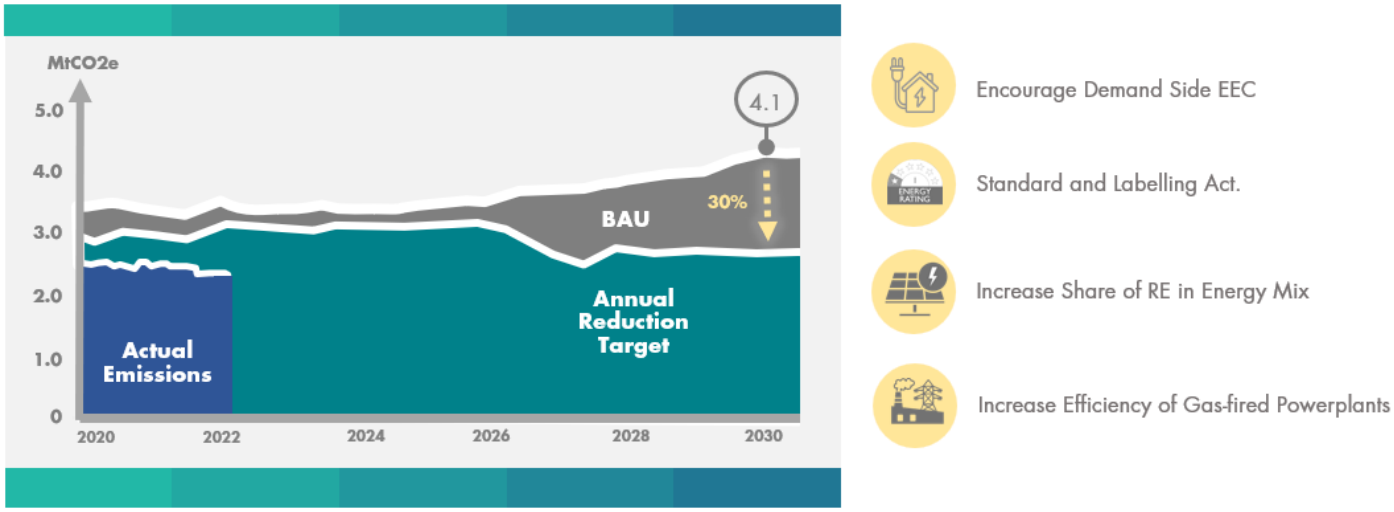
Emissions in the power sector is projected to nearly double by 2030 to 4.1 MtCO2e from 2.2 MtCO2e in 2020 based on historical trends.

The Business-As-Usual (BAU) scenario for power generation represents the projected emissions trajectory, assuming no additional mitigation measures or policy interventions are implemented.

This scenario assumes the sector continues to operate based on historical trends, with fuel consumption growing at an average annual growth rate (AAGR) of 2.8%, and no deployment of new renewable energy (RE) projects. Furthermore, the BAU scenario assumes no technological upgrades, with all public utility power plants maintaining an operational efficiency of 28%.

Activity data consists of consumption data from natural gas and diesel used in eight power plants in Brunei are converted into GHG emissions using the Tier 1 IPCC methodology. Further details can be found in *Chapter 2 of the BTR, Table 2.7a.* To avoid double counting, only emissions from grid-connected public utilities are included in the national GHG inventory. RE generation are accounted as zero emission sources. The same methodologies are used for both GHG inventories and NDC progress tracking to ensure comparability over time.

Figure 4.3 Emissions from Power Generation (Public Utilities), 2020-2030



The progress of the strategy is consolidated and tracked by the DOE, PMO on a quarterly basis, and reported to ExComm members, which include Permanent Secretaries of relevant ministries and heads of emission-emitting industries.

The information on mitigation actions for power includes the following;

PROJECT	Develop robust strategy to deliver the >45% Energy Efficiency of Power plants by 2035.				
SECTORS AFFECTED	GASSES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Energy Power	CO_2, CH_4	On-going	2023-2035	DOE, PMO	Regulatory
DESCRIPTION & OBJECTIVES	To enhance the overall energy efficiency of electricity power plants in Brunei to more than 45% by 2035 through comprehensive technological upgrades and operational improvements.				
ACTION PLAN	It involves implementing technology enhancements and upgrades, conducting initial comprehensive energy audits to identify inefficiencies, and developing a routine maintenance and optimization schedule based on the audit results. Additionally, combined cycle power plants will be explored as a potential solution.				
EST. OUTCOME	Higher energy output per unit of fuel consumed results in lower emissions. The reduced need for fuel allows it to be redirected for other economic uses, particularly in downstream activities. This also leads to lower operational costs for power plants due to decreased fuel consumption and improved efficiency. Enhanced efficiency further contributes to more reliable power generation, ensuring greater grid stability and reducing the likelihood of power outages.				
GHG REDUCTION	TBC				
PROGRESS INDICATORS	• Gas consumed in MMBtu by power plant to generate electricity • Increase RE capacity to total energy mix • Emissions reduced from gas generated powerplant				
CURRENT PROGRESS	Overall average efficiency of 26% across 8 power utilities in Brunei.				
CHALLENGES	High initial capital costs, older power plants are more challenging and expensive to retrofit, operational disruption due to upgrade projects,				
MITIGATING ACTIONS	Careful planning of upgrade projects is essential to minimize downtime. Additionally, exploring various financing options and conducting thorough cost-benefit analyses will help demonstrate long-term savings and environmental benefits.				

PROJECT	Expand Brunei's Energy Efficiency (Standard and Labelling) Act.				
SECTORS AFFECTED	GASSES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Energy Power	CO_2, CH_4	On-going	2023-2035	DOE, PMO	Regulatory
DESCRIPTION & OBJECTIVES	The Energy Efficiency (Standards and Labelling) Act, which promotes the use of highly efficient electrical appliances meeting the Minimum Energy Performance Standard (MEPS) in Brunei, was initially focused on air-conditioning systems. The Act will now be expanded to include other home appliances.				
ACTION PLAN	A comprehensive review of the existing act will be conducted to identify necessary amendments for the inclusion of additional home appliances. Consultation sessions with stakeholders—such as appliance manufacturers, importers, retailers, and consumer groups—will be organized to gather input and discuss proposed changes. Based on regulatory reviews and stakeholder feedback, amendments to the act will be drafted, focusing on criteria for including new appliance categories. Detailed implementation plans, including timelines, resource allocations, and enforcement responsibilities, will also be developed to ensure the effective execution of the updated act.				
EST. OUTCOME	The use of energy-efficient appliances in Brunei will lead to a significant improvement in the overall energy efficiency of household appliances, resulting in lower household energy consumption. This shift will contribute to a reduction in GHG emissions from the power sector due to decreased energy consumption. Furthermore, consumer awareness about energy efficiency will increase, and national standards will be better aligned with international energy efficiency benchmarks.				
GHG REDUCTION	TBC				
PROGRESS INDICATORS	• Percentage of appliances in the market that comply with the new energy efficiency standards. • Decrease in national energy consumption (MWh) • Proportion of energy-labelled products in the consumer market. • Number of New Efficient Products Introduced				
CURRENT PROGRESS	In planning				
CHALLENGES	The lack of a domestic testing laboratory hinders the verification of appliances' claimed efficiency levels, while Brunei Darussalam is regarded as a very small market, leading manufacturers to be generally unwilling to accommodate its specific Minimum Energy Performance Standards (MEPS) requirements due to the limited overall volume. Additionally, data collection is challenging because there is insufficient detailed efficiency information from suppliers about their appliances, and obtaining reliable test reports for Original Equipment Manufacturer (OEM) products is typically more difficult than for genuine products. Notably, more than 70% of air conditioners in the Brunei market are classified under the 1-Star Rating.				
MITIGATING ACTIONS	To explore regional testing laboratories that have been accredited while strengthening collaboration with suppliers and other stakeholders to increase the frequency and reliability of data. Additionally, to continue promoting the benefits of higher star-rated appliances to encourage better purchasing decisions.				

PROJECT	Develop robust RE portfolio Strategy for Brunei Darussalam				
SECTORS AFFECTED	GASSES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Energy Power	CO_2	On-going	2025	DOE, PMO	Regulatory
DESCRIPTION & OBJECTIVES	To transition the country towards a sustainable, diversified, and resilient energy sector. This strategy aims to reduce dependence on fossil fuels and decrease emissions form gas powered powerplants. The current objective is to increase the renewable energy (RE) share to at least 30% of the total installed capacity by 2035.				
ACTION PLAN	Comprehensive assessments will be conducted to map out potential renewable energy (RE) sources, such as solar, wind, hydroelectric, and biomass resources. The technical and economic feasibility of RE projects will be evaluated, taking local environmental impacts and community interests into consideration. To encourage investments in renewable energy projects, tax incentives, subsidies, and financing programs will be introduced. Partnerships between the government, private sector, and research institutions will be fostered to increase RE usage, along with engagement with international bodies and foreign investors to gain access to expertise, funding, and advanced technologies.				
EST. OUTCOME	The percentage of total energy production derived from renewable sources will be monitored, along with the development of new industries and the expansion of existing ones related to renewable energy (RE). Additionally, there will be a focus on reducing greenhouse gas emissions through the displacement of fossil fuel-based power generation, which will ultimately strengthen energy security.				
GHG REDUCTION	TBC				
PROGRESS INDICATORS	• MWh of electricity generated by plant • Increase RE capacity to total energy mix • Emissions reduced from gas generated powerplant				
CURRENT PROGRESS	On-going				
CHALLENGES	High initial costs and a lack of a regulatory and policy framework to support the development and integration of renewable energy (RE) pose significant challenges. Additionally, land and resource constraints, along with a lack of incentives, hinder progress. Low electricity prices also deter the transition to renewable options, while a shortage of skilled workforce and technical expertise in the RE sector in Brunei further complicates the situation.				
MITIGATING ACTIONS	Alternative financing options will be explored, including international funding, alongside phased implementations. Collaboration with the TCP will be undertaken to gazette more lands for projects, and the feasibility of floating solar PV systems will also be investigated.				

4.2.3 Transport

This strategy seeks to **reduce emissions from land transport by 20% by 2030** through increasing sales of low carbon vehicles such as electrical vehicles, hybrid cars and improving public transportation.

For the national inventory, transportation emissions are calculated based on the combustion of fossil fuels (gasoline and diesel) used in road transport and domestic aviation (limited to helicopters). Road transport includes cars, buses, heavy vehicles, and motorcycles operating within the national territory. Data are collected from fuel sales (MOGAS and Diesel) measured in M3 and converted in TJ before estimating for GHG emissions using the Tier 1 IPCC methodology and country specific calorific value. Further details can be found in *Chapter 2 of the BTR, Table 2.7c.*

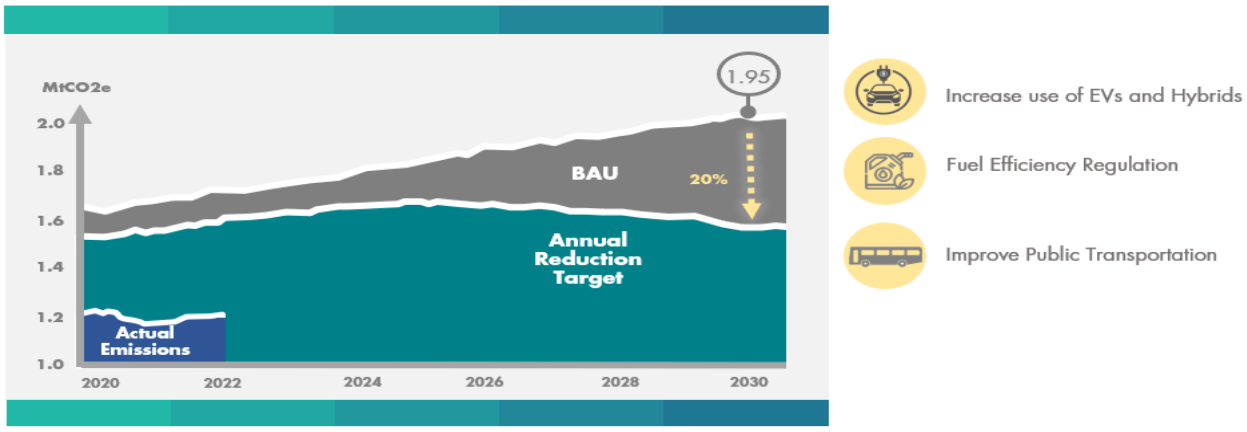
The BAU scenario assumes a 3.6% annual growth in fuel consumption, with the majority of active vehicles remaining internal combustion engine (ICE) vehicles, and only minor growth in hybrid and EVs.

As shown in figure 4.4, emissions are tracked in terms of absolute GHG emissions compared to BAU scenario and integrated into the overall NDC target. Over the past few years, emissions from land transportation have shown a downward trend, primarily due to improvements in vehicle fuel efficiency. Due to the insignificant amount, no measures are in place to reduce domestic aviation.

Currently, Brunei Darussalam has no specific emissions reduction regulations for car emissions. However, to achieve a reduction of at least 20% in emissions from land transportation, the country is actively promoting the adoption of low-carbon vehicles, such as electric vehicles (EVs) and hybrids. Efforts are also underway to enhance the existing EV infrastructure to support this transition.

The strategy's progress is tracked quarterly by LTD, MTIC, DOE, and PMO, and reported to ExComm members, including Permanent Secretaries of relevant ministries and industry leaders.

