

Brunei Darussalam's Second National Communication

Under the United Nations Framework
Convention on Climate Change

Energy and Industry Department
The Prime Minister's Office

Brunei Darussalam

2017

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Convention on Climate Change

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Preface

Climate change is a global challenge that calls for all parties to the United Nations Framework Convention on Climate Change (UNFCCC) to come together and play their part on their common but differentiated responsibilities, their respective capabilities, in light of the different national circumstances.

Brunei Darussalam, a country that is vulnerable to the impacts of climate change, believes that the challenges posed by climate change demand urgent, decisive and concerted global action. We find ourselves in agreement that the world and all its member states can no longer afford to delay regarding innovative and coordinated action to confront climate change. As an oil producing country, we aim to reduce the energy intensity by 45% in 2035 from the baseline year of 2005. This will be achieved through enhancing energy efficiency and conservation as well as increasing deployment of renewable energies. This movement towards action against climate change will open up economic and entrepreneurial opportunities and innovation in the private sector in developing green technology in Brunei Darussalam.

Towards fulfilment of obligations under the UNFCCC, Brunei Darussalam has submitted its Initial National Communication (INC) in April 2016. This Second National Communication to the Conference of the Parties reflects the firm commitment of the Government of His Majesty Sultan and Yang Di-Pertuan of Brunei Darussalam to the Convention, its ultimate objective and principles.

I am pleased to note that this Second National Communication contains comprehensive assessments on Brunei Darussalam's economic and technical challenges in achieving a balanced mix of measures that satisfies various concerns. It also contains national circumstances, Greenhouse Gas (GHG) inventory, programmes containing measures to mitigate climate change, vulnerability and adaptation and the lines of research, and systematic observation specific to the topic. It has been prepared in accordance with the methodologies provided by the Intergovernmental Panel on Climate Change (IPCC) and the guidelines by the Conference of Parties. The information contained in this submission reflects the best available at time of writing this report.

This important report would not have been possible without the cooperation of numerous experts and stakeholders. My gratitude and thanks to the relevant ministries, government agencies, research institutes as well as institutes of higher learning for their dedication and commitment in providing necessary and updated information for the preparation of this report.

Yours sincerely,

Pehin Dato (Dr) Mohammad Yasmin Umar
Minister of Energy and Industry at the Prime Minister's Office
Brunei Darussalam

Executive Summary

National Circumstances

Addressing climate change in Brunei Darussalam requires a prudent approach to balance the interaction between key economic and environmental parameters. The country faces various economic and technical challenges in achieving a balanced mix of measures that satisfies various concerns.

Small net-energy exporting country. With high conventional energy resources relative to its population size, the oil and gas sector plays a dominant role in Brunei Darussalam's economy. Oil and gas industry contributes around 60% of the country's GDP. Consequently, emissions from the production, processing and transport of oil and natural gas represent an important source of GHG emissions in the country.

The plummeting international prices of oil and gas, and declining energy reserves indicate that there is an urgent need to diversify the economic base of the country. Diversification of the economy will however depend on the country's competitive advantage relative to its neighbouring countries with respect to natural, physical and human resources as well as the governance and incentive frameworks being put in place to attract private sector investments.

High per capita energy consumption. Brunei Darussalam is one of the countries in the world with very high income per capita. This affluence, combined with low prices for energy services (which is typical to most energy exporting countries) creates a society with very high demand for energy services. Emissions from the consumption of energy are in fact much higher than those from the extraction, transport and processing of oil and gas resources.

One of the key measures to reduce consumption and emissions of GHGs is to promote energy efficiency and conservation and increase the share of alternative energy sources. The main challenge in the deployment of more efficient technologies and alternative energy sources is to strike the right balance between pricing reforms and incentive mechanisms without affecting the overall welfare of consumers as well as public sector budgetary requirements.

High forest cover and pristine forest reserves. Aside from energy resources, the country also possesses a diverse and complex forest ecosystem. Since 2010, the country has managed to cease forest land conversions and maintain around 75% of the land area with forest cover. On the other hand, 41% of the land area have been gazetted as forest reserves. These resources are important carbon sinks and their preservation is an important strategy to mitigate climate change. Balancing conservation and sustainable management while optimizing resource benefits would remain a key challenge in managing natural resources in Brunei Darussalam.

National Greenhouse Gas Inventory 2014

Brunei Darussalam's gross GHG emissions amounted to 11,192.11 Gg CO₂ equivalent in 2014. Forest land under the Agriculture, Forestry and Land Use (AFOLU) on the other hand removed 2,839.80 Gg CO₂ equivalent from the atmosphere resulting a net emission of 8,352.31 Gg CO₂ equivalent. Compared with the emissions and removals in 2010, gross emissions had increased by 10.2% while the net emissions grew by 12.5% during the same period.

CO₂ and CH₄ are the dominant gases emitted in Brunei Darussalam with combined share of more than 98% in 2014. Between 2010 and 2014, CO₂ emissions had slightly increased to 67.5% due to rising consumption of fossil fuels. On the other hand, CH₄ emissions had reduced to 32.1% due to the decline in the domestic oil and gas production.

The energy sector represented the biggest emitter of GHG amounting to 98% of the total emissions in 2014. This was followed by the waste sector and industrial processes with shares

of 1.36% and 0.27% respectively. Contribution from AFOLU (excluding Forest Land) was 0.24%. During the period 2010-2014, the share of the energy sector had slightly declined while those of the waste sector and industrial processes had slightly increased due to increasing generation of waste and increasing methanol production.

Under the energy sector, electricity generation, fugitive emissions and land transportation were the dominant subsectors contributing 48.7%, 34.5% and 12.6% of the total energy sector emissions respectively. Emissions from the electricity generation had increased by 28% while emissions from the land transport sector had increased by 15% between 2010 and 2014. Fugitive emissions however declined during the same period due to the reduction of oil and gas production, transport and processing.

Forest land in AFOLU removed significant amount of CO₂, representing around 23% of the total emissions. Between 2010 and 2014, the removals had increased by 3.8% due to the increase of land area for forest plantations and reduction of round wood commercial harvesting.

Vulnerability and Adaptation

With increasing global surface mean temperature and weather variability due to global warming, Brunei Darussalam is vulnerable to the following impacts: i) flooding, landslides and strong wind; ii) loss of forestry and biodiversity; iii) loss of food security; and iv) public health impacts from the resurgence of diseases.

At various levels, measures were put in place to make the country resilient and adapt to climate change impacts.