Figure 4.4 Emissions from Land Transport Sector, 2020-2030



The information on mitigation actions for transport includes the following;

PROJECT	Low Carbon Emission Mobility				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Energy Transportation	CO_2	On-going	2025	LTD, MTIC	Regulatory
DESCRIPTION & OBJECTIVES	To increase sales of EV and hybrid in Brunei with the objective of reducing GHG emissions from the land transportation sector.				
ACTION PLAN	Efforts will be made to improve electric vehicle (EV) infrastructure by increasing the number of rapid charging stations and developing an EV commercial tariff in Brunei. The policy on excise duty rates for the importation of EVs and EV charging tariffs will be finalized, along with amendments to the Road Traffic Act regarding driving licenses for Class 1 EVs. Additionally, there will be a push for EV adoption in the government fleet and a continuation of public awareness programs.				
EST. OUTCOME	Increase use of EVs and Hybrid in Brunei.				
GHG REDUCTION	~0.7 $MtCO_2e$				
PROGRESS INDICATORS	• Number of EVs and hybrid cars sold in the market annually. • Reduction in emissions from land transportation ($MtCO_2e$)				
CURRENT PROGRESS	225 EVs sold since 2020.				
CHALLENGES	The transition to electric vehicles is impeded by a lack of policy incentives promoting EV use on both the supply and demand sides, insufficient commercial charging infrastructure, range anxiety, higher upfront costs of EVs compared to traditional vehicles, and a general lack of awareness. Additionally, the increased demand for electricity due to EV charging necessitates careful management to avoid straining the electric grid, particularly during peak times.				
MITIGATING ACTIONS	Efforts to collaborate with the automotive industry to introduce more affordable electric vehicles (EVs) while also increasing public awareness campaigns.				

PROJECT	Minimum EV Charging Network				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Energy Transportation	CO_2	Planning	2025	LTD, MTIC	Regulatory
DESCRIPTION & OBJECTIVES	Establish a minimum EV charging network that supports the increasing number of electric vehicles, aiming to reduce carbon emissions, improve air quality and promote sustainable transportation.				
ACTION PLAN	Collaboration with relevant agencies will be established to develop the necessary infrastructure, guidelines, policies, regulations, and standards for EV charging stations. Building codes will be updated to incentivize EV charging in new developments and major renovations. Campaigns will be launched to educate the public on the benefits of electric vehicles (EVs) and the availability of charging options, while technology and infrastructure will be upgraded as needed to meet demand and technological advancements.				
EST. OUTCOME	• A reliable and accessible charging infrastructure reduces range anxiety, encouraging more consumers and businesses to switch to electric vehicles. • Reducing dependence on heavily subsidized gasoline.				
GHG REDUCTION	~0.7 $MtCO_2e$				
PROGRESS INDICATORS	• Number of EVs and hybrid cars sold in the market annually. • Reduction in emissions from land transportation ($MtCO_2e$)				
CURRENT PROGRESS	In planning				
CHALLENGES	Establishing a comprehensive EV charging network requires significant upfront capital investment in infrastructure, including chargers, grid enhancements, and installation costs.				
MITIGATING ACTIONS	Increasing public-private partnerships will facilitate phased deployment and support the integration of renewable energy.				

4.2.4 Waste Management

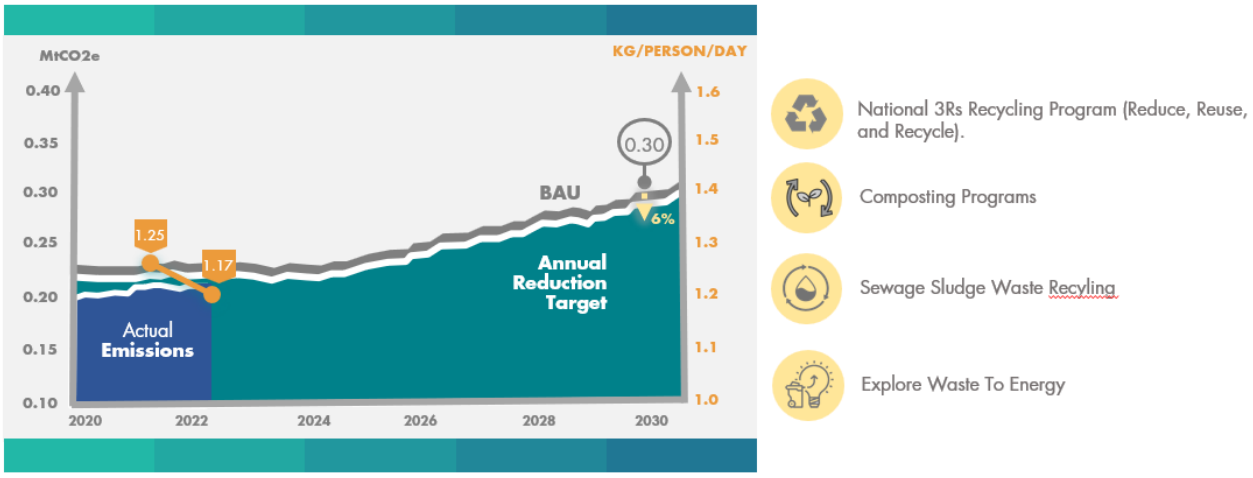
This strategy aims to reduce GHG emissions from waste landfills and wastewater treatment and discharge, from both domestic and industrial sector. The current target is to decrease municipal waste sent to landfills to 1 kg per person per day and **reduce GHG emissions by 6% from business-as-usual (BAU) levels by 2030.**

The BAU scenario assumes no change to waste generation pattern of 1.4 kg/person/day, an annual population growth rate of 1%, no improvements to current landfill and wastewater treatment technology, and minimal growth in recycling patterns.

As shown in figure 4.5, emissions are tracked as absolute GHG emissions relative to the BAU scenario and are integrated into the overall NDC target. Activity data consists of the volume of municipal solid waste (MSW) disposed of at designated landfill sites. Emissions are estimated using the Tier 2 IPCC methodology, incorporating reliable country-specific activity data on both current and historical waste disposal at solid waste disposal sites (SWDSs) alongside some default parameters. The activity data is further converted into GHG emissions using the Tier 1 IPCC methodology and further details further details can be found in *Chapter 2 of the BTR, Table 2.19a and 2.19b.*

As shown in figure 4.5, Emissions are tracked in terms of absolute GHG emissions compared to BAU scenario and integrated into the overall NDC target. In the last three years, emissions have been trending lower due to improvements in fuel efficiency most likely attributed to increase efforts in recycling activities in Brunei Darussalam.

Figure 4.5 Emissions from Waste Sector, 2020-2035



The government is actively exploring the potential for introducing incineration and waste-to-energy (WTE) technologies in the country. Incineration with energy recovery could serve as an alternative waste management solution, significantly reducing the volume of waste while generating electricity. In addition, the government has set a target to recycle 30% of all solid waste by 2035.

The progress of the strategy is consolidated and tracked by the DEPR, MOD on a quarterly basis, and reported to ExComm members, which include Permanent Secretaries of relevant ministries and heads of emission-emitting industries.

The information on mitigation actions for waste includes the following;

PROJECT	Waste-to-Energy (WtE) Project				
SECTORS AFFECTED	GASSES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Waste	CO_2, CH_4	In planning	2030	DEPR, MOD DOE, PMO MOFE	Regulatory
DESCRIPTION & OBJECTIVES	To convert solid waste materials into usable energy, thereby addressing waste management challenges reduce emissions from landfills while generating alternative energy source.				
ACTION PLAN	The feasibility of the Waste-to-Energy (WtE) project will be assessed from technical, economic, and environmental perspectives, including potential sites, available technologies, and feedstock analysis. Funding options will be explored, encompassing government grants, private investments, and public-private partnerships. Input will be gathered to address concerns and build support for the project. Finally, the most suitable WtE technology, such as incineration, anaerobic digestion, or gasification, will be identified, and the facility layout and processes will be designed accordingly.				
EST. OUTCOME	To reduce solid waste sent to landfills by 80%, thereby decreasing emissions from landfills and improving leachate management. This initiative will also supply electricity to the national grid while simultaneously reducing greenhouse gas emissions from fossil fuel-fired power generation.				
GHG REDUCTION	0.24 $MtCO_2e$ by 2030 from landfills.				
PROGRESS INDICATORS	• Tons of emissions per year reduced in Landfills ($MtCO_2e$) • MWh of electricity generated by WtE (MWh) • Emissions reduced from gas generated powerplant				
CURRENT PROGRESS	Development and framing of Request for Proposal (RFP) Document for the establishment of a WtE Facility in Brunei				
CHALLENGES	High initial capital costs, technological complexity, feedstock variability and economic viability				
MITIGATING ACTIONS	Explore funding options and get government support				

PROJECT	Composting Programs				
SECTORS AFFECTED	GASSES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Waste	CH_4, N_2O	On-going	2030	DEPR, MOD DoAA, MPRT	Regulatory
DESCRIPTION & OBJECTIVES	The project aims to increase composting facilities to process organic waste, diverting it from landfills to reduce methane (CH4) emissions and extend landfill lifespan. Organic waste will be converted into nutrient-rich compost for use in agriculture, gardening, and landscaping, enhancing soil health and supporting sustainable agriculture. Furthermore, the project seeks to reduce the use of synthetic fertilizers, which produce high levels of nitrous oxide (N2O), while also minimizing odors and fly populations.				
ACTION PLAN	A feasibility study will be conducted for the expansion of the composting program, followed by the development of a business plan for this expansion. Workshops and training sessions will be organized, and collaboration with the private sector will be encouraged to enhance composting programs.				
EST. OUTCOME	The initiative aims to reduce solid waste sent to landfills, decrease the need for synthetic fertilizers, which produce high levels of nitrous oxide (N2O), and promote carbon sequestration in soils.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	• Amount of organic waste collected for composting (tonnes) to indicate scale of waste diversion from landfills • Tons of emissions per year reduced in Landfills ($MtCO_2e$)				
CURRENT PROGRESS	On-going				
CHALLENGES	Public participation and education, contamination of organic waste, infrastructure requirements, economic viability of conducting on a larger scale and consistency of organic waste supply.				
MITIGATING ACTIONS	Public/business awareness campaign to promote current facility – generate more demand.				

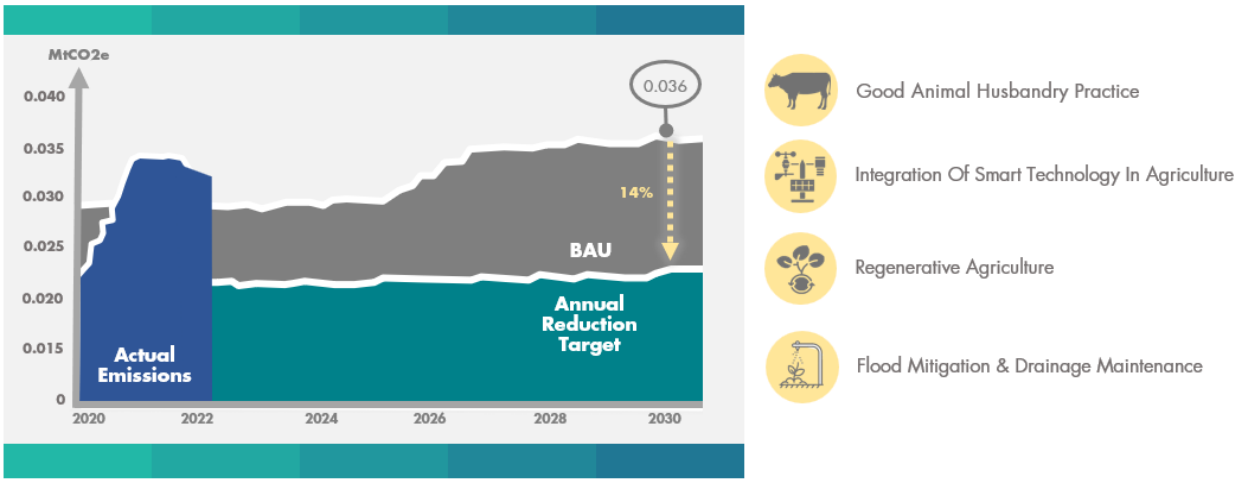
PROJECT	National Recycling Program through the 3Rs (Reduce, Reuse, and Recycle).				
SECTORS AFFECTED	GASSES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Waste	CO_2, CH_4	On-going	2030	DEPR, MOD	Regulatory
DESCRIPTION & OBJECTIVES	The objective is to manage waste sustainably by conserving natural resources, reducing environmental pollution, and minimizing the amount of waste sent to landfills, with a target to recycle 30% of all solid waste generated by 2035.				
ACTION PLAN	Various programs will be conducted, including Brunei's ongoing 'No Plastic Bag Everyday' initiative and the 'Bring Your Own Reusable (BYOR)' campaign. Additionally, more public awareness campaigns will be launched, encompassing recycling initiatives, media outreach, school programs, and community workshops to raise awareness about recycling. Support will be provided for recycling markets to foster the development of recycling-related markets, and collaboration with the private sector will be encouraged for recycling programs.				
EST. OUTCOME	• Increase recycling rate.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	• Amount of organic waste collected for composting (tonnes) to indicate scale of waste diversion from landfills • Tons of emissions per year reduced in Landfills ($MtCO_2e$)				
CURRENT PROGRESS	On-going. Recycling rate stands at 14%				
CHALLENGES	Public participation and behavior change, contamination of recyclables, lack of infrastructure and logistics, market demand and absence of a clear policy poses a significant hurdle in the effective implementation of the 3Rs.				
MITIGATING ACTIONS	• As per action plan.				

PROJECT	Recycling of sludge waste at Sewage Treatment Plant				
SECTORS AFFECTED	GASSES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
Waste	CO_2	In planning	2026	DDS, PWD, MOD	Study & Regulatory
DESCRIPTION & OBJECTIVES	To convert sludge waste into recyclable material such as fertilizer				
ACTION PLAN	The action plan includes assessing the technical, economic, and environmental feasibility of the project, which will encompass evaluating potential sites and available technologies, as well as exploring funding options that include government funding, private investments, and public-private partnerships.				
EST. OUTCOME	The aim is to eliminate sludge waste from treatment plants sent to landfills, reduce carbon emissions generated during logistics to landfills, and minimize the amount of sludge waste sent to landfills, thereby indirectly improving leachate management.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	• Tons of emissions per year reduced in treatment plant ($MtCO_2e$)				
CURRENT PROGRESS	Feasibility study with relevant agencies and expert companies to assess on the technical, economic, and environmental feasibility on the conversion of the sludge waste to recyclable material such as fertilizer				
CHALLENGES	Consistency on the amount of sludge waste produced at the treatment plant				
MITIGATING ACTIONS	It involves exploring the centralization of treatment facilities in Brunei to ensure more efficient management and processing of sludge waste. All sewage treatment facilities and equipment will be optimized to enhance the overall quality and consistency of treated sludge, facilitating its recycling or repurposing into valuable materials, such as fertilizers. Furthermore, this approach can reduce transportation costs, streamline operations, and contribute to better environmental outcomes by minimizing the environmental footprint associated with waste handling and disposal.				

4.2.5 AFOLU

4.2.5.1 Agriculture

Figure 4.6 Emissions from Agriculture Sector, 2020-2035



The BAU scenario assumes a population growth of 1% and no major changes to agriculture activities, methodologies and technologies. More data is required to monitor emissions from the agriculture sector.

Data also does not include information pertaining to land-use changes.

The progress of the strategy is consolidated and tracked by the DoAA, MPRT on a quarterly basis, and reported to ExComm members, which include permanent secretaries of relevant ministries and heads of emission-emitting industries.

The information on mitigation actions for agriculture includes the following;

PROJECT	Smart Farm Pilot Project				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
ENERGY TRANSPORTATION	CO_2	In planning	2020-2030	DoAA, MPRT	Regulatory
DESCRIPTION & OBJECTIVES	The initiative is aimed on integrating advanced technologies into agriculture to optimize farm management, increase productivity, promote sustainable farming practices, and enhance food security.				
ACTION PLAN	• This involves conducting site selection and soil analysis to determine the best location and crop types for the pilot, implementing precision agriculture equipment, monitoring crop growth and system operations with parameters adjusted based on AI recommendations, and conducting workshops and training sessions to encourage wider adoption among the farming community.				
EST. OUTCOME	Precision farming techniques can result in higher productivity per acre, leading to increased crop yields and improved quality, while data-driven insights allow for better decision-making in crop management and resource allocation.				
GHG REDUCTION	~0.02 $MtCO_2e$ annually				
PROGRESS INDICATORS	• Percentage increase in yield and improvement in quality indicators compared to traditional farming methods. • Number of farms adopting the technology post-pilot and the expansion rate of smart farming solutions. • Reduction in GHG emission through improvement in soil health indicators.				
CURRENT PROGRESS	Peat swamp Forest study completed, other forests types on-going. Result for all 7 types of forest to be completed by mid-2025.				
CHALLENGES	High initial costs, connectivity issues for rural areas, data management, maintenance and reliability, Scalability and Replicability and measuring impact.				
MITIGATING ACTIONS	Explore funding opportunities through grants, subsidies, or partnerships with technology companies.				

PROJECT	Crop Insurance Feasibility Study				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	-	Planning	2024-2029	DoAA, MPRT	Research
DESCRIPTION & OBJECTIVES	Crop insurance is one of the initiatives that can be taken in dealing with weather risks. The programme can provide assistance to farmers through financial protection against disasters, reduce the burden on governments, and support sustainable development and food security. It also helps to protect the farmers' livelihoods, enable them to recover from extreme weather events, distribute the risk to insurance, as well as facilitate faster recovery, and reducing the need for emergency assistance. Additionally, crop insurance can replace collateral for financial loan, improving the farmers' ability to make loan payments. It will aid to stabilize expenses and income if results are not encouraging. Overall, crop insurance plays an important role in ensuring food security, promoting resilience, and enhancing progress during climate uncertainties.				
ACTION PLAN	Several key steps are required, starting with a needs assessment through engagement with stakeholders and a technological readiness assessment. It will include studying policies and technologies currently available and practiced in other countries, followed by a feasibility study that evaluates economic viability, practicality, social acceptance, and social innovation and sustainability. Next, the initiative will develop a policy and framework, outlining the stakeholders' responsibilities, and preparing the processes for implementation. This will be followed by the socialization of farmers to launch a pilot project, after which monitoring, evaluation, and review of both pilot project and project scaling up will take place.				
EST. OUTCOME	The objectives are to protect farmers and their livelihoods from the negative impact of natural disasters. It is also aimed to provide financial assistance through insurance protection policies in the event of natural disasters including enemy attacks and disease, helpingthe farmers to manage risk and encourage them in innovation and investment. Ultimately, the programmes strive to stabilize their income and revenue.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	• Development of policy and framework • Product development • Pilot project launch • Number of farmers subscribing to crop insurance				
CURRENT PROGRESS	In planning				
CHALLENGES	The challenges include the absence of existing cases or programs, and policy framework. There is also a significant lack of knowledge and expertise as well as the know-how to start (5W1H). Additionally, identifying the relevant stakeholders and effective cross agencies coordination are also required				
MITIGATING ACTIONS	Several actions are identified like capacity buildings for the stakeholders (government, policy makers, private sectors, farmers, financial institution, academia). Support from development agencies will also be critical to establishing taskforce / working group and find funding support partners to develop a national strategy.				

PROJECT	Assessment & Monitoring on the Impact of Climate Change on Agriculture				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	CH_4, N_2O, CO_2	Planning	2025-2030	DoAA, MPRT	-
DESCRIPTION & OBJECTIVES	Aims to evaluate and track how climate change affects agricultural systems. The objective is to analyse changes in temperature, precipitation patterns, and extreme weather events and how these changes impact crop yields, soil health, and agricultural productivity. The project will involve data collection, modeling, and field studies to provide actionable insights and develop adaptive strategies to mitigate the negative effects of climate change on agriculture. The ultimate goal is to support sustainable farming practices and ensure food security in the face of a changing climate.				
ACTION PLAN	Establishing a dedicated team and embarking on data collection which includes identifying sources, conducting baseline surveys, and analyzing climate data. Impact assessments are made through developing climate models, evaluating crop vulnerability, and assessing socioeconomic impacts. Setting up monitoring systems with effective data management and remote sensing technologies. Adaptation strategies are then designed, tested through pilot projects, and supported by training and capacity building. Reporting includes preparing documentation, engaging policymakers, and raising public awareness. Continuous improvement is ensured through regular reviews and refinement of strategies.				
EST. OUTCOME	The initiative aims to promote adaptive farming techniques to improve agricultural productivity and optimize resource use. By implementing these strategies, farmers can build resilience to climate variability and reduce their vulnerability to environmental changes.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	• Relationship of climate change and agricultural production established • Mitigation projects proposed and launched				
CURRENT PROGRESS	In planning				
CHALLENGES	Several challenges include absence of experts, difficulty in cross agencies coordination, funding, infrastructure and manpower.				
MITIGATING ACTIONS	Support from development agencies is essential especially for establishing taskforce / working group, finding funding support partners and engage academia in the initiative.				

PROJECT	Crop Residue Management				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	CH_4, N_2O, CO_2	Continuos	Since 1998	DoAA, MPRT	Regulatory
DESCRIPTION & OBJECTIVES	To support the implementation of the ASEAN Strategy on Carbon Neutrality through the ASEAN Guidelines on Reducing Crop Burning that will be developed in 2024 to help farmers, policymakers, and relevant stakeholders protect the environment, improve public health, and foster sustainable economic growth for the benefit of the present and future generations in ASEAN. Objective: to promote appropriate sustainable agricultural practices that will contribute to minimizing air pollution, protecting public health, preventing soil and landscape degradation, and mitigating climate change impacts caused by the burning of agricultural residues.				
ACTION PLAN	Implementing Penal Code (Chapter 22)				
EST. OUTCOME	Advocate for the adoption of sustainable agriculture, including the use of innovative technologies, best practices, and alternative residue management methods to minimize the practice of crop burning.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	• Improving soil health by not practicing crop burning • Reduction of GHG emission				
CURRENT PROGRESS	Generally practiced in Brunei				
CHALLENGES	Farmers are not aware of the repercussions such as soil health reduction and the disobedience of the Penal Code (Chapter 22).				
MITIGATING ACTIONS	Conducting awareness programs.				

PROJECT	Brunei Good Agriculture Practice (BGAP)				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	N_2O, CO_2	Continuos	Since 2014	DoAA, MPRT	Certification
DESCRIPTION & OBJECTIVES	Set of principles, regulations and technical recommendations applicable to production, processing and food transport addressing human health care, environment protection, and improvement of worker conditions and their families. Objective: Prevent or reduce the risk of hazards during production, harvesting and postharvest handling				
ACTION PLAN	Implementing the BGAP				
EST. OUTCOME	The initiative focuses on improving resource efficiency to enhance food security and foster sustainable agriculture. Additionally, it aims to facilitate trade between countries, promoting a more interconnected and resilient agricultural market.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	Number of companies certified per year				
CURRENT PROGRESS	On-going and continuous				
CHALLENGES	Farmers' acceptance is crucial to the implementation of BGAP.				
MITIGATING ACTIONS	Increase awareness on importance of BGAP to farmers and the general public and increase collaborations with other agencies.				

PROJECT	Brunei Good Animal Husbandry Practice (GAHP)				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	CH_4, N_2O, CO_2	Since 2023	On-going	DoAA, MPRT	Certification
DESCRIPTION & OBJECTIVES	The initiative aims to ensure that farming practices produce safe final products while minimizing the risk of diseases, ensuring health and comfort for both farm workers and animals, and preventing environmental degradation. It seeks to implement environmentally sustainable practices in animal farming to reduce ecological footprints. Additionally, the initiative focuses on decreasing methane emissions from enteric fermentation and minimizing nitrous oxide (N_2O) emissions.				
ACTION PLAN	There are several key actions aimed at improving agricultural practices in Brunei such as developing and standardizing Good Agricultural and Handling Practices (GAHP) guidelines tailored to the local context. Establishing a regulatory body to oversee GAHP certifications and ensure compliance as well as upgrading existing farm facilities and to meet GAHP standards. To support these efforts, training programs will be conducted for farmers, handlers, and inspectors on GAHP standards and practices. Public awareness campaigns will be launched to promote the benefits of GAHP, and the certification will be expanded to include all relevant farms across Brunei.				
EST. OUTCOME	• Adaptation: Improved animal welfare, productivity, quality and enhanced food safety, disease control and biosecurity as well as public health and safety. • Mitigation: Improved feeding practices and better digestive health management can reduce methane emissions from ruminants which reduces methane emissions. Better manure management techniques, such as improved storage and handling, can reduce ammonia and nitrous oxide emissions. Moreover, adoption of pasture management practices that enhance soil health can increase carbon sequestration in soil.				
GHG REDUCTION	~0.01 $MtCO_2e$ annually				
PROGRESS INDICATORS	Decrease in N_2O and ammonia emissions Reduction in CH_4 emissions per head of livestock				
CURRENT PROGRESS	On-going and continuous				
CHALLENGES	High initial costs, lack of knowledge for farmers and technological challenges (farming system & availability to measure progress indicators.				
MITIGATING ACTIONS	Explore funding opportunities through grants, subsidies, or partnerships with technology companies.				

PROJECT	Rice Farmer Field School (RFFS)				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	CH_4, N_2O, CO_2	Continuos	Since 2010	DoAA, MPRT	-
DESCRIPTION & OBJECTIVES	A form of participatory learning approach designed to improve rice farming practices by educating the farmers on best practices in rice cultivation as well as building their capabilities to make the right decisions to achieve optimum yield in a sustainable manner. RFFS covers the principal areas of crop management from seed selection to land preparation until postharvest management which are structured as key checks that needs to be fulfilled in order to attain high yields. Among the key management techniques emphasized in RFFS are sustainable also reduces GHG emissions such as alternate wetting and drying (AWD), integrated pest management (IPM) and proper nutrient management.				
ACTION PLAN	Conducting lectures, workshops and training sessions for farmers and sharing best management practices in paddy cultivation. Another proposed action plan is setting up demo plots.				
EST. OUTCOME	This can help farmers to improve farm management by achieving higher productivity per hectare with practicing best farm management and promoting sustainable agriculture, while indirectly help farmers become more climate resilient.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	• Percentage increase in yield and productivity before and after using paddy checks • Number of hectares under sustainable practices. • Increase in soil organic carbon (SOC) levels in agricultural soils.				
CURRENT PROGRESS	On-going / concurrent				
CHALLENGES	• Lack of farmers participation due to time constraints and old age • Farmers difficulty to apply new knowledge due to lack of experience or understanding • Limited manpower resources, DoAA are not able to provide day to day support to the farmers beyond the training period hence application as well as uptake of technology may be limited.				
MITIGATING ACTIONS	Having demo fields can enhance farmer's understanding of management techniques. Regular assessments and feedbacks from farmers from time to time can also be done to ensure relevance of technology. Sharing of success stories of real life examples can also help to encourage and motivate other farmers to participate as well as learne management and techniques which are more suitable. Retraining of officers from time to time can also ensure competency in understanding of new concepts and recommendations.				

PROJECT	Rice varietal trial to select high yielding varieties that are suitable to be planted in Brunei Darussalam				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	CH_4, N_2O, CO_2	On-going	-	DoAA, MPRT	Research
DESCRIPTION & OBJECTIVES	The initiative aims to identify suitable high-yielding rice varieties specifically for irrigated areas in Brunei Darussalam. Given the limited suitable land for rice production in the region, enhancing rice production must focus on improving crop productivity. This approach not only aims to increase local rice production but also helps reduce methane emissions from rice cultivation areas. In addition to yield, the selection of rice varieties will consider their resilience to drought, pests, and diseases, ensuring that the chosen varieties can withstand environmental challenges and contribute to sustainable agricultural practices.				
ACTION PLAN	Conducting suitability testing in field using hybrid paddy varieties obtained from various research partners including Yuan Longping High Tech Agriculture Co. L.T.D, People's Republic of China, Hunan Hybrid Rice Research Centre, International Rice Research Institute and Jiayuan Trading Company				
EST. OUTCOME	Selection of high-yielding varieties for irrigated areas and non-irrigated areas, as well as higher domestic rice production through improvement of rice productivity.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	• Identification of at least 1 variety which are able to produce at least 8 MT/Ha (for Irrigated areas) and 5MT/Ha (for non-irriagated areas) under Brunei Darussalam's environmental condition. • Improvement of local rice production through the use of high-yielding varieties.				
CURRENT PROGRESS	On-going				
CHALLENGES	The presence of acid sulphate in soil affects plant growth and yield. Additionally, climate variability can also impact the growth cycle and productivity of rice. There is also pest and disease pressures as different locations have different pest and disease profiles. Moreover, there is a lack of experts and general manpower to run different trials at the same time.				
MITIGATING ACTIONS	Soil remediation through incorporating organic fertilizers, and ensure effective collaboration with farmers during the trial.				