- **Disaster Risk Reduction.** The Strategic National Plan for Disaster Risk Reduction (SNAP) outlines priority actions to ensure disaster resiliency in Brunei Darussalam.
- **Coastal and Flood Protection.** Both structural and non-structural measures were implemented to mitigate flood and landslide problems.
- **Safeguarding Forestry and Biodiversity.** The National Biological Resources Policy and Strategic Action Plan which outlines the strategic plans to conserve biodiversity was introduced. Several government agencies also implemented various measures to protect, conserve and manage sustainably forest and marine resources of the country.
- **Protecting Water Resources.** Sufficiency of fresh water supply were ensured through investments in enhancing and protecting supply infrastructures as well as improving efficiency at the consumption level.
- **Managing Food Security.** Various initiatives were undertaken to enhance productivity and improve national food security. In the field of crop production, food security initiatives focus on the use of modern, high-yielding varieties for irrigated areas, drought-tolerant varieties for rain-fed areas as well as the use of sustainable technologies for optimum resource utilisation.
- **Strengthening Resilience in Public Health.** The Ministry of Health has carried out various activities and measures to prevent and reduce the spread of vector borne diseases.

Mitigation

Brunei Darussalam's GHG net emissions are influenced by the level of activity and intensity of GHG emitting sectors, mainly from the energy sector, as well as those from land-use change and forestry that removes CO₂ from the atmosphere.

While the main thrust of sectoral policies are to manage resources efficiently and sustainably at the sectoral level, existing strategies and measures address both the sectoral and climate change concerns. Mitigation strategies and measures in Brunei Darussalam could be categorized as follows:

i) Setting Energy Sector Sustainable Development Targets

At the macro level, targets were set mainly to provide guidance on energy sector development and on the elaboration of specific policy strategies and measures but have also profound implications with respect to GHG emissions reductions.

- a) The energy sector aims to reduce the energy intensity by 45% in 2035 from the baseline year of 2005. The reduction of energy intensity can be achieved through energy efficiency improvements and energy conservation as well as in diversifying the economy to high value-added but less energy intensive industries.
- b) In addition, the government also aimed at reducing fossil fuel consumption by 63% in 2035 from 2009 consumption levels. This will be achieved through enhancing energy efficiency and conservation as well as increasing deployment of renewable energies.
- c) Deployment of renewable energy technologies is targeted to increase by 10% by 2035. This could be achieved by both public and private sector investments on these technologies. At present, policy frameworks that incentivize private sector investments are being prepared.

ii) Promoting Energy Efficiency and Conservation

- a) Improving Supply-Side Efficiency. At present, the government is pursuing a strategy to improve efficiency of existing open-cycle gas turbines through the installation of heat recovery steam generators while more efficient combined cycle gas turbines are being used for new capacity expansion.
- b) Managing Electricity Demand. Demand management is one of the strategies to reduce the use of fossil fuels in electricity generation. This could be achieved through improving energy efficiency of the stock of energy technologies and increasing the efficiency of the utilisation of existing technologies.
 - EEC Building Guidelines and Standards and Labelling Scheme. The Building Guidelines and the soon-to-be implemented Standards and Labelling Order for electrical appliances are regulatory frameworks that allow only efficient technologies to be used in new buildings, and only efficient electrical appliances to be sold in the market.
 - Energy Management. The planned energy management scheme will ensure that existing equipment and technologies are operating at efficiency levels consistent with industry's best practice.
 - Tariff Reforms. The progressive electricity tariff structure which was introduced in 2012, is an economic tool to manage efficient use of energy by providing a financial disincentive for higher consumption of energy.

- c) **Managing Land Transport Energy Demand.** Among the end-use sectors, the contribution of transport sector in the overall emissions is significant. Road transport energy demand management is key to reducing fossil fuel consumption of the transportation sector. The strategies outlined in the Land Transport Master Plan (LTMP) launched by the Ministry of Communications in 2014 could be categorized as follows:
- **Efficient Transport Technologies.** Promoting the deployment of efficient and less polluting vehicle and fuel technologies are outlined in the 4th strategy of the LTMP. The implementation of measures under this strategy will improve the overall efficiency of the road transport fleet.
 - **Improving Fuel Economy through Traffic Flow Improvement.** Vehicles often reach their optimal fuel economy at specific speeds. Vehicles have lower fuel economy at slower speeds. Managing traffic volume and reducing road congestion would improve fuel economy of the vehicle fleet.
 - **Managing Private Transport Demand.** The strategy to reduce car dependency through the development of public transport systems would eventually reduce individual transport demand and consequently would reduce fuel consumption. In addition, strengthening the management of the transport infrastructure and services would further encourage shift from individual travel towards mass transport system.

iv) Managing Natural Resources Sustainably

- a) **Agriculture Sector.** Despite the low contribution of agriculture sector in the total GHG emissions, there are production management practices that were promoted by the Department of Agriculture and Agrifood, such as recycling of paddy straw and alternate wetting and drying water regime that help reduce emissions of GHGs. In addition, the indigenous fruit crops planting programme contributes to the removal of CO₂ from the atmosphere.
- b) **Land-use and Forestry.** CO₂ removals from forestry represented almost one-third of the gross emissions in 2014. The i) no-logging policy in pristine peatland forests, ii) sustainable harvesting in production forests, iii) reforestation, and iv) resource management and policy enforcement under the Heart of Borneo (HoB) Initiative contribute to maintaining the forest cover area which serve as the carbon reservoirs and sinks that offset carbon emissions.

v) Minimising Waste Generation

The government set strategies to reduce the generation of total solid waste nationwide through:

- i) Waste Minimisation through 3-R (Reduce, Reuse and Recycle)
- ii) Waste Recycling with a target of 15% recycling rate by 2020 aims to reduce the amount of waste disposed of at the landfill site.

vi) Raising Awareness and Empowerment

Behavioural changes could lead to significant resource savings and efficiency improvement if the stakeholders are aware on the resource costs and benefits and if they are also aware on their power to control resource savings. Initiatives by different government agencies are important measures to reduce GHG emissions and increase GHG removals. This includes initiatives from i) EIDPMO in raising energy efficiency and conservation awareness and establishing Energy Clubs; ii) Department of Environment, Parks and Recreation (JASTRe) in

raising environmental awareness and establishment of Eco-Clubs; iii) PWD on water savings awareness and iv) HoB on forest protection, conservation and biodiversity awareness.

1 National Circumstances

1.1 Land

Brunei Darussalam is located on the northwest coast of the island of Borneo in South East Asia between latitude 4°30'N and longitude 114°04'E, approximately 442 kilometres north of the Equator. It has a total land area of 5,765 square kilometres and a coastline of 168 kilometres bounded by the South China Sea on the north and the East Malaysian states of Sarawak and Sabah on the east and west respectively.

Brunei Darussalam comprises four main districts: Belait, Tutong, Brunei-Muara and Temburong. Brunei-Muara is home to the capital city, Bandar Seri Begawan.

The country has hilly lowlands and peat swamp forests in the west, rugged mountains in the east, and swampy, flat plain along the coast. The southern part largely comprises mountains with summit levels ranging between 700 and 900 metres.

1.2 Forestry and Biodiversity

Brunei Darussalam possesses a diverse and complex forest ecosystem and is considered as one of the countries with high percentage of forest cover. Seven broad types of forests can be found in the country which include mangrove forests, beach-type forests, freshwater swamp forests, peat swamp forests, tropical heath forests (*Kerangas*), mixed dipterocarp forests and montane forests. Brunei Darussalam's peat swamps represent 18% of the land area, and are currently the most intact in the island of Borneo. High leaching rates and low decomposition rates make these peat swamps internationally recognized as powerful carbon sinks.