PROJECT	Utilising regenerative agriculture methods for soil improvement and GHG reduction (Paddy)				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	CH_4, N_2O, CO_2	On-going	Starting August 2024	DoAA, MPRT	Research
DESCRIPTION & OBJECTIVES	Regenerative agriculture is a conservation and rehabilitation approach to food and farming systems. It focuses on topsoil regeneration, enriching biodiversity, improving water cycle, enhances ecosystem services, supporting biosequestration, increasing resilience to climate change and strengthening the health and vitality of soil. The projects aims to increase crop production sustainably using regenerative agriculture. In this early phase, DoAA will be conducting trials involving the use of various organic fertilizers including composted waste from local agriculture farms to improve soil health.				
ACTION PLAN	The project aims to identify suitable organic fertilizers to improve soil fertility and manage acid sulfate soil, while also assessing other practical focus areas that will significantly impact soil health and crop productivity.				
EST. OUTCOME	The project is expected to lead to improvements in soil health and increases in crop productivity, as well as the identification of an effective organic fertilizer regime that enhances soil health. Additionally, it aims to reduce greenhouse gas (GHG) emissions on farms, improve resource efficiency, and promote long-term sustainable agriculture.				
GHG REDUCTION	-				
PROGRESS INDICATORS	• GHG emissions per unit of agricultural area (rice field hectarage x EF) • Number of hectares under sustainable practices. • Increase in SOC levels in agricultural soils.				
CURRENT PROGRESS	Preparation for the trial in which is set to start in September 2024 in an area of 48ha				
CHALLENGES	The trial may require a longer time to yield results, and due to the size of the plots, it is expected to be quite costly. Additionally, there is limited manpower available for data collection and nutrient analyses, and ensuring that farm inputs are delivered on time poses another challenge.				
MITIGATING ACTIONS	The project involves collaboration with PaddyCo Sdn. Bhd., where costs will be shared, and it also explores the possibility of partnering with research institutions for data collection and analyses.				

The information on mitigation actions for Forestry includes the following;

PROJECT	National Forest Resources Inventory (NFRI) Project				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	CO_2	On-going	2023-2025	Forestry Department, MPRT	Regulatory
DESCRIPTION & OBJECTIVES	The project involves preparing a national forest inventory for the entire national estate forests, with a primary focus on the carbon inventory of the Belait Peat Swamp Forest. The inventory from 1984, conducted by Anderson Marsden, along with the Forest Management Plan, will be updated, validated, and enhanced for multi-purpose use by the Forestry Department. The objectives are to determine forest carbon stocks and changes in carbon storage, establishing baseline data for forest carbon projects and reporting to the National GHG Inventory.				
ACTION PLAN	The project will ensure progress according to schedule, verify the obtained data through a third party, and conduct further studies and analyses of the data to assess the feasibility of the forest carbon project.				
EST. OUTCOME	Update Forest Resources Inventory to improve the estimation of carbon sink calculations using IPCC measurements, upgrading from Tier 1 to Tier 2/3, for all forest types in Brunei.				
GHG REDUCTION	Depending on the data obtained from the project, which is expected to be completed by April 2025.				
PROGRESS INDICATORS	Quality of data.				
CURRENT PROGRESS	The study of Peat Swamp Forests is complete, while studies on other forest types are ongoing. Results for all seven forest types are expected to be completed by April 2025.				
CHALLENGES	Data integration issues, including the challenge of combining data from various sources (e.g., remote sensing and ground surveys), can affect consistency. Given the considerable time gap since 1984, conducting an inventory project requires extensive effort, utilizing both manual methods and remote sensing technologies. Accessibility challenges arise because some Continuous Forest Inventory (CFI) plots and peat mapping areas are located in remote areas.				
MITIGATING ACTIONS	Hire a third-party verifier. Conduct a workshop to disseminate knowledge on updating the forest resources inventory and calculating carbon.				

PROJECT	Planting 500,000 Trees by 2035.				
SECTORS AFFECTED	GASES AFFECTED	STATUS	IMPLEMENTATION TIMELINE	IMPLEMENTATION AGENCIES	TYPE OF INSTRUMENTS
AFOLU/ LULUCF	CO_2	On-going	2020-2035	Forestry Department, MPRT	Regulatory
DESCRIPTION & OBJECTIVES	Increase Brunei's carbon sink through afforestation and reforestation programmes with a target of planting 500,000 new trees by 2035.				
ACTION PLAN	The target is to plant 35,700 trees annually, which will be achieved through the following actions: • The Forestry Department will plant at least 2,000 trees each year. • Each ministry will plant at least 2,000 trees annually (totaling 26,000) under the *Protokol Hijau* initiative. • Additional greening projects under the NDP.				
EST. OUTCOME	Increase carbon sequestration to mitigate climate change. Enhance biodiversity to support local ecosystems.				
GHG REDUCTION	N/A				
PROGRESS INDICATORS	Number of trees planted				
CURRENT PROGRESS	183,876 trees planted under this initiative as of October 2024.				
CHALLENGES	The project faces challenges such as changing weather patterns through increased temperatures, prolonged dry seasons, and excessive rainfall can impact plant survival and disrupt planting schedules; resource constraints, such as those for maintenance and seedling supply, further limit the project's effectiveness.				
MITIGATING ACTIONS	The project will collaborate with relevant government agencies to address land allocation issues for reforestation and afforestation initiatives, allocate an annual government budget specifically for these initiatives, and involve local communities in planting activities to enhance engagement and support. To optimize planting success, schedules will be adjusted based on real-time weather data and forecasts. This adaptive approach will help prevent planting during extreme weather. Additionally, the project will bring together government agencies, the private sector, local communities, and volunteers to participate in planting, maintenance, and monitoring activities, reducing labor costs and building long-term community support for the project.				



CHAPTER 5

FINANCIAL, TECHNICAL AND POTENTIAL CONSTRAINTS AND NEEDS

5.0 FINANCIAL, TECHNICAL AND POTENTIAL CONSTRAINTS AND NEEDS

This chapter provides updated information on support needed and received for the implementation of Article 13 of the Paris Agreement in the area of transparency, financial resources, technology transfer, capacity-building, and technical support from multilateral institutions, and other developed country parties for activities relating to climate change, including the preparation of this BTR. The contents of this chapter are updated information from year 2020 till 2022. The constraints, gaps and needs were summarised in the section 5.1 and support received is in Section 5.2.

5.1 Constraints, Gaps and Support Required

Brunei faces significant challenges in addressing climate change due to limited technical, financial, and institutional capacity. To overcome these obstacles, Brunei plans to continue investing in national capacity-building initiatives, which include upgrading data collection methodologies, enhancing institutional frameworks, and fostering inter-agency collaboration to streamline the reporting process. The government also recognizes the critical role of international cooperation in these efforts. Sustained support from bilateral and multilateral partners, as well as donor institutions, will be essential. This support may involve technical assistance, capacity-building programs, financial aid, and the sharing of best practices. Table 5.1 provides an overview of the key constraints and gaps encountered, along with proposed solutions. It outlines the specific areas where Brunei faces difficulties, such as technical expertise, financial resources, and institutional capacity, and suggests targeted actions to address each issue.

Table 5.1a Key Constraints and Gaps, and Support Required

Sector	Key Constraints and Gaps	Status Proposed Solutions	International Support Required		
			Finance	Technical/ Technology Support	Capacity Building
GHG Inventory Preparation					
GHG Inventory	The lack of country-specific GHG emission factors (Tier 2 and 3) results in poor estimation of GHG emissions across all relevant sectors due to the absence of credible data and time series data.	• Increase Capacity Building programs specifically designed for GHG Inventory preparations • Enhance efforts to provide accessibility to technical tools/facilities for preparing GHG inventories		1. More training on inventory preparation, quality assurance and control procedures. 2. Technical expertise for hands on training to local staff. 3. Demonstration programs on certification of facilities and individuals 4. Technical equipment to prepare GHG inventory	
Emission Projections (All Sectors)	Improving the capacity to use models and tools for emission and mitigation scenarios. Training on Simulation and Modelling: Best available models and tools particularly on Long-range Energy Alternatives Planning (LEAP), Cropwat and SimClim, LoClim, Water Evaluation and Planning (WEAP) etc. (Capacity building and financial support).	-		1. Training on specific software and tools commonly used in emissions projections, including their application and limitations. 2. Hands-on training with the tools and software commonly used for emissions projections, including data input, scenario analysis, and result interpretation. 3. Techniques for managing uncertainties in projections and understanding their impact on long-term climate strategies.	
Agriculture					
AFOLU (Agriculture)	Livestock: Challenges associated with manure as landfills in terms of tracking and categorization.	Develop and implement standardized reporting frameworks for manure management practices.		System to improve monitoring.	Creation of guidelines.
AFOLU (Agriculture)	Crop: Land degradation and soil health	High-efficiency irrigation equipment, introducing precision farming tools, and knowledge on sustainable farming techniques.	Yes	Yes	Yes
AFOLU (Agriculture)	BGAP: Farmers acceptance and implementation	Increase awareness on importance of BGAP to farmers and the general public and increase collaborations with other agencies.	Yes	Yes	Yes

Table 5.1b Key Constraints and Gaps, and Support Required

Sector	Key Constraints and Gaps	Status Proposed Solutions	International Support Required		
			Finance	Technical/ Technology Support	Capacity Building
AFOLU (Agriculture)	Regenerative Agriculture: Willingness of farmers to participate in this project. Price of compost varies depending on the waste products used.	• Do trial in small plots. • Provide subsidies for compost. • Develop a standard for ideal compost fit for use.	Yes	Yes	Yes
AFOLU (Agriculture)	Rice: Limited sustainable methods of rice farming.	Rainwater harvesting, implementation of AWD, improving soil pH to improve nutrient uptake.	Yes	Yes	Yes
Adaptation and Resilience					
Adaptation	Fragmented and unreliable data required led to uncertainties in cohesively inform effective nation-wide climate adaptation and resilient strategies.	• Financial support to receive technological equipment and expertise for data collection and monitoring. • Capacity building programs and trainings for data analysis and improved coordination of activities.	1. Provide and/or improve data collection and monitoring systems e.g., satellite imagery, drones, early warning systems and Internet of Things (IoT) sensors, especially for remote and data-scarce areas. 2. Technical support to establish a centralised data repository to obtain the best available and accurate climate science data. 3. Training and knowledge-sharing on analysing different data sources, as well as aid in formulating integrated and multi-sectoral solutions.		
	Absence of knowledge and expertise in monitoring, reviewing, verifying and evaluating progress and/or outcomes of adaptation strategies.	Access to capacity building programs and technical expertise.		Workshops and trainings in evaluating both short- and long-term impacts of adaptation strategies, including the social, environmental and economic aspects.	

5.2 Support Received

To date, Brunei has not received any financial or technology support. However, the country has benefited from various forms of capacity building support aimed at enhancing national climate-related reporting, particularly in areas such as GHG inventory, mitigation actions, and their effects, including institutional arrangements and the MRV (Monitoring, Reporting, and Verification) system. All the support provided has been in the form of capacity building through online sessions and workshops, as detailed in Table 5.2.

Table 5.2a Capacity Building Support Received

Capacity Building Support	Year received	Source of Support
Pilot Project in Brunei Darussalam under the PASTI-JAIF Phase 3	2024	PASTI-JAIF, Overseas Environmental Cooperation Center, Japan (OECC)
6th Greenhouse Gas Inventory System Training workshop	2024	United Nations Office for Sustainable Development (UNOSD), United Nation Economic and Social Commission for Asia and the Pacific (UNESCAP), UNFCCC, IPCC and Thailand's Department of Climate Change and Environment.
Hands-on training workshop on transitioning to the ETF, including the preparation of the Biennial Transparency Report for Asia Region	2024	National Climate Change Singapore (NCCS), United States Environmental Protection Agency (US EPA), NDC Partnership, UNFCCC
Singapore-U.S. Third Country Training Program (TCTP) Workshop on Environmental Drivers of Health Security	2024	US and ASEAN
Regional Training Workshop on NAP Development Process: Strengthening Capacity for Multi-Sectoral Involvement in the NAP Process in the Asia Pacific Region	2024	The Asian Institute of Technology, Regional Resource Centre for Asia and the Pacific, in collaboration with the United Nations Framework Convention on Climate Change, the Asia Pacific Adaptation Network (APAN), the United Nations Human Settlements Programme (UN-HABITAT), the Asian Disaster Preparedness Centre (ADPC) and the Ministry of Environment, Japan
The 21st Workshop on Greenhouse Gas Inventories in Asia (WGIA21)	2024	National Institute for Environmental Studies (NIES) and Ministry of the Environment of Japan
Meeting on Developing Guideline for Reduction of Crop Burning in ASEAN	2024	ASEAN Secretariat
Regional Technical Meeting on Climate-Resilient Crop Insurance	2024	ASEAN Secretariat
2nd Project Steering Committee (2nd PSC) Meeting of Agri-Climate Risk Financing Project	2024	ASEAN Secretariat
Knowledge Exchange Meeting on Sustainable Agricultural Practices and Initiatives for Managing Crop Burning in ASEAN	2024	ASEAN Secretariat
Capacity Building Seminar on GHG emission M&R in Agriculture and Agrifood Sectors	2024	Brunei Climate Change Office
13th UNFCCC-GIR-CASTT Training Programme on Greenhouse Gases	2023	UNFCCC, Partnership on Transparency in the Paris Agreement (PATPA) and Greenhouse Gas Inventory and Research Center (GIR)