Around 75% of Brunei Darussalam's land area is covered with forests. The country has managed to maintain this forest coverage level since 2010. The National Forestry Policy has committed around 55% of the land area to be permanent forest reserves which have been classified into 5 functional forest zones (Table 1-1). The National Forestry Policy also designated a national forest reserve totalling 41% of the land area to be administered and managed directly by the government which limits harvesting to 100,000 cubic meters per year in production forests.

Table 1-1: Allocation of Functional Forest under the National Forest Policy

National Category	Undisturbed	Disturbed	Non-Forest	Total
	(in thousand hectares)			
Conservation Forests	31.364			31.684
Protection Forests	18.070	0.477	0.015	18.562
National Parks	48.854			48.854
Recreational Forests	4.445			4.445
Production Forests	218.650			218.650
TOTAL	321.703	0.477	0.015	322.195

At present, the total forest area in Brunei Darussalam is recorded at 380,000 hectares. Of these, 263,000 hectares are primary forests, 114,000 hectares are naturally regenerated forests and around 3,000 hectares are planted forests.

As part of the commitment to the Heart of Borneo (HOB) Initiative, the government designated 58% of the country's land area under HOB management. HOB aims not only to conserve but also to manage natural resources sustainably in conservation and protected areas as well as production forest and other land-uses.

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 square kilometres from the coast to the end of the 200 nautical mile Exclusive Economic Zone (EEZ). 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 Darussalam has 6 marine protected areas covering around 182.53 square kilometres.

1.3 Water Resources

Water supply in Brunei Darussalam 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 square kilometres 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 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.

1.4 Climate

Brunei Darussalam has an equatorial climate 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 (2010-2014). Being in an equatorial climate country, the temperature is hot throughout the year. The mean daily temperature is 28.04°C, with maximum mean of 32.4°C and minimum mean of 23.7°C (2010-2014).

Table 1-2. Climatological Statistics 2014

Mean daily maximum temperature	32.9°C
Mean daily minimum temperature	23.1°C
Mean daily maximum relative humidity	99%
Mean daily minimum relative humidity	60%
Total rainfall	3,173.5 mm
Number of rainy days	210
Mean daily bright sunshine hours	6.9 hours

1.5 Population

The population of Brunei Darussalam in 2014 was 411,900 inhabitants. Between 2010 and 2014, the population has grown at an annual rate of 1.27%.

Around 66% of the population are ethnic Malays while the rest of the population consists of Chinese and other ethnic groups residing in the country.

1.6 Economy

Brunei Darussalam has developed its economy around the production and export of oil and gas given that the country has vast hydrocarbon reserves relative to its population size. However, the plummeting oil prices since the past years and the need for a sustainable economy have driven the country to realign its goals towards the development of local capacity and expertise in other industries and to diversify the economy in order to reduce its dependency on a single industry.

Brunei Darussalam's Gross Domestic Product (GDP) in 2014 was valued at BND 18,702 million at constant 2010 prices (Figure 1-1). The country's per capita income was BND 45,404. The oil and gas sector contributed to about nearly BND 11,000 million, equivalent to about 60% of the total GDP. The contribution from oil and gas sector to the country's national output had been declining since 2010 due to falling oil prices. The oil and gas sector's value added dropped from BND 12,199.8 million in 2010 to BND 11,000 million in 2014. The export of oil and gas however remains the largest contributor to the country's income. The non-oil and gas sector mainly the service sector had contributed a third of Brunei Darussalam's GDP.

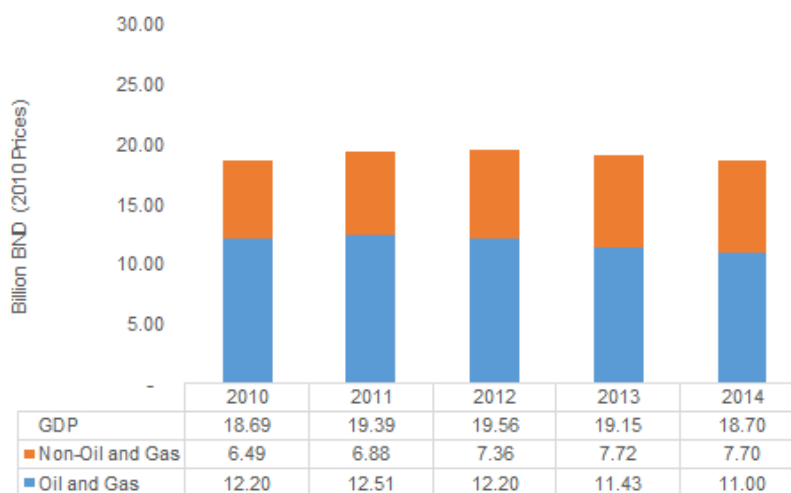


Figure 1-1. GDP Contribution by Sector

Note: Non-oil and gas sector excludes taxes and subsidies

1.7 Energy Sector

1.7.1 Oil and Gas

Oil and gas have been the core of Brunei Darussalam's economy ever since the first commercial well was drilled in 1929. The industry was initially developed from the discoveries of 3 major onshore and offshore fields which at present remain to have a majority contribution to industry's output. Recent discoveries of mid-size and smaller fields in the shallow off-shore shelf on the other hand contribute significantly to overall oil and gas production. Future development is aimed at the deep-water shelf of the country.

Oil and gas production is mainly operated by government joint venture companies such as Brunei Shell Petroleum (BSP), Total E&P Borneo and Shell Deepwater Borneo. To develop the liquefied natural gas (LNG) exports, the government also established several joint venture companies such as the Brunei LNG, Brunei Gas Carriers and Brunei Shell Tankers.

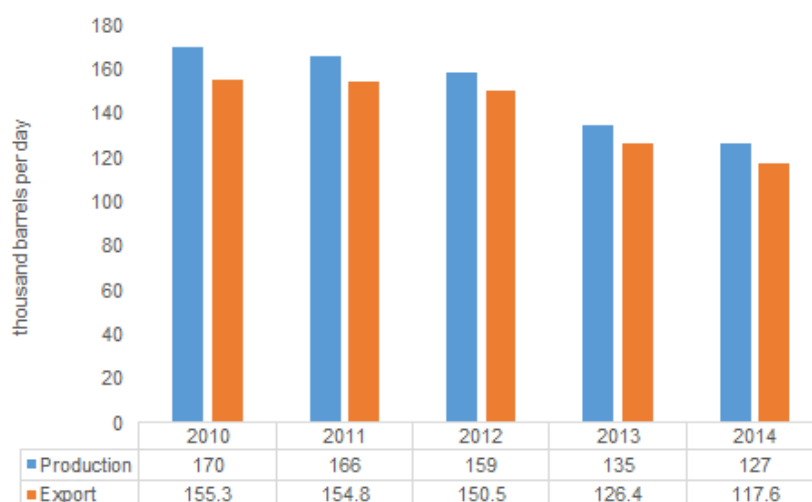


Figure 1-2. Crude Oil Production and Export

Oil production in 2014 amounted to 127 thousand barrels per day (Figure 1-2). Most of the production is exported though a small fraction is used in a local refinery. Since 2010, crude oil production and export have been declining. Production declined by more than 25% while exports had slowed down by almost the same rate between 2010 and 2014.

The production of natural gas, on the other hand, had increased by almost 12% between 2010 and 2014 though LNG exports has slightly declined by around 5% during the same period (Figure 1-3). In 2014, natural gas production reached 38 million cubic meters while exports was registered at more than 25 million cubic meters.

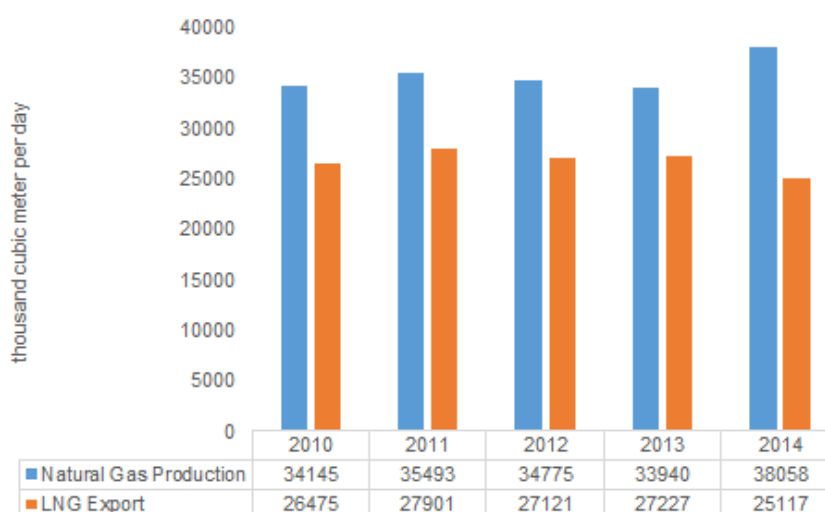


Figure 1-3. Natural Gas Production and Export

BSP also operates a local refinery which produces around 10,000 bpd of petroleum products. The country's demand is however placed at around 15,000 bpd. The Brunei Shell Marketing (BSM), also a joint venture company between the government and BSP, is mainly responsible for the distribution and sales of refined petroleum products in the country.

To diversify the economy, the government is taking the lead in developing the downstream energy industry. The government established a joint venture company, the Brunei Methanol Company (BMC) to produce and export methanol as a high value alternative to exporting natural gas. The USD 600 million methanol plant with a capacity of 850,000 metric tonnes per year was opened in 2010.

The biggest downstream development is the upcoming investment by a petrochemical company for a new integrated oil refinery and aromatics cracker complex at the Pulau Muara Besar (PMB) industrial site. The investment is seen as an opportunity for Brunei to upgrade its petroleum refinery and to position the country as the hub for processing Gulf oil for the Asian market. The project will be implemented in 2 phases, with the first phase which requires an investment of USD 4.3 billion is expected to commence operation in 2019.

1.7.2 Power Sector

The power sector in Brunei Darussalam is operated mainly by the Department of Electrical Services (DES) and the Berakas Power Company (BPC). DES operates four natural gas-based power plants (Gadong 1 and 2, Lumut and Bukit Panggal) and a diesel power plant (Belingus) located in the isolated Temburong District with total installed capacity of 469 MW. BPC on the other hand operates three gas-based power plants (Berakas, Jerudong and Gadong) with installed capacity of 266 MW. DES is the main utility responsible for distributing power throughout the country. BPC's power is distributed to strategic customers though it also supplies power to DES.

The government and the Mitsubishi Corporation have implemented a utility-scale solar PV pilot project, the 1.2 MWp Tenaga Surya Brunei (TSB), in Seria, Belait District. The project was carried out to assess the performance of 6 different solar PV module types at local meteorological conditions. The project is injecting on average around 1600 MWh of electricity to the national grid annually since 2011.

Electricity production has been increasing since 2010. The total generation in 2014 totalled 4,055 GWh which is an increase of almost 7% of the generation level in 2010. Similarly, electricity consumption has been increasing though at a much faster rate of more than 13% during the same period. Electricity consumption amounted to 3,766 GWh in 2014.

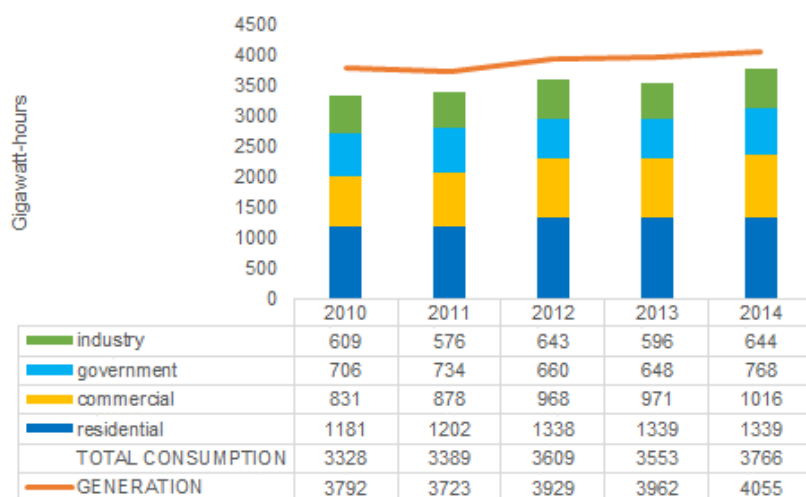


Figure 1-4. Electricity Generation and Consumption by Sectors

Among the electricity consuming sectors, the residential sector accounted the highest share of 36% in the total consumption in 2014. This was followed by commercial (27%), government (20%) and industry (17%). During the period 2010-2014, electricity consumption of the commercial sector consumption had grown rapidly at 22%. The residential sector registered an increase of more than 13%. Both government and industrial electricity consumption had grown by almost 9% and 6% respectively.

Electricity tariff rates in Brunei Darussalam are very low. For residential sector, the first 600 kWh of consumption is charged at USD 0.007 per kWh; the rate of second block between 600 kWh and 2000 kWh is USD 0.06; the third block between 2000 kWh and 4000 kWh at USD

0.07 and the highest block above 4000 kWh is charged at USD 0.08. Despite being progressive in structure, the average rate is still among the lowest in the region.

1.8 Other Sectors

1.8.1 Transportation

Land transport sector in Brunei Darussalam is governed by multiple agencies. While the Public Works Department is responsible for the planning, construction and management of the road network system in Brunei Darussalam, the Land Transport Department (LTD) is responsible for regulating land transport and drivers as well as promoting the development of land transport in the country. In terms of road safety, the Brunei National Road Safety Council (BRNSC), which comprises various stakeholders are continuously working towards promoting road safety and reducing casualties in the country based on the '5E Thrusts' of 'Engineering, Education, Enforcement, Environment, and Enforcement'.