Table 5.2b Capacity Building Support Received

Capacity Building Support	Year received	Source of Support
Singapore Cooperation Programme Training Award (SCPTA): Climate Change Adaptation and Mitigation Strategies	2023	Singapore Cooperation Programme
Regional Kick-Off Meeting for the Innovative Climate Risk Financing for the Agricultural Sector in the ASEAN Region" Project (Agri-Climate Risk Financing), and the 1st Project Steering Committee Meeting of Agri-Climate Risk Financing Project	2023	ASEAN Secretariat
Hardware Barrier and Bowtie Analyses Workshop 2.0	2023	Brunei Climate Change Office
Workshop on The Development of Action Plan For The Implementation Of The ASEAN Guidelines On Sustainable Agriculture	2023	ASEAN Secretariat
ASEAN Sub-Regional Training on ICT for Climate Resilient Development	2023	Asian and Pacific Training Centre for Information and Communication Technology for Development and United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
Consultation Workshop for Prioritizing Commodities of Interest for ASEAN-India Digitalization towards Climate-Smart Agriculture (CSA)	2023	Deutsche Gessellschaft fur Internationale Zusammenarbeit (GIZ) and ASEAN Secretariat
Opportunity Framing Workshop for National Adaptation Plan	2023	N/A
The Workshop Of The Project For Strengthening ASEAN Food Security Information System (AFSIS) Function For Emergency (SAFER)	2023	AFSIS Secretariat
GHG Management Institute Certification Of Proficiency In 501 IPPC: Introduction To Cross-Cutting Issues	2023	Greenhouse Gas Management Institute (GHGMI)
GHG Management Institute Certification Of Proficiency In 531 IPPC: Agriculture	2023	GHGMI
Hardware Barrier and Bowtie Analyses Workshop	2023	Brunei Climate Change Office
ASEAN Climate Resilience Network (ASEAN-CRN) - Transformation to Low Emissions and Resilient Agrifood System: A Knowledge Exchange Event and Climate Policy Negotiations Training	2022	National Research and Innovation Agency (BRIN), Republic of Indonesia and ASEAN Secretariat
ASEAN-CropLife Asia - PMH PHASE VI: Good Laboratory Practice (GLP), Data Acceptance and Protection of Regulatory Data	2022	Croplife Asia
BCG Symposium: APEC Best Practices for Green and Innovate MSMEs by Using the BCG Economy Model	2022	The Department of International Trade Promotion (DITP), Ministry of Commerce, Thailand
Training on Solar Farming as Mitigation Options for Climate Change Risks in Agriculture	2022	National Institute of Agriculture Extension Management (MANAGE) and Ministry of Agriculture and Farmers Welfare, Government of India
SCE POLICY DIALOGUE: Understanding the Bio-Circular-Green Economy Model for Strong, Balanced, Secure, Sustainable and Inclusive Growth in the Asia-Pacific	2022	N/A
Quality Assurance of the National Greenhouse Gas Inventory Management System and National Greenhouse Gas Inventories of Brunei Darussalam	2022	Ministry of Development, UNFCCC, FAO
ASEAN Climate Change and Energy Project (ACCEPT) Support for Brunei Darussalam on the National GHG Inventory	2022	ASEAN Centre for Energy (ACE)

Peer Review of Brunei Darussalam's 3rd National Communication	2022	UNFCCC Reviewer
UNFCCC Online IPCC Guidelines Training Programme	2021	GHGMI
ASEAN workshop on Climate Smart Agricultural Practices (Virtual)	2021	Center for International Affairs, Walailak University
SEAMEO Climate Smart Agriculture Workshop, Adapting to a Changing World, Walailak University, The Kingdom of Thailand (Virtual)	2021	Center for International Affairs, Walailak University

Table 5.2c Capacity Building Support Received

Capacity Building Support	Year received	Source of Support
SEAMEO Climate Smart Agriculture Workshop, Adapting to A Changing World, Walailak University, The Kingdom of Thailand (Virtual)	2021	Walailak University, Thailand, Southeast Asian Ministers of Education Organization Regional Centre for STEM Education (SEAMEO STEM-ED), United Nations Educational, Scientific, and Cultural Organization (UNESCO)
PASTI-JAIF Phase 1 Project on Development of Facility/Company level Measurement, Reporting and Verification (MRV) to support carbon pricing in ASEAN Member States (AMS)	2020	PASTI-JAIF, OECC
ASEAN Climate Leadership Programme	2020	N/A

TECHNICAL ANNEXES

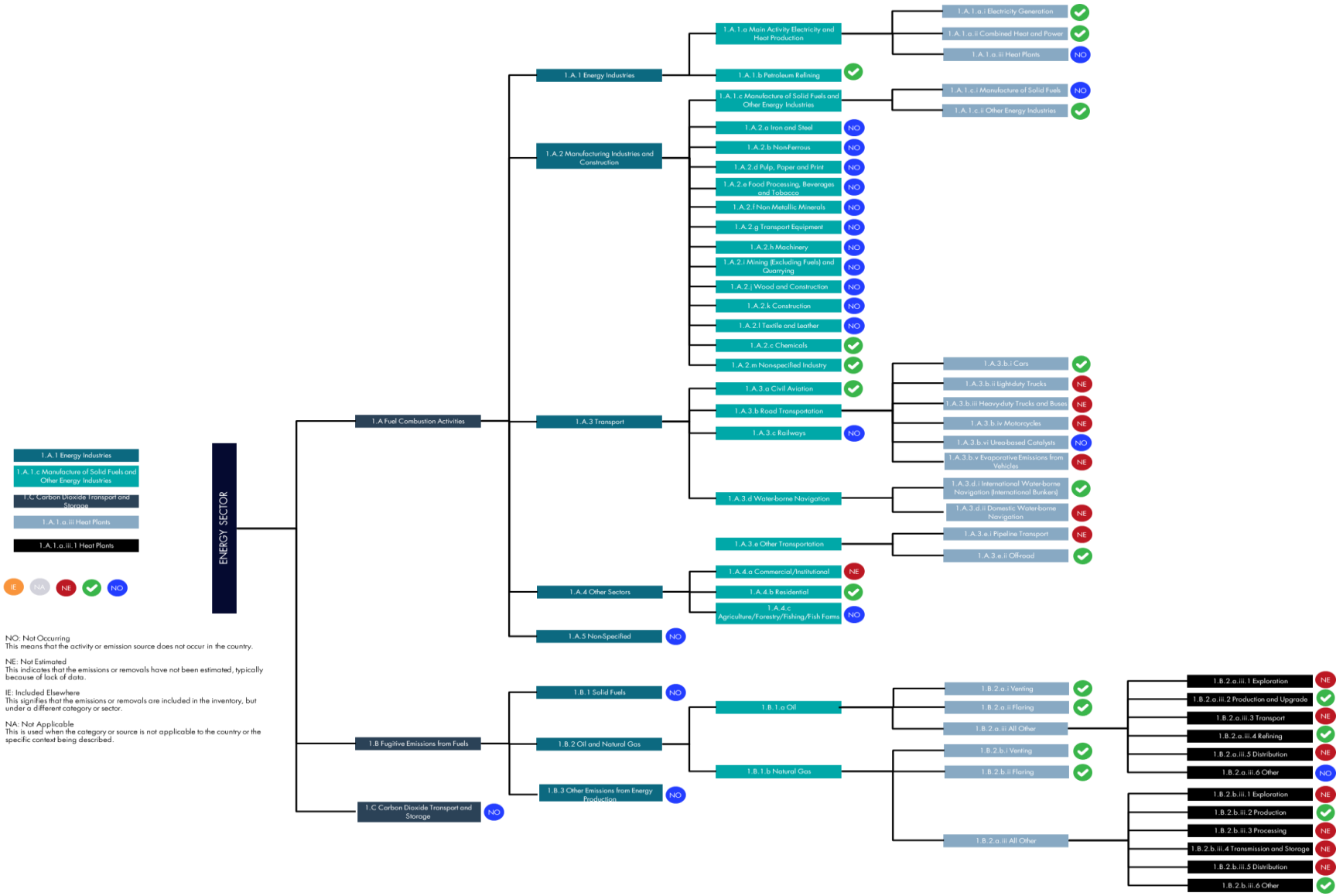
ANNEX I	**Coverage of IPCC Sectors, using notation keys**
ANNEX II	**IPCC Approach 1 Key Category Analysis**
ANNEX III	**IPCC Approach 1 Uncertainty Analysis**
ANNEX IV	**IPCC Reference approach for Estimating CO_2 Emissions from Fossil fuel combustion**

ANNEX I Coverage of IPCC Sectors, using notation keys

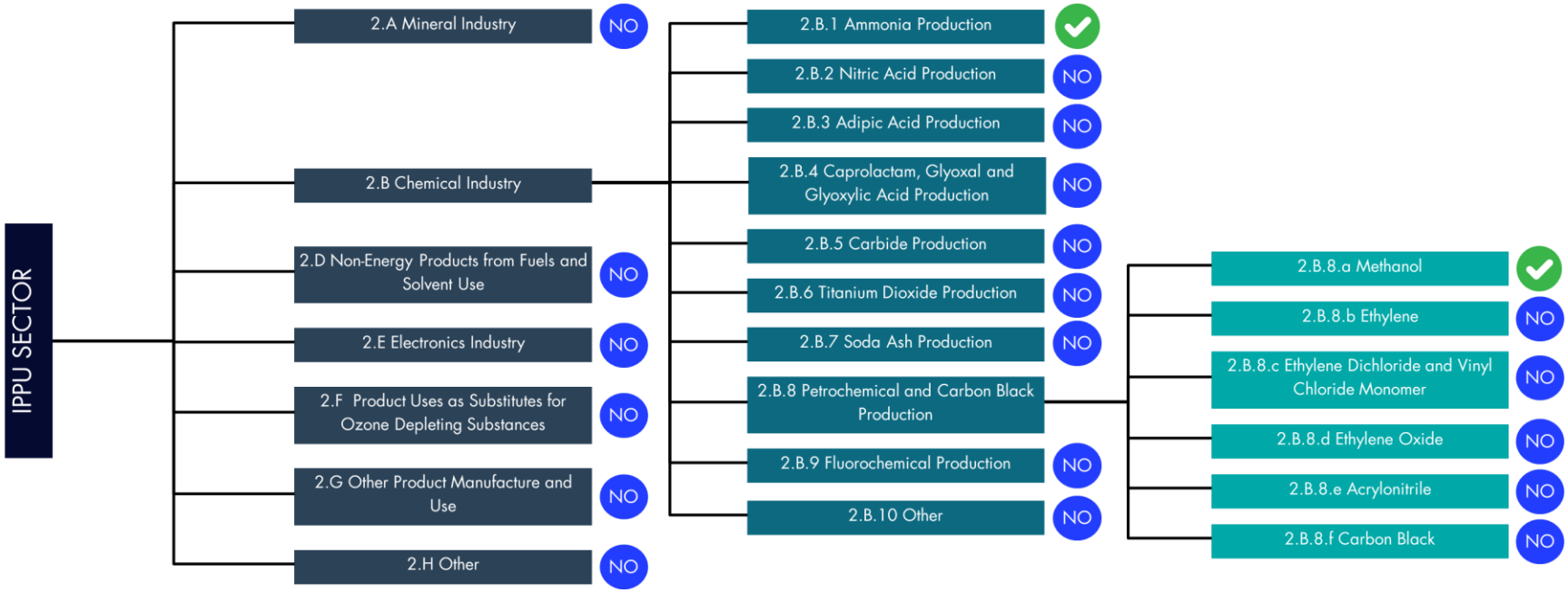
Note: The following standard indicators are used in this Technical Annex:

- **NO** (Not occurring) for activities or processes that do not occur for a particular gas or source/sink category within a country;
- **NE** (Not estimated) for existing emissions and removals which have not been estimated;
- **NA** (Not applicable) for activities in a given source/sink category which do not result in emissions or removals of a specific gas;
- **IE** (Included elsewhere) for emissions or removals estimated but included elsewhere in the inventory; C denotes confidential data

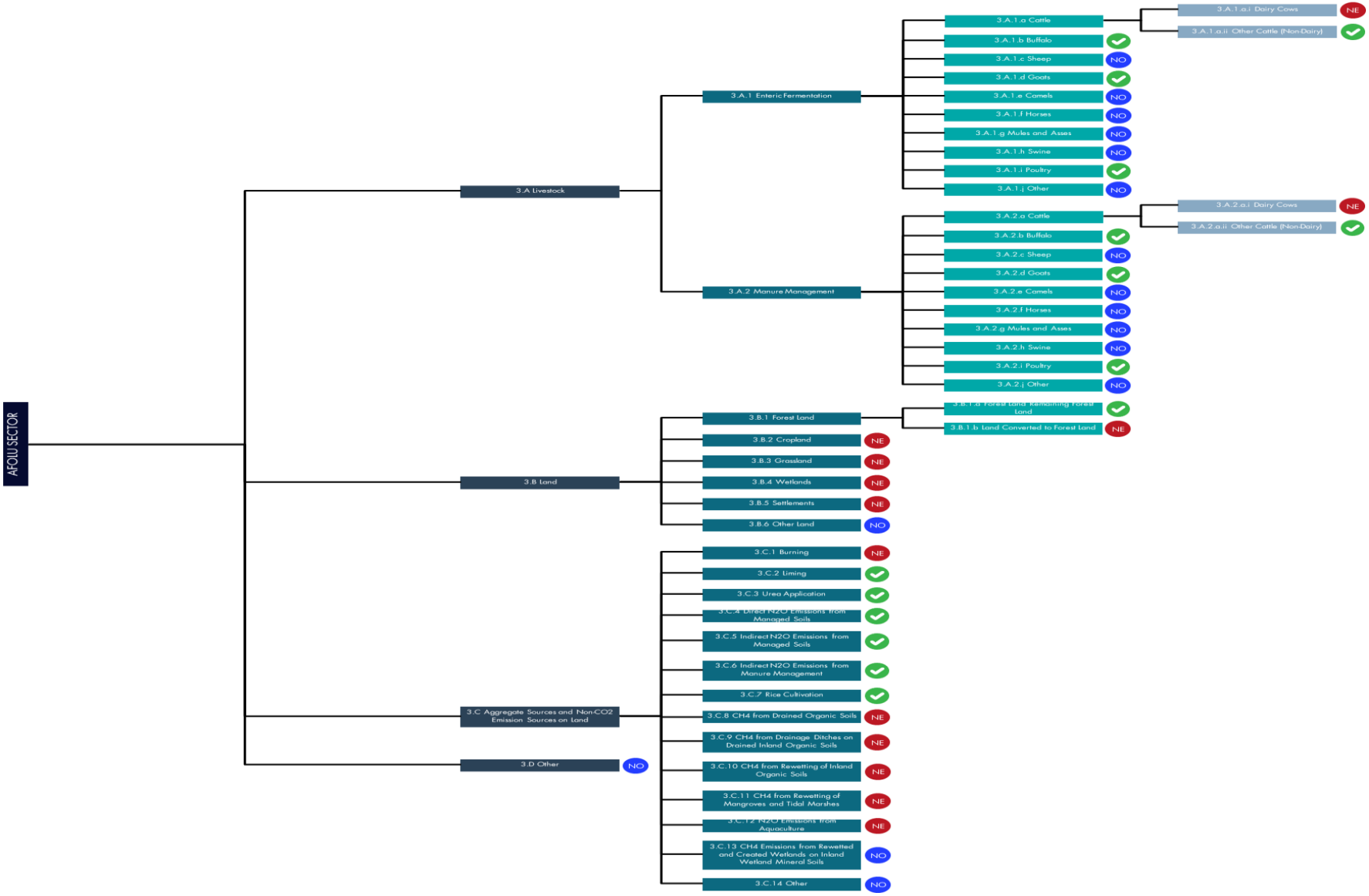
Annex Figure I-A: Brunei Darussalam Energy Sector Coverage