As of 2014, the total road length was 3191.2 km, which includes 2976.1 km of roads under PWD supervision, 120.6 km and 94.4 km of roads under supervision of District Offices and of Royal Brunei Armed Forces (RBAF) respectively.

In order to improve connections between districts, the country's four major highways of Muara-Tutong, Sultan Hassanal Bolkiah, Tungku and Kuala Belait are joined by the 18.6 km Telisai – Lumut dual carriageway, which was completed in 2016. The new highway thus provides an additional pathway between Kuala Belait and Bandar Seri Begawan via Sungai Liang area and at the same time, relieve the road demand on the current Tutong-Seria single-lane road.

Another focus of the current transport development plan is the mega-project of Temburong Bridge connecting Brunei Muara and Temburong Districts. Once it is completed by 2019, the bridge is expected to cut journey time across the two districts to between 30 and 40 minutes from the current 45 minutes journey via speedboat or 1 hour and a half drive across Malaysian district of Limbang.

The dominance of private vehicles compared to public transportation is due to lack of stringent policies to control private vehicle ownership and its usage as well as due to the existing public transport system that needs to be made efficient and reliable. Between 2010 and 2014, the total number of vehicle licenses issued had more than doubled. In 2014 alone, a total of 262,649 private vehicles were licensed against a population of 411,900 (about 2 vehicles per capita), indicating a high dependency on private vehicles.

In a surveyed trip carried out in 2012 for the Ministry of Communications' Land Transport Masterplan (LTMP) reported that 98% took a private vehicle as the primary mode. Other alternative modes such as buses, taxis, water transport, walking and cycling, only account for 2% of the trips taken. The LTMP highlighted that if no measures are taken to improve the situation (business as usual):

- the average journey time in the country is expected to increase from 27 minutes in 2012 to 68 minutes in 2035;
- transport costs estimated between BND7 and BND8 based on current land transport situation, will double to about BND19; and
- 71% of the trips will take longer than 30 minutes compared to 24% today.



Figure 1-5. Number of Vehicle Licences Issued per Year

1.8.2 Manufacturing Industries

As part of the government's long-term diversification strategy, the Brunei Economic Development Board (BEDB), in collaboration with Industry Side Management (ISM) had established nine industrial sites located throughout the country with a wide variety of manufacturing, services and storage activities. One of the establishments is the Sungai Liang Industrial Park (SPARK), a 271-ha industrial park opened in 2010 which currently houses the Brunei Methanol Company (BMC). In addition, Butra Heidelberg Cement or Brunei Cement which produces 70% of the country's cement needs was established in Serasa Industrial Estate in 2003.

Key industries that are being pursued include manufacturing of urea and a steel factory. The urea-manufacturing plant by the Brunei Fertiliser Industry (BFI) is to be located at SPARK and set to commence operation in 2020, yielding 1,365 kilotonnes of urea per annum. The steel factory, on the other hand, is to be built on a 4.6-ha site in Salambigar Industrial Park. Once completed in the first quarter of 2018, the facility will be able to produce 100,000 tonnes of welded rounding carbon steel pipes for export to North America.

The development of the halal industry is also being pursued by BEBD. A local company is planning to establish a halal food production and export facility in Salambigar Industrial Park. Expected to commence operation in 2017, the plant will prepare and package ready-made halal meals using locally-sourced raw materials for export to neighbouring ASEAN countries.

1.8.3 Agriculture and Fishery

The agriculture sector comprises production of main crops (rice, vegetables, fruits, ornamental plants, cut flowers and miscellaneous) and production of livestock (buffaloes, cattles, goats and poultry). Capture, aquaculture and processing industries make up the fisheries sector.

Domestic rice production which stood at 1382 tonnes in 2014 represented only 4.05% of the total demand while the rest was supplied by imports. The majority of rice production came from Brunei Muara District (939.4 tonnes), followed by Temburong (203.4 tonnes), Tutong (120.4 tonnes) and Belait (118.5 tonnes).

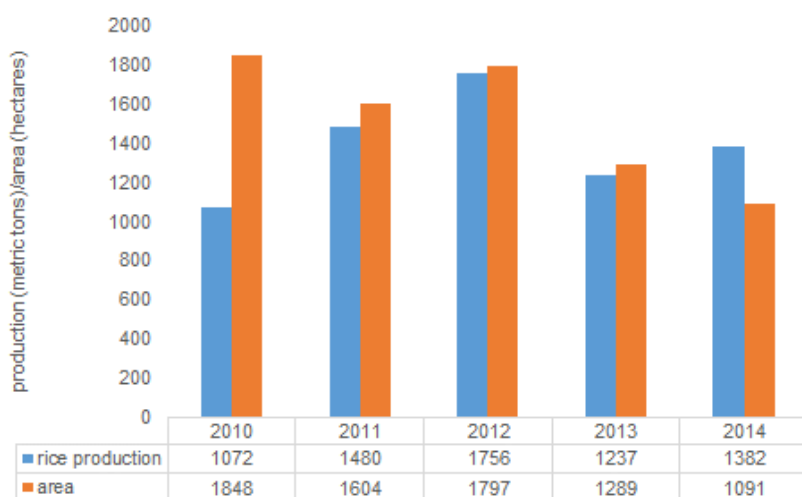


Figure 1-6. Rice Production and Area of Cultivation

Rice production and the area of cultivation had been fluctuating during the period 2010-2014 though the trend is slightly increasing for rice production but rapidly declining for the total land area of cultivation (Figure 1-6). This reflects an improvement of land productivity through the use of high yielding rice varieties as well as transformation towards mechanisation.

Despite the high dependence on rice imports, other products have reached self-sufficiency level, such as poultry, eggs and leafy vegetables. Other products such as fruits, and meat from water buffalo, cattle and goats, similar to rice have yet to achieve self-sufficient levels. Domestic production buffalo, cattle and goats had been declining between 2010 and 2014 (Figure 1-7). Chicken production on the other hand had been increasing during the same period.

In terms of fisheries, the overall fish production in 2014 amounted to 15,753 tonnes. Capture fisheries contributed the most significant production, standing at 15,329 tonnes, while the aquaculture industry's production was 424 tonnes. Production from capture fisheries and aquaculture combined has been increasing since 2011 (Figure 1-7).

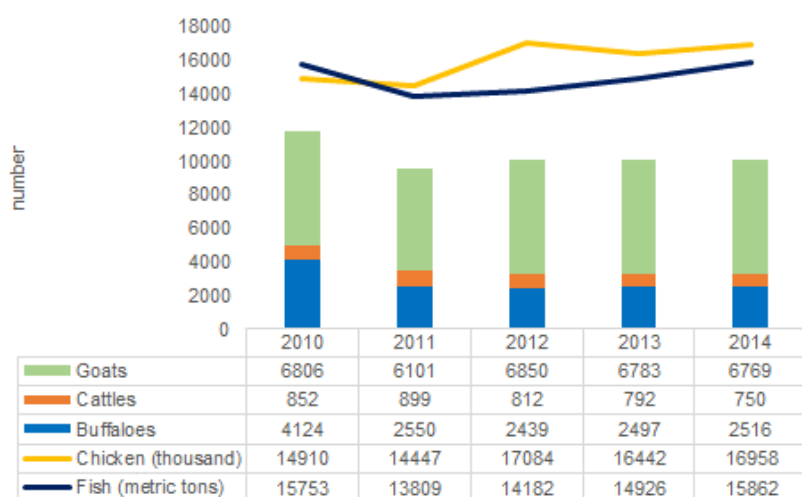


Figure 1-7. Domestic Production of Livestock and Fishery

1.8.4 Waste Sector

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

Municipal Solid Waste (MSW) has been growing substantially due to population growth which gives rise to increasing demands, emergence of new business activities and increase in lifestyle standards.

The landfill covers an area of 110 hectares and is equipped with odour control measures, environmental monitoring systems and leachate treatment. The expected lifespan of the landfill site is between 15 and 20 years.

With a population of over 400,000, Brunei Darussalam is one of the highest in the region in terms of waste generation per capita, standing at 1.4 kilogrammes per person per day. Food waste makes up 36% of the total waste share, followed by paper (18%) and plastics (16%). Most of the waste generated comes from Brunei Muara District as the district has the highest population.

In the 1950s, the Panaga Centralised Sewerage System was built excluding wastewater treatment plant. The wastewater might incorporate a centralised or communal septic tank. The first centralised wastewater treatment plant began operations about early 1971 which is Pintu Malim Sewage Treatment Works for Brunei town then or Bandar Seri Begawan now. Since then Brunei has improved its sanitation infrastructure and currently has achieved 92% of improved sanitation (septic tank and centralised sewerage system) to the public of which 56% is of centralised sewerage system. Improvements to the system also include a sewerage vacuum system for the water village in the capital. At present, the Public Works Department is operating 34 sewage treatment plants all over the country, consisting of Major STP and subsidiary or package-type plants.

1.9 Institutional Arrangement

The Energy and Industry Department at the Prime Minister's Office (EIDPMO) is Brunei Darussalam's designated National Focal Point for UNFCCC. EIDPMO coordinates the formulation and implementation of Brunei Darussalam obligations and commitments to the Convention.

A High Level Segment, a decision making body, presided by the Minister of Energy and Industry with members comprising of Permanent Secretaries from Energy and Industry Department, and International Affairs Department of Prime Minister Office, the Ministry of Foreign Affairs and Trade, the Ministry of Development, the Ministry of Primary Resources and Tourism and the Ministry of Communications coordinates the formulation of and oversee the implementation of national obligations and commitments to the UNFCCC.

A Stakeholders Consultative Committee on Climate Change (SCCCC) coordinates the technical and implementation aspects of national obligations and commitments to the UNFCCC. SCCCC tasks include coordinating the preparation of Brunei Darussalam Intended Nationally Determined Contributions (INDC) and Brunei Darussalam Initial National Communications (INC). The SCCCC is comprised of representatives from several government departments and agencies and the University of Brunei Darussalam.

1.10 Special Considerations under Article 4.8 and Article 4.10 of UNFCCC

Both Article 4.8 and 4.10 of the United Nations Convention on Climate Change (UNFCCC) are of specific relevance to Brunei Darussalam.

Article 4.8:

Parties shall give full consideration to actions to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures. Sub clause 4.8 (h) is of specific relevance to Brunei Darussalam:

- Countries whose economies are highly dependent on income generated from the production, processing and export and/or consumption of fossil fuels and associated energy-intensive products

Article 4.10:

The Parties shall, in accordance with Article 10, take into consideration in the implementation of the commitments of the Convention the situation of the parties, particularly developing country Parties with economies that are vulnerable to the adverse effects of the implementation of measure to respond climate change. This applies notably to Parties with economies of scale that are highly dependent on income generated from the production, processing and export, and /or consumption of fossil fuels and associated energy-intensive products and/or the use of fossil fuels for which such Parties have serious difficulties in switching to alternatives.

2 National Greenhouse Gas Inventory

The energy sector remains to be the dominant source of greenhouse gas (GHG) emissions in Brunei Darussalam. The main GHG emitted in the country is carbon dioxide (CO₂) which comes from the combustion of fossil fuels used in the provision of energy services. Methane also contributes an important share in the total emissions which comes as fugitive emissions from the production, transport and processing of oil and gas, and emitted from the waste sector. A significant amount of carbon dioxide is removed from the atmosphere mainly by the naturally regenerated forests and planted forests in the country.

Brunei Darussalam has submitted its Initial National Communications containing inventory for the year 2010, which was developed in line with Articles 4 and 12 of the UNFCCC and the Guidelines for Non-Annex I countries for the preparation of National Communications. The Second National Communications here includes the 2014 inventory as well as the evolution of emissions and removals between 2010 and 2014.

2.1 Methodology

2.1.1 Guidelines and Software

The 2006 IPCC Guidelines was used as a basis for the preparation of Brunei Darussalam's GHG inventory for 2010 - 2014, while the data were computed using the corresponding IPCC 2006 software. As a result, the 2010 inventory that was based on the Revised 1996 IPCC Guidelines in the Initial National Communications was recalculated to provide consistent time-series emissions between 2010 and 2014.

Among the changes in the 2006 IPCC Guidelines are:

- Agriculture, Forestry and Land Use are combined together into Agriculture, Forestry and Land Use sector (AFOLU)
- Waste sector – Methodology changes in the solid waste disposal sites (SWDS) where the First Order Decay (FOD) methodology has replaced the old Mass-Balance approach.

However, the general equation used to calculate the emissions remains unchanged as follow:

$$Emissions = Activity Data \times Emission Factor$$

Where:

- The activity data are defined as data produced due to human activities that result in emissions or removals taking place during a given period of time.
- The emission factor is the average emission rate of a given GHG for a given source, relative to units of activity.

2.1.2 Reference Approach (RA) and Sectoral Approach (SA)

The Reference Approach is a top-down approach that calculates directly the CO₂ emissions using the country's energy data on production, import-export and stock change. Sectoral Approach, on the other hand, is used to calculate the emissions based on the demand-side energy consumption. As a result, both sectors usually yield different results due to statistical differences between the energy supply and the energy consumption. In this inventory, both approaches were used to estimate the emissions as it is recommended by IPCC.

2.1.3 Activity Data and Emission Factors

The activity data used in the inventory were sourced from Brunei Darussalam Statistical Yearbook (BDSY) provided by JPKE, as the agency that produces and disseminate quality,

comprehensive, timely, accurate and accessible statistics. Additional data or information were further supplemented through direct contacts with relevant focal points in government and private agencies.

In terms of emission factors, all the sectors utilised the default values as recommended by 2006 IPCC Guidelines and IPCC Good Practice Guidance, since country-specific emission factors are yet to be developed.