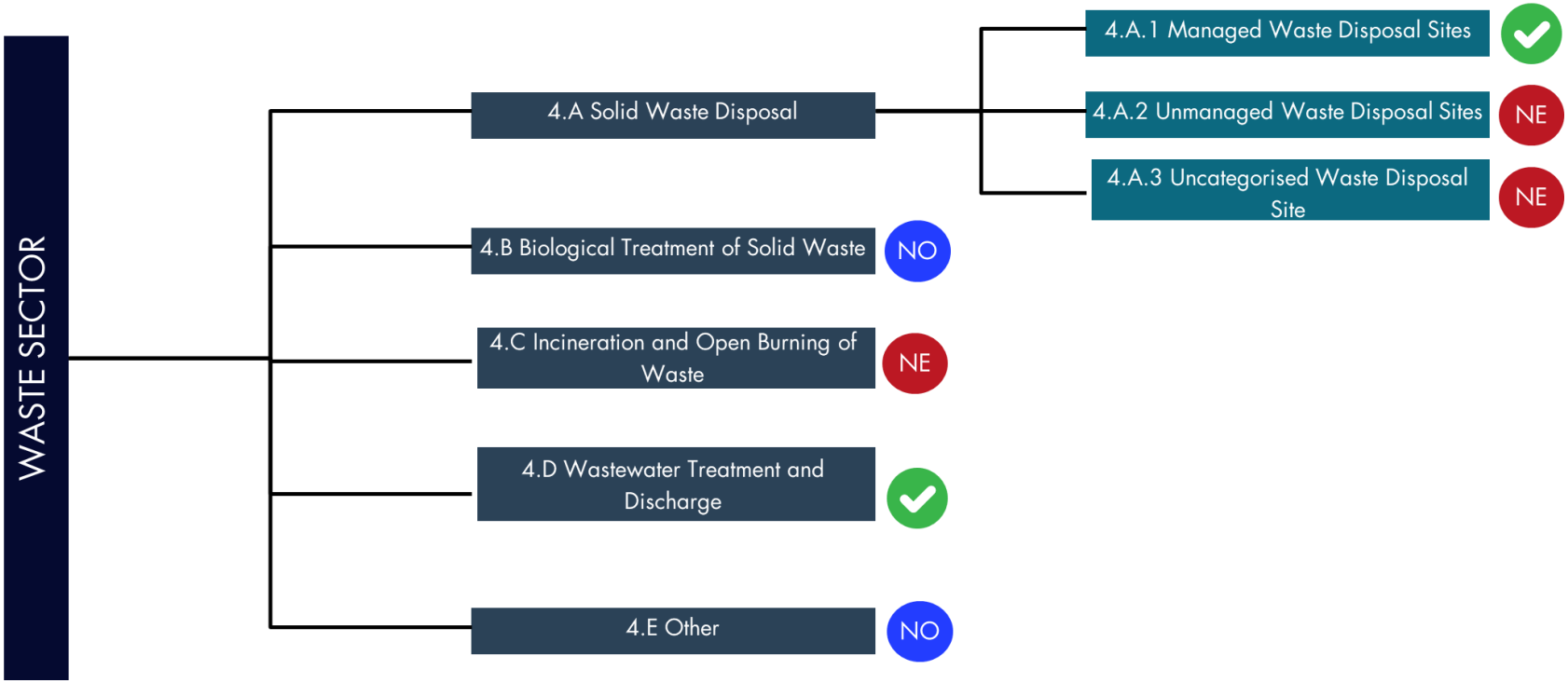
Annex Figure I-B: Brunei Darussalam IPPU Sector Coverage



Annex Figure I-C: Brunei Darussalam AFOLU Sector Coverage



Annex Figure I-D: Brunei Darussalam Waste Sector Coverage



ANNEX II Key Category Analysis

Key category refers to an emissions source that contribute to 95% of the total emissions or the trend in the inventory, and is prioritized within the national GHG Inventory due to its significant impact on the total emissions, trends, and uncertainties in GHG emissions.

In accordance with the 2006 IPCC Guideline (Volume 1, Chapter 4), Brunei has undertaken a Key Category Analysis (KCA) to identify key categories of GHG emissions for starting year and the latest reporting year i.e. 2010 and 2022.

The result shows significant changes in emission sources. Energy Industries – Gaseous fuels and Forest land remaining Forest land remain the largest source of CO_2 emissions in 2010 and 2022. Energy Industries – Solid Fuels has emerged as a new key category in 2022.

Annex Table II-A Key Category Analysis for 2010 Inventory - Approach 1 Level Assessment

CRT Category code	IPCC Category	GHG	2010 Estimate ($MtCO_2e$)	Individual Contribution	Cumulative Contribution
1.A.1	Energy Industries - Gaseous Fuels	CO_2	5,970.38	38.71%	38.71%
3.B.1.a	Forest land Remaining Forest land	CO_2	5,761.43	37.35%	76.06%
1.A.3.b	Road Transportation - Liquid Fuels	CO_2	1,181.74	7.66%	83.72%
1.B.2.b	Fugitive Emissions - Natural Gas	CO_2	893.11	5.79%	89.51%
1.B.2.a	Fugitive Emissions - Oil	CH_4	411.17	2.67%	92.18%
1.A.2	Manufacturing Industries & Construction - Liquid Fuels	CO_2	337.19	2.19%	94.37%
2.B.8	Petrochemical and Carbon Black Production	CO_2	225.21	1.46%	95.83%

Annex Table II-B Key Category Analysis for 2022 Inventory - Approach 1 Level Assessment

CRT Category code	IPCC Category	GHG	2022 Estimate ($MtCO_2e$)	Individual Contribution	Cumulative Contribution
1.A.1	Energy Industries - Gaseous Fuels	CO_2	5,374.09	28.95%	28.95%
3.B.1.a	Forest land Remaining Forest land	CO_2	5,302.74	28.57%	57.52%
1.A.1	Energy Industries - Solid Fuels	CO_2	2,515.74	13.55%	71.07%
1.A.1	Energy Industries - Liquid Fuels	CO_2	2,098.97	11.31%	82.38%
1.A.3.b	Road Transportation - Liquid Fuels	CO_2	1,176.01	6.34%	88.71%
1.A.2	Manufacturing Industries & Construction - Liquid Fuels	CO_2	402.18	2.17%	90.88%
1.B.2.b	Fugitive Emissions - Natural Gas	CO_2	301.90	1.63%	92.51%
1.B.2.a	Fugitive Emissions - Oil	CH_4	287.29	1.55%	94.06%
1.A.2	Manufacturing Industries & Construction - Gaseous Fuels	CO_2	264.72	1.43%	95.48%

Annex Table II-C Key Category Analysis for 2022 Inventory - Approach 1 Trend Assessment

CRT Category code	IPCC Category	GHG	2010 Estimate ($MtCO_2e$)	2022 Estimate ($MtCO_2e$)	% Contribution to Trend	Cumulative Contribution
1.A.1	Energy Industries - Gaseous Fuels	CO_2	5,970.52	5,374.09	27.72%	27.72%
3.B.1.a	Forest land Remaining Forest land	CO_2	4,004.47	4,463.16	19.01%	46.73%
1.A.1	Energy Industries - Solid Fuels	CO_2	0.00	2,515.74	17.75%	64.48%
1.A.1	Energy Industries - Liquid Fuels	CO_2	32.86	2,098.97	14.45%	78.93%
1.B.2.b	Fugitive Emissions - Natural Gas	CO_2	846.71	301.90	7.18%	86.11%
1.A.3.b	Road Transportation - Liquid Fuels	CO_2	1,181.74	1,176.01	4.69%	90.80%
1.B.2.a	Fugitive Emissions - Oil	CH_4	411.17	287.29	2.49%	93.30%
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CO_2	14.76	264.72	1.71%	95.00%

ANNEX III IPCC Approach 1 Uncertainty Analysis

Annex Table III-A: Approach 1 Uncertainty Analysis for GHG Inventory Year 2022 - Including LULUCF

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2e)	Year T emissions or removals (Gg CO_2e)	Activity Data Uncertainty (%)		Emission Factor Uncertainty (%)		Combined Uncertainty (%)		Contribution to Variance by Category in Year T (%)		Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)		Uncertainty in trend in national emissions introduced by activity data uncertainty (%)		Uncertainty introduced into the trend in total national emissions (%)	
				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
1.A - Fuel Combustion Activities																			
1.A.1.a.i - Electricity Generation - Liquid Fuels	CO_2	32.86	32.86	5.00	5.00	6.14	6.14	7.92	7.92	0.00	0.00	0.01	0.01	0.04	0.04	0.04	0.04	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a.i - Electricity Generation - Gaseous Fuels	CO_2	1742.78	4638.54	5.00	5.00	3.92	3.92	6.35	6.35	5.63	5.63	0.15	0.82	0.57	0.57	5.77	5.77	33.58	33.58
	CH_4	0.03	0.08	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.01	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a.ii - Combined Heat and Power Generation (CHP) - Gaseous Fuels	CO_2	1028.76	1028.76	5.00	5.00	3.92	3.92	6.35	6.35	0.28	0.28	0.21	0.18	0.84	0.84	1.28	1.28	2.34	2.34
	CH_4	0.02	0.02	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Liquid Fuels	CO_2	0.00	2059.40	5.00	5.00	6.14	6.14	7.92	7.92	1.72	1.72	0.36	0.36	2.22	2.22	2.56	2.56	11.49	11.49
	CH_4	0.00	0.04	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Solid Fuels	CO_2	0.00	2515.74	5.00	5.00	12.46	12.46	13.43	13.43	7.39	7.39	0.44	0.44	5.51	5.51	3.13	3.13	40.15	40.15
	CH_4	0.00	0.03	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.04	5.00	5.00	222.22	222.22	222.28	222.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Gaseous Fuels	CO_2	606.84	606.84	5.00	5.00	3.92	3.92	6.35	6.35	0.10	0.10	0.13	0.11	0.50	0.50	0.75	0.75	0.81	0.81
	CH_4	0.01	0.01	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2e)	Year T emissions or removals (Gg CO_2e)	Activity Data Uncertainty (%)		Emission Factor Uncertainty (%)		Combined Uncertainty (%)		Contribution to Variance by Category in Year T (%)		Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)		Uncertainty in trend in national emissions introduced by activity data uncertainty (%)		Uncertainty introduced into the trend in total national emissions (%)	
				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
	N_2O	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Biomass	CH_4	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	14.76	14.76	5.00	5.00	3.92	3.92	6.35	6.35	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00	0.00
1.A.1.c.ii - Other Energy Industries - Gaseous Fuels	CO_2	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	42.52	90.31	5.00	5.00	6.14	6.14	7.92	7.92	0.00	0.00	0.00	0.02	0.00	0.00	0.11	0.11	0.01	0.01
1.A.2.c - Chemicals – Gaseous Fuels	CO_2	0.00	0.01	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	236.36	236.36	236.42	236.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	38.59	38.59	5.00	5.00	3.92	3.92	6.35	6.35	0.00	0.00	0.01	0.01	0.03	0.03	0.05	0.05	0.00	0.00
1.A.2.m - Non-specified Industry - Liquid Fuels	CO_2	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	2592.15	2592.15	5.00	5.00	3.92	3.92	6.35	6.35	1.76	1.76	0.54	0.46	2.11	2.11	3.22	3.22	14.83	14.83
1.A.4.b - Residential - Gaseous Fuels	CO_2	0.04	0.04	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.01	0.01	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	337.19	337.19	5.00	5.00	6.14	6.14	7.92	7.92	0.05	0.05	0.07	0.06	0.43	0.43	0.42	0.42	0.36	0.36
1.A.1.c.i - Manufacture of Solid Fuels	CO_2	0.01	0.01	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	317.39	317.39	5.00	5.00	4.21	4.21	6.54	6.54	0.03	0.03	0.07	0.06	0.28	0.28	0.39	0.39	0.23	0.23
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CO_2	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.01	0.01	5.00	5.00	150.00	150.00	150.08	150.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	7.09	7.09	5.00	5.00	4.21	4.21	6.54	6.54	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	CO_2	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	150.00	150.00	150.08	150.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
	N_2O	1181.74	1181.74	5.00	5.00	3.07	3.07	5.87	5.87	0.31	0.31	0.25	0.21	0.75	0.75	1.47	1.47	2.73	2.73
1.A.3.b.i - Cars - Liquid Fuels	CO_2	0.37	0.37	5.00	5.00	244.69	244.69	244.74	244.74	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
	CH_4	0.06	0.06	5.00	5.00	209.94	209.94	210.00	210.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	143.70	143.70	5.00	0.00	4.30	4.30	6.60	4.30	0.01	0.00	0.03	0.03	0.13	0.13	0.18	0.00	0.05	0.02
1.A.3.d.i - International water-borne navigation (International bunkers) - Liquid Fuels	CO_2	0.01	0.01	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	140.00	140.00	140.09	140.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.67	0.67	5.00	5.00	3.87	3.87	6.33	6.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.e.ii - Off-road - Liquid Fuels	CO_2	0.00	0.00	5.00	5.00	150.22	150.22	150.30	150.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	32.86	32.86	5.00	5.00	6.14	6.14	7.92	7.92	0.00	0.00	0.01	0.01	0.04	0.04	0.04	0.04	0.00	0.00
1.B.2 - Fugitive Emissions from Fuels - Oil and Natural Gas																			
1.B.2.a.i - Venting	CO_2	0.41	0.24	15.00	15.00	50.00	50.00	52.20	52.20	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
	CH_4	396.19	228.97	15.00	15.00	50.00	50.00	52.20	52.20	0.92	0.92	0.11	0.04	5.59	5.59	0.85	0.85	32.01	32.01
1.B.2.a.ii - Flaring	CO_2	153.03	263.17	15.00	15.00	50.00	50.00	52.20	52.20	1.22	1.22	0.01	0.05	0.63	0.63	0.98	0.98	1.35	1.35
	CH_4	14.70	25.27	15.00	15.00	50.00	50.00	52.20	52.20	0.01	0.01	0.00	0.00	0.06	0.06	0.09	0.09	0.01	0.01
	N_2O	0.07	0.13	15.00	15.00	999.00	999.00	999.11	999.11	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
1.B.2.a.iii.2 - Production and Upgrading	CO_2	0.00	0.03	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	28.30	15.00	15.00	100.00	100.00	101.12	101.12	0.05	0.05	0.00	0.00	0.50	0.50	0.11	0.11	0.26	0.26
1.B.2.a.iii.4 - Refining	CH_4	0.28	4.75	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.07	0.07	0.02	0.02	0.01	0.01
1.B.2.b.i - Venting	CO_2	493.72	97.62	15.00	15.00	999.00	999.00	999.11	999.11	61.59	61.59	0.17	0.02	172.18	172.18	0.36	0.36	29645.19	29645.19
	CH_4	147.03	66.72	15.00	15.00	100.00	100.00	101.12	101.12	0.29	0.29	0.04	0.01	4.47	4.47	0.25	0.25	20.08	20.08
1.B.2.b.ii - Flaring	CO_2	325.23	204.27	15.00	15.00	75.00	75.00	76.49	76.49	1.58	1.58	0.09	0.04	6.67	6.67	0.76	0.76	45.11	45.11
	CH_4	31.71	22.24	15.00	15.00	25.00	25.00	29.15	29.15	0.00	0.00	0.01	0.00	0.21	0.21	0.08	0.08	0.05	0.05