2.1.3.1 Energy Sector

Activity data for the energy sector were derived from EIDPMO through APEC-EGEDA¹ energy database. The database contains country's annual energy table which includes energy supply and demands. In terms of the emission factors, default IPCC emission factors were used in the absence of country-specific factors. Tables below illustrate the default emission factors for fuel combustion activities and fugitive emissions.

Table 2-1: List of Emission Factors used in Fuel Combustion Activities

Fuel	Emission Factor (kg GHG/TJ)		
	CO ₂	CH ₄	N ₂ O
Natural Gas (Dry) – Electricity Generation	56,100	1	0.1
Natural Gas (Dry) – Residential	56,100	5	0.1
Gas/Diesel Oil – Electricity Generation	74,100	3	0.6
Gas/Diesel Oil – Land Transportation	74,100	3.9	3.9
Refinery Gas	57,600	1	0.1
Kerosene	71,900	3	0.6
Lubricants	73,300	3	0.6
Jet Kerosene	71,500	0.5	2
Motor Gasoline	69,300	33	3.2
Liquefied Petroleum Gas (LPG)	63,100	5	0.1

Table 2-2: List of Emission Factors used in Fugitive Emissions

	Category	Sub-Category	Emission Factor		
			CO ₂	CH ₄	N ₂ O
Oil	Venting	Oil Production			
		<i>Conventional Oil</i>	0.0001125	0.000855	-
	Flaring	Oil Production			
		<i>Conventional Oil</i>	0.0485	0.0000295	0.00000076
	Production & Upgrading	Oil Production			
		<i>Conventional Oil</i>	0.000000043	0.00000059	-
	Transport	Natural Gas Liquids			
		<i>Condensate</i>	0.0000072	0.00011	-
Oil					
Refining	<i>Pipelines</i>	0.00000049	0.0000054	-	
	All	-	0.0000218	-	
Gas	Flaring	Gas Processing			
		<i>Sweet Gas Plants</i>	0.00215	0.0000014	0.0000000295
		Gas Production			
		<i>All</i>	0.0014	0.00000088	0.000000025
	Production	Gas Production	0.0000975	0.01219	-
Processing	Gas Processing	0.00025	0.00079	-	

¹ APEC-EGEDA: Asia Pacific Energy Cooperation. The Expert Group on Energy Data and Analysis collects energy data from economies, including Brunei Darussalam, within the APEC region.

2.1.3.2 Industrial Processes and Product Use (IPPU)

Activity data for IPPU includes annual production of methanol from Brunei Methanol Company (BMC), which was provided by EIDPMO. Since there is no country-specific emission factor for methanol production, a value of 2.3 kg of CH₄ per tonne of methanol is recommended by IPCC.

2.1.3.3 Agriculture, Forestry and Land Use (AFOLU)

The AFOLU sector in Brunei Darussalam comprises activities from agriculture (livestock and rice cultivation), changes in forest land, and land use which includes the use of fertilisers.

Activity data for livestock, rice cultivation and fertilisers use were sourced from DAA while that for forest land came from the Forestry Department. Emission factors were all sourced from IPCC.

2.1.3.4 Waste

Solid waste disposal and wastewater treatment and discharge are the two main activities under the waste sector in Brunei Darussalam. JASTRe provided the data on the amount of municipal solid waste disposal for the year 2013 and 2014. Based on this, the average waste per capita was determined and was then used to estimate the amount of waste for 2010, 2011 and 2012.

2.1.4 Greenhouse Gases

The gases covered in this inventory are Carbon Dioxide (CO₂), Methane and Nitrous Oxide (N₂O) in sources and sinks in energy, industrial processes and product use, agriculture, forestry and land use, and waste sectors.

2.1.5 Global Warming Potentials (GWPs)

Global Warming Potentials are used to estimate the emissions in CO₂ equivalents. The GWP values were adopted based on the IPCC Second Assessment Report (SAR) on the effect of GHGs over a 100-year time horizon.

Table 2-3: Global Warming Potentials based on IPCC's Fifth Assessment Report

Greenhouse Gas	Global Warming Potential
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310

2.2 Recalculated GHG Emissions for 2010

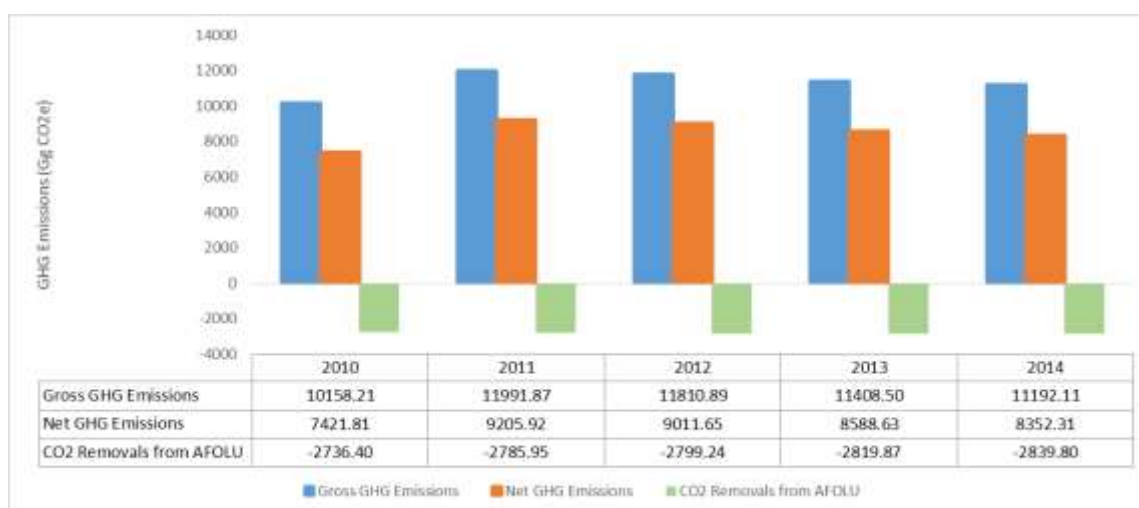
In order to provide for a more consistent time series data between 2010 and 2014, the 2010 inventory was recalculated based on the 2006 IPCC Guidelines, while retaining the GWP values based on the SAR report that were applied in the Initial National Communications.

In the fugitive emissions, the CO₂ and N₂O gases were included in the emissions as the Revised 1996 Guidelines do not take into account such gases. Furthermore, the solid waste disposal sites (SWDS) subcategory of the waste sector was recalculated as the previous Tier 1 in the Revised 1996 IPCC guidelines, based on the maximum potential release of methane in each year, has been replaced by a simple first order decay approach. This particular approach takes into account slow decay of degradable organic component over a few decades.