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				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
	N_2O	0.76	0.16	15.00	15.00	999.00	999.00	999.11	999.11	0.00	0.00	0.00	0.00	0.27	0.27	0.00	0.00	0.07	0.07
1.B.2.b.iii.2 - Production	CO_2	0.00	0.01	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	7.07	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.12	0.12	0.03	0.03	0.02	0.02
1.B.2.b.iii.6 - Other	CO_2	0.01	0.01	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	15.79	21.99	15.00	15.00	100.00	100.00	101.12	101.12	0.03	0.03	0.00	0.00	0.22	0.22	0.08	0.08	0.06	0.06
2.B - Chemical Industry																			
2.B.8.a - Methanol	CO_2	225.21	130.56	17.32	17.32	5.00	5.00	18.03	18.03	0.04	0.04	0.06	0.02	0.32	0.32	0.56	0.56	0.42	0.42
	CH_4	21.89	0.00	14.14	14.14	5.00	5.00	15.00	15.00	0.00	0.00	0.01	0.00	0.04	0.04	0.00	0.00	0.00	0.00
3.A - Livestock																			
3.A.1.a.ii - Other Cattle	CH_4	1.64	2.03	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
3.A.1.b - Buffalo	CH_4	5.06	2.38	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.01	0.01
3.A.1.c - Sheep	CH_4	0.00	0.29	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.1.d - Goats	CH_4	0.88	0.44	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
3.A.2.a.ii - Other cattle	CH_4	0.03	0.04	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.b - Buffalo	CH_4	0.18	0.09	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.c - Sheep	CH_4	0.00	0.01	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.d - Goats	CH_4	0.04	0.02	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.i - Poultry	CH_4	0.93	1.61	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	4.41	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.17	0.17	0.00	0.00	0.03	0.03
3.B - Land																			

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				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
3.B.1.a - Forest land Remaining Forest land	CO_2	-4004.47	-4463.16	10.00	10.00	60.00	60.00	60.83	60.83	477.19	477.19	0.76	0.78	45.54	45.54	11.10	11.10	2196.89	2196.89
3.B.5.a - Settlements Remaining Settlements	CO_2	-377.92	0.00	0.00	0.00	50.00	50.00	50.00	50.00	0.00	0.00	0.15	0.00	7.26	7.26	0.00	0.00	52.76	52.76
3.C - Aggregate sources and non-CO2 emissions sources on land																			
3.C.2 - Liming	CO_2	0.01	0.19	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.3 - Urea application	CO_2	0.18	0.07	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.4 - Direct N2O Emissions from managed soils	N_2O	24.82	14.17	8.66	8.66	268.47	268.47	268.61	268.61	0.09	0.09	0.01	0.00	1.89	1.89	0.03	0.03	3.57	3.57
3.C.5 - Indirect N2O Emissions from managed soils	N_2O	9.00	5.96	7.07	7.07	219.20	219.20	219.32	219.32	0.01	0.01	0.00	0.00	0.53	0.53	0.01	0.01	0.28	0.28
3.C.6 - Indirect N2O Emissions from manure management	N_2O	0.05	0.07	10.00	10.00	80.00	80.00	80.62	80.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.7 - Rice cultivation	CH_4	1.46	3.18	5.00	5.00	133.00	133.00	133.09	133.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.A - Solid Waste Disposal																			
4.A.1 - Managed Waste Disposal Sites	CH_4	56.42	92.04	10.00	10.00	30.00	30.00	31.62	31.62	0.05	0.05	0.01	0.02	0.16	0.16	0.23	0.23	0.08	0.08
4.D - Wastewater Treatment and Discharge																			
4.D.1 - Domestic Wastewater Treatment and Discharge	CH_4	39.94	45.99	5.00	5.00	30.00	30.00	30.41	30.41	0.01	0.01	0.01	0.01	0.22	0.22	0.06	0.06	0.05	0.05
	N_2O	8.18	9.42	10.00	10.00	120.00	120.00	120.42	120.42	0.01	0.01	0.00	0.00	0.18	0.18	0.02	0.02	0.03	0.03
4.D.2 - Industrial Wastewater Treatment and Discharge	CH_4	3.34	5.02	25.00	25.00	30.00	30.00	39.05	39.05	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.03	0.00	0.00
		5687.85	12427.85					560.38	560.38									32104.93	32104.90
						Uncertainty in total inventory		23.67	23.67							Trend uncertainty		179.18	179.18

Annex Table III-B: Approach 1 Uncertainty Analysis for GHG Inventory Year 2022 - Excluding LULUCF

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2e)	Year T emissions or removals (Gg CO_2e)	Activity Data Uncertainty (%)		Emission Factor Uncertainty (%)		Combined Uncertainty (%)		Contribution to Variance by Category in Year T (%)		Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)		Uncertainty in trend in national emissions introduced by activity data uncertainty (%)		Uncertainty introduced into the trend in total national emissions (%)	
				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
1.A - Fuel Combustion Activities																			
1.A.1.a.i - Electricity Generation - Liquid Fuels	CO_2	32.86	32.86	5.00	5.00	6.14	6.14	7.92	7.92	0.00	0.00	0.01	0.01	0.04	0.04	0.04	0.04	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a.i - Electricity Generation - Gaseous Fuels	CO_2	1742.78	4638.54	5.00	5.00	3.92	3.92	6.35	6.35	5.63	5.63	0.15	0.82	0.57	0.57	5.77	5.77	33.58	33.58
	CH_4	0.03	0.08	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.01	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a.ii - Combined Heat and Power Generation (CHP) - Gaseous Fuels	CO_2	1028.76	1028.76	5.00	5.00	3.92	3.92	6.35	6.35	0.28	0.28	0.21	0.18	0.84	0.84	1.28	1.28	2.34	2.34
	CH_4	0.02	0.02	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Liquid Fuels	CO_2	0.00	2059.40	5.00	5.00	6.14	6.14	7.92	7.92	1.72	1.72	0.36	0.36	2.22	2.22	2.56	2.56	11.49	11.49
	CH_4	0.00	0.04	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Solid Fuels	CO_2	0.00	2515.74	5.00	5.00	12.46	12.46	13.43	13.43	7.39	7.39	0.44	0.44	5.51	5.51	3.13	3.13	40.15	40.15
	CH_4	0.00	0.03	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.04	5.00	5.00	222.22	222.22	222.28	222.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Gaseous Fuels	CO_2	606.84	606.84	5.00	5.00	3.92	3.92	6.35	6.35	0.10	0.10	0.13	0.11	0.50	0.50	0.75	0.75	0.81	0.81
	CH_4	0.01	0.01	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2e)	Year T emissions or removals (Gg CO_2e)	Activity Data Uncertainty (%)		Emission Factor Uncertainty (%)		Combined Uncertainty (%)		Contribution to Variance by Category in Year T (%)		Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)		Uncertainty in trend in national emissions introduced by activity data uncertainty (%)		Uncertainty introduced into the trend in total national emissions (%)	
				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
1.A.1.b - Petroleum Refining - Biomass	N_2O	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c.ii - Other Energy Industries - Gaseous Fuels	CO_2	14.76	14.76	5.00	5.00	3.92	3.92	6.35	6.35	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c - Chemicals – Gaseous Fuels	CO_2	42.52	90.31	5.00	5.00	6.14	6.14	7.92	7.92	0.00	0.00	0.00	0.02	0.00	0.00	0.11	0.11	0.01	0.01
	CH_4	0.00	0.01	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	236.36	236.36	236.42	236.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.m - Non-specified Industry - Liquid Fuels	CO_2	38.59	38.59	5.00	5.00	3.92	3.92	6.35	6.35	0.00	0.00	0.01	0.01	0.03	0.03	0.05	0.05	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b - Residential - Gaseous Fuels	CO_2	2592.15	2592.15	5.00	5.00	3.92	3.92	6.35	6.35	1.76	1.76	0.54	0.46	2.11	2.11	3.22	3.22	14.83	14.83
	CH_4	0.04	0.04	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.01	0.01	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c.i - Manufacture of Solid Fuels	CO_2	337.19	337.19	5.00	5.00	6.14	6.14	7.92	7.92	0.05	0.05	0.07	0.06	0.43	0.43	0.42	0.42	0.36	0.36
	CH_4	0.01	0.01	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	228.79	228.79	228.84	228.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CO_2	317.39	317.39	5.00	5.00	4.21	4.21	6.54	6.54	0.03	0.03	0.07	0.06	0.28	0.28	0.39	0.39	0.23	0.23
	CH_4	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.01	0.01	5.00	5.00	150.00	150.00	150.08	150.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	CO_2	7.09	7.09	5.00	5.00	4.21	4.21	6.54	6.54	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	150.00	150.00	150.08	150.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b.i - Cars - Liquid Fuels	CO_2	1181.74	1181.74	5.00	5.00	3.07	3.07	5.87	5.87	0.31	0.31	0.25	0.21	0.75	0.75	1.47	1.47	2.73	2.73

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2e)	Year T emissions or removals (Gg CO_2e)	Activity Data Uncertainty (%)		Emission Factor Uncertainty (%)		Combined Uncertainty (%)		Contribution to Variance by Category in Year T (%)		Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)		Uncertainty in trend in national emissions introduced by activity data uncertainty (%)		Uncertainty introduced into the trend in total national emissions (%)	
				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
	CH_4	0.37	0.37	5.00	5.00	244.69	244.69	244.74	244.74	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
	N_2O	0.06	0.06	5.00	5.00	209.94	209.94	210.00	210.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.d.i - International water-borne navigation (International bunkers) - Liquid Fuels	CO_2	143.70	143.70	5.00	0.00	4.30	4.30	6.60	4.30	0.01	0.00	0.03	0.03	0.13	0.13	0.18	0.00	0.05	0.02
	CH_4	0.01	0.01	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	140.00	140.00	140.09	140.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.e.ii - Off-road - Liquid Fuels	CO_2	0.67	0.67	5.00	5.00	3.87	3.87	6.33	6.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	0.00	5.00	5.00	150.22	150.22	150.30	150.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	200.00	200.00	200.06	200.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.2 - Fugitive Emissions from Fuels - Oil and Natural Gas																			
1.B.2.a.i - Venting	CO_2	0.41	0.24	15.00	15.00	50.00	50.00	52.20	52.20	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
	CH_4	396.19	228.97	15.00	15.00	50.00	50.00	52.20	52.20	0.92	0.92	0.11	0.04	5.59	5.59	0.85	0.85	32.01	32.01
1.B.2.a.ii - Flaring	CO_2	153.03	263.17	15.00	15.00	50.00	50.00	52.20	52.20	1.22	1.22	0.01	0.05	0.63	0.63	0.98	0.98	1.35	1.35
	CH_4	14.70	25.27	15.00	15.00	50.00	50.00	52.20	52.20	0.01	0.01	0.00	0.00	0.06	0.06	0.09	0.09	0.01	0.01
	N_2O	0.07	0.13	15.00	15.00	999.00	999.00	999.11	999.11	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
1.B.2.a.iii.2 - Production and Upgrading	CO_2	0.00	0.03	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	0.00	28.30	15.00	15.00	100.00	100.00	101.12	101.12	0.05	0.05	0.00	0.00	0.50	0.50	0.11	0.11	0.26	0.26
1.B.2.a.iii.4 - Refining	CH_4	0.28	4.75	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.07	0.07	0.02	0.02	0.01	0.01
1.B.2.b.i - Venting	CO_2	493.72	97.62	15.00	15.00	999.00	999.00	999.11	999.11	61.59	61.59	0.17	0.02	172.18	172.18	0.36	0.36	29645.19	29645.19
	CH_4	147.03	66.72	15.00	15.00	100.00	100.00	101.12	101.12	0.29	0.29	0.04	0.01	4.47	4.47	0.25	0.25	20.08	20.08
1.B.2.b.ii - Flaring	CO_2	325.23	204.27	15.00	15.00	75.00	75.00	76.49	76.49	1.58	1.58	0.09	0.04	6.67	6.67	0.76	0.76	45.11	45.11
	CH_4	31.71	22.24	15.00	15.00	25.00	25.00	29.15	29.15	0.00	0.00	0.01	0.00	0.21	0.21	0.08	0.08	0.05	0.05
	N_2O	0.76	0.16	15.00	15.00	999.00	999.00	999.11	999.11	0.00	0.00	0.00	0.00	0.27	0.27	0.00	0.00	0.07	0.07
1.B.2.b.iii.2 - Production	CO_2	0.00	0.01	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2e)	Year T emissions or removals (Gg CO_2e)	Activity Data Uncertainty (%)		Emission Factor Uncertainty (%)		Combined Uncertainty (%)		Contribution to Variance by Category in Year T (%)		Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)		Uncertainty in trend in national emissions introduced by activity data uncertainty (%)		Uncertainty introduced into the trend in total national emissions (%)	
				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
	CH_4	0.00	7.07	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.12	0.12	0.03	0.03	0.02	0.02
1.B.2.b.iii.6 - Other	CO_2	0.01	0.01	15.00	15.00	100.00	100.00	101.12	101.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CH_4	15.79	21.99	15.00	15.00	100.00	100.00	101.12	101.12	0.03	0.03	0.00	0.00	0.22	0.22	0.08	0.08	0.06	0.06
2.B - Chemical Industry																			
2.B.8.a - Methanol	CO_2	225.21	130.56	17.32	17.32	5.00	5.00	18.03	18.03	0.04	0.04	0.06	0.02	0.32	0.32	0.56	0.56	0.42	0.42
	CH_4	21.89	0.00	14.14	14.14	5.00	5.00	15.00	15.00	0.00	0.00	0.01	0.00	0.04	0.04	0.00	0.00	0.00	0.00
3.A - Livestock																			
3.A.1.a.ii - Other Cattle	CH_4	1.64	2.03	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
3.A.1.b - Buffalo	CH_4	5.06	2.38	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.01	0.01
3.A.1.c - Sheep	CH_4	0.00	0.29	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.1.d - Goats	CH_4	0.88	0.44	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
3.A.2.a.ii - Other cattle	CH_4	0.03	0.04	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.b - Buffalo	CH_4	0.18	0.09	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.c - Sheep	CH_4	0.00	0.01	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.d - Goats	CH_4	0.04	0.02	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	0.00	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.A.2.i - Poultry	CH_4	0.93	1.61	5.00	5.00	30.00	30.00	30.41	30.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N_2O	4.41	0.00	5.00	5.00	100.00	100.00	100.12	100.12	0.00	0.00	0.00	0.00	0.17	0.17	0.00	0.00	0.03	0.03
3.C - Aggregate sources and non-CO2 emissions sources on land																			
3.C.2 - Liming	CO_2	0.01	0.19	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.3 - Urea application	CO_2	0.18	0.07	5.00	5.00	50.00	50.00	50.25	50.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2e)	Year T emissions or removals (Gg CO_2e)	Activity Data Uncertainty (%)		Emission Factor Uncertainty (%)		Combined Uncertainty (%)		Contribution to Variance by Category in Year T (%)		Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)		Uncertainty in trend in national emissions introduced by activity data uncertainty (%)		Uncertainty introduced into the trend in total national emissions (%)	
				(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)			(-)	(+)	(-)	(+)	(-)	(+)
3.C.4 - Direct N2O Emissions from managed soils	N_2O	24.82	14.17	8.66	8.66	268.47	268.47	268.61	268.61	0.09	0.09	0.01	0.00	1.89	1.89	0.03	0.03	3.57	3.57
3.C.5 - Indirect N2O Emissions from managed soils	N_2O	9.00	5.96	7.07	7.07	219.20	219.20	219.32	219.32	0.01	0.01	0.00	0.00	0.53	0.53	0.01	0.01	0.28	0.28
3.C.6 - Indirect N2O Emissions from manure management	N_2O	0.05	0.07	10.00	10.00	80.00	80.00	80.62	80.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.C.7 - Rice cultivation	CH_4	1.46	3.18	5.00	5.00	133.00	133.00	133.09	133.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.A - Solid Waste Disposal																			
4.A.1 - Managed Waste Disposal Sites	CH_4	56.42	92.04	10.00	10.00	30.00	30.00	31.62	31.62	0.05	0.05	0.01	0.02	0.16	0.16	0.23	0.23	0.08	0.08
4.D - Wastewater Treatment and Discharge																			
4.D.1 - Domestic Wastewater Treatment and Discharge	CH_4	39.94	45.99	5.00	5.00	30.00	30.00	30.41	30.41	0.01	0.01	0.01	0.01	0.22	0.22	0.06	0.06	0.05	0.05
	N_2O	8.18	9.42	10.00	10.00	120.00	120.00	120.42	120.42	0.01	0.01	0.00	0.00	0.18	0.18	0.02	0.02	0.03	0.03
4.D.2 - Industrial Wastewater Treatment and Discharge	CH_4	3.34	5.02	25.00	25.00	30.00	30.00	39.05	39.05	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.03	0.00	0.00
		10070.24	16891.00					45.03	45.03									5295.53	5295.52
						Uncertainty in total inventory (%)		6.71	6.71							Trend uncertainty (%)		72.77	72.77

ANNEX IV IPCC Reference approach for Estimating CO_2 Emissions from Fossil fuel combustion

In accordance with the 2006 IPCC Guidelines, Brunei Darussalam estimates its CO_2 emissions from fossil fuel combustion using a top-down method that calculates using the country's energy supply data.

Step 1: Estimate Apparent Fuel Consumption (Annex Table IV-A and Table IV-B)

The national energy balance table (Annex Table IV-A and Table IV-B) were collected from APEC EGEDA database, sourced by DOE. The IPCC Reference Approach estimates "apparent consumption" of fuels by balancing fuel production, imports, exports, international bunkers while adjusting for stock changes. Apparent consumption is calculated using the formula:

Apparent Consumption = Production + Imports - Exports – International Bunkers - Stock Change

Negative values indicate net exports or stock increases.

Step 2: Convert Apparent Fuel Consumption from ktoe to TJ by multiplying 41.868 (Annex Table IV-C and Table IV-D)

Step 3: Estimate Carbon Emissions by multiplying with carbon content (Annex Table IV-E and Table IV-F)

Step 4: Estimate Net Carbon Emissions by excluding Carbon in non-energy uses (Annex Table IV-E and Table IV-F)

Step 5: Convert to CO_2 Emissions by multiplying 44/12, assuming 100% of carbon are oxidised (Annex Table IV-E and Table IV-F)

Annex Table IV-A: Energy Balance Table (thousand tonnes of oil equivalent - ktoe), 2010

Fuel Category	Fuel type	Production	Imports	Exports	International Bunkers	Stock Change	Total Primary Energy Supply	Total Transformation sector	Total Final Energy consumption	Non-energy Use
Solid Fuels	Lignite	-	-	-	-	-	-		-	-
Gaseous Fuels	Natural Gas (Dry)	10,579	-	8,203	-	-	2,377	-1,208	25	3
Liquid Fuels	Crude Oil	8,186	14	7,891	-	-177	486		451	-
	Gas/Diesel Oil	-	86	-	-	3	83	165	249	-
	Jet Kerosene	-	3	-	111	-1	-108	116	-	-
	Liquefied Petroleum Gases	-	-	-	-	-	-	17	16	-
	Motor Gasoline	-	38	-	-	-	38	210	251	-
	Naphtha	-	-	-	-	-	-	-	-	-
	Other Kerosene	-	-	-	-	-	-	4	4	-
	Other Petroleum Products									
	Refinery Gas	-	-	-	-	-	-	56	-	-

Source: APEC EGEDA

Annex Table IV-B: Energy Balance Table (ktoe), 2022

Fuel Category	Fuel type	Production	Imports	Exports	International Bunkers	Stock Change	Total Primary Energy Supply	Total Transformation sector	Total Final Energy consumption	Non-energy Use
Solid Fuels	Lignite	-	718.9	-	-	-	**718.9**	-718.9	-	-
Gaseous Fuels	Natural Gas (Dry)	8,354	-	5,499	-	3	**2,853**	-1,244	16	450
Liquid Fuels	Crude Oil	4,846	7,903	2,917	-	27	**9,804**	-9,364	-	-
	Gas/Diesel Oil	-	-	2,926	-	205	**-3.131**	3,166	244	-
	Jet Kerosene	-	40	17	42	32	**-52**	51	-	-
	Liquefied Petroleum Gases	-	-	609	-	-	**-609**	627	17	-
	Motor Gasoline	-	517	1,849	-	241	**-1,574**	2,102	286	-
	Naphtha	-	-	859	-	-31	**-828**	828	-	-
	Other Kerosene	-	-	-	-	-	**-**	3	3	-
	Other Petroleum Products	-	2	2,021	-	-168	**-1,851**	1,853	4	4
	Refinery Gas	-	-	-	-	-	**-**	56	-	-

Source: DOE

Annex Table IV-C: Apparent Consumption (TJ), 2010

Fuel Category	Fuel type	Production	Imports	Exports	International Bunkers	Stock Change	Apparent Consumption
Solid Fuels	Lignite	-	-	-	-	-	-
Gaseous Fuels	Natural Gas (Dry)	442,922	-	343,443	-	-	99,520
Liquid Fuels	Crude Oil	342,731	586	330,380	-	-7,411	20,348
	Gas/Diesel Oil	-	3,601	-	-	126	3,475
	Jet Kerosene	-	126	-	4,647	-42	-4,522
	Liquefied Petroleum Gases	-	-	-	-	-	-
	Motor Gasoline	-	1,591	-	-	-	1,591
	Naphtha	-	-	-	-	-	-
	Other Kerosene	-	-	-	-	-	-
	Other Petroleum Products	-	-	-	-	-	-
	Refinery Gas	-	-	-	-	-	-
						Total	**120,412**

Annex Table IV-D: Apparent Consumption (TJ), 2022

Fuel Category	Fuel type	Production	Imports	Exports	International Bunkers	Stock Change	Apparent Consumption
Solid Fuels	Lignite	-	30,098	-	-	-	30,098
Gaseous Fuels	Natural Gas (Dry)	349,774	-	230,217	-	112	119,446
Liquid Fuels	Crude Oil	202,880	330,889	122,145	-	1,134	410,490
	Gas/Diesel Oil	-	-	122,497	-	8,578	-131,075
	Jet Kerosene	-	1,676	717	1,770	1,360	-2,171
	Liquefied Petroleum Gases	-	-	25,498	-	2	-25,499
	Motor Gasoline	-	21,631	77,418	-	10,095	-65,882
	Naphtha	-	-	35,961	-	-1,299	-34,662
	Other Kerosene	-	-	-	-	-	-
	Other Petroleum Products	-	82	-84,614	-	7,031	-77,501
	Refinery Gas	-	-	-	-	-	-
						Total	**223,242**

Annex Table IV-E: Reference Approach Total Carbon (Gg C), Net Carbon Emissions (Gg C), and Actual CO_2 Emissions ($GgCO_2$), 2010

		Step 2	Step 3		Step 4		Step 5	
Fuel Category	**Fuel type**	**Apparent Consumption (TJ)**	**Carbon Content (tC/TJ)**	**Total Carbon (Gg C)**	**Excluded Carbon (Gg C)**	**Net Carbon Emissions (Gg C)**	**Fraction of Carbon Oxidised**	**Actual CO_2 Emissions ($GgCO_2$)**
		A	**B**	**C = A*B/1000**	**D**	**E = C - D**	**F**	**G = E*F*44/12**
Solid Fuels	Lignite	-	27.6	-	-	-		-
Gaseous Fuels	Natural Gas (Dry)	99,520	15.3	1,552.66	126	1,396.66		5,121.07
Liquid Fuels	Crude Oil	20,348	20	406.96	-	406.96		1,492.19
	Gas/Diesel Oil	3,475	20.2	70.195	-	70.195		257.38
	Jet Kerosene	-4,522	19.5	-88.179	-	-88.179		-323.32
	Liquefied Petroleum Gases	-	17.2	-	-	-	1	-
	Motor Gasoline	1,591	18.9	30.07	-	30.07		110.26
	Naphtha	-	20	-	-	-		-
	Other Kerosene	-	19.6	-	-	-		-
	Other Petroleum Products	-	20	-	-	-		-
	Refinery Gas	-	15.7	-	-	-		-
		120,412		**1,941.70**	**126**			**6,658**

Annex Table IV-F: Reference Approach Total Carbon (Gg C), Net Carbon Emissions (Gg C), and Actual CO_2 Emissions ($GgCO_2$), 2022.

		Step 2	Step 3		Step 4		Step 5	
Fuel Category	**Fuel type**	**Apparent Consumption (TJ)**	**Carbon Content (tC/TJ)**	**Total Carbon (Gg C)**	**Excluded Carbon (Gg C)**	**Net Carbon Emissions (Gg C)**	**Fraction of Carbon Oxidised**	**Actual CO_2 Emissions ($GgCO_2$)**
		A	**B**	**C = A*B/1000**	**D**	**E = C - D**	**F**	**G = E*F*44/12**
Solid Fuels	Lignite	30,098	27.6	830.71	-	830.71		-3,045.94
Gaseous Fuels	Natural Gas (Dry)	119,446	15.3	1,827.51	288.34	1,539.16		-5,643.60
Liquid Fuels	Crude Oil	410,490	20	8,209.8	-	8,209.8		30,102.60
	Gas/Diesel Oil	-131,075	20.2	-2,647.72	-	-2,647.72		-9,708.3
	Jet Kerosene	-2,171	19.5	-42.33	-	-42.33		-155.23
	Liquefied Petroleum Gases	-25,499	17.2	-438.6	-	-438.6	1	1,608.20
	Motor Gasoline	-65,882	18.9	-1,245.17	-	-1,245.17		-4,565.62
	Naphtha	-34,662	20	-693.24	-	-693.24		-2,541.88
	Other Kerosene	-	19.6	-	-	-		-
	Other Petroleum Products	-77,501	20	-1,550.02	3.54	-1,553.56		-5,696.39
	Refinery Gas	30,098	15.7	-	-	-		-
		119,446		**4,250.94**	**291.88**	**3,959.06**		**14,516.54**