2.3 GHG Emissions between 2010 and 2014

Brunei Darussalam's total gross emissions ranged from 10,158.21 Gg CO₂e in 2010 to 11,192.11 Gg CO₂e in 2014, representing a percentage increase of 10.2% over 5 years. Net emissions on the other hand grew from 7,421.81 Gg CO₂e to 8,352.31 Gg CO₂e in 2014, corresponding to an increase of 12.5%. On an annual basis, the net emissions grew at a rate of 3% per year. The forest land from AFOLU sector contributed to the sink with increase of 3.8% over 5 years. The increasing trend in both gross and net emissions of GHGs has been influenced by the changes in activity levels of key sectors.

Figure 2-1: Evolution of GHG Gross and Net Emissions, as well as Removals



The use of fossil fuels for the provision of energy services in the end-use sectors and for electricity generation had significantly increased during this period. The production of oil and gas had however declined resulting in the reduction of the fugitive emissions. On the other hand, removals had increased due to the increase in the number of land area used for tree plantations in the country while forest conversions had been stopped since 2010.

Table 2-4. Brunei Darussalam's GHG Emissions and Removals in 2014

Categories		GHG Emissions (Gg CO ₂ Equivalent)			
		CO ₂	CH ₄	N ₂ O	TOTAL
ENERGY	Fuel Combustion Activities	7,160.18	11.58	24.29	7,196.05
	Energy Industries	5,341.90	2.02	3.02	5,346.93
	Manufacturing Industries and Construction	376.17	0.30	0.87	377.34
	Land Transportation	1,352.53	9.11	20.35	1,382.00
	Residential Sector	89.58	0.16	0.05	89.79
	Fugitive Emissions	396.99	3,388.67	1.91	3,787.57
	From Oil and Gas	396.99	3,388.67	1.91	3,787.57
	SUB-TOTAL	7,557.17	3,400.26	26.20	11,192.11
INDUSTRIAL PROCESSES &	Chemical Industry		29.76		29.76
	Methanol Production		29.76		29.76

PRODUCT USE (IPPU)	<u>SUB-TOTAL</u>		<u>29.76</u>		<u>29.76</u>
WASTE	Solid Waste Disposal		107.73		
	Wastewater Treatment and Discharge		35.79	8.71	
	<u>SUB-TOTAL</u>		<u>143.52</u>	<u>8.71</u>	<u>152.23</u>
AGRICULTURE, FORESTRY & LAND USE (AFOLU)	Livestock		11.81	0.58	12.38
	Enteric Fermentation		4.36		4.36
	Manure Management		7.44	0.58	8.02
	Land	-2,839.80			-2,839.80
	Forest Land	-2,839.80			-2,839.80
	Aggregate Sources & Non-CO₂ Emissions Sources on Land		2.04	12.07	14.11
	Direct N ₂ O Emissions from Managed Soils			9.07	9.07
	Indirect N ₂ O Emissions from Managed Soils			2.99	2.99
	Indirect N ₂ O Emissions from Manure Management			0.02	0.02
	Rice Cultivations		2.04		2.04
	<u>SUB-TOTAL</u>	<u>-2,839.80</u>	<u>13.85</u>	<u>12.65</u>	<u>-2,810.52</u>
	TOTAL GROSS EMISSIONS	<u>7,557.17</u>	<u>3,587.38</u>	<u>47.55</u>	<u>11,192.11</u>
TOTAL NET EMISSIONS	<u>4,717.37</u>	<u>3,587.38</u>	<u>47.55</u>	<u>8,352.31</u>	

Note: (-) represents sink

As shown in the table above, in 2014 the country's gross GHG emissions, excluding CO₂ sink from Forest Land in AFOLU, totalled 11,192.11 Gg CO₂ equivalent. Forest Land absorbed 2,839.80 Gg CO₂ equivalent of CO₂, therefore resulting in a net emission of 8,352.31 Gg CO₂ equivalent.

2.3.1 Emissions by GHG Type

CO₂ and CH₄ are the two dominant GHGs emitted in Brunei Darussalam with both gases representing around 99.6% of total GHG emissions in 2014 (Figure 2-2). CO₂ emissions amounted to 7,557.17 Gg of CO₂ equivalent while CH₄ registered a total emission of 3,587.38 Gg of CO₂ equivalent. The N₂O emissions were relatively small at 47.55 Gg CO₂ equivalent.



Figure 2-2. Percentage Share of GHG Emissions

Note: Values are in Gg of CO₂ equivalent

Between 2010 and 2014, the overall share of CO₂ emissions had increased from 63.2% to 67.5% while that of CH₄ had declined from 36.4% to around 32.1% during the same period. The increase in CO₂ emissions was due to increased consumption of fossil fuels in energy industries while CH₄ emissions reduction was attributed to the decline in the production of oil and gas. The share of N₂O remained constant at 0.4%.

2.3.2 Sectoral Emissions

Among the key sectors, energy industries was the biggest contributor to the national GHG emissions representing about 98% in 2014 (Figure 2-3). This was followed by the waste sector and IPPU with shares of about 1.36% and 0.27% respectively. The share of AFOLU was the least at 0.24%.

Between 2010 and 2014, the emissions from IPPU and waste had been growing faster than the other sectors which resulted in an increase of their share. Consequently, the shares of energy and AFOLU had slightly declined during the same period (Figure 2-3).

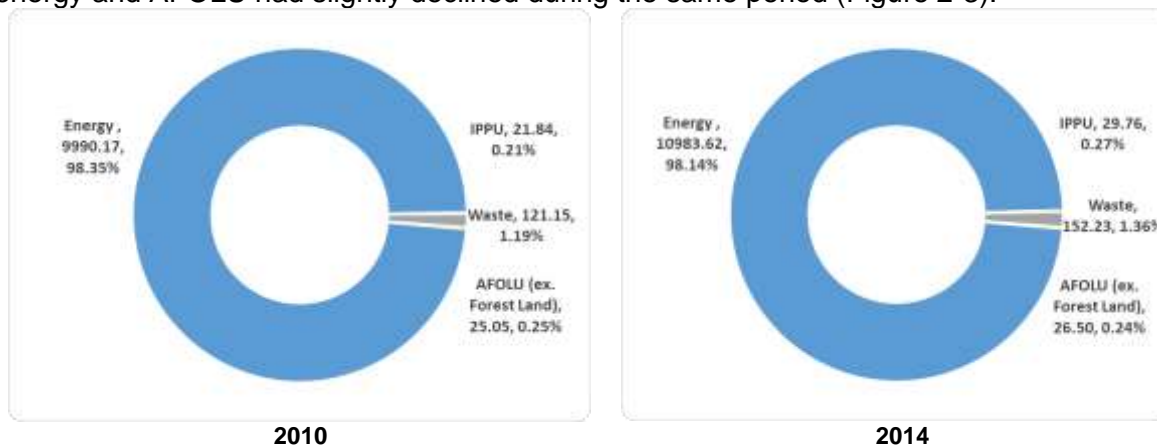


Figure 2-3. GHG Emissions by Sector

Note: Values are in Gg of CO₂ equivalent

2.3.2.1 Energy Sector

Energy sector emissions totalled 10,983.62 Gg of CO₂ equivalent in 2014 (Figure 2-4) of which 48% came from energy industries emissions, 34% from fugitive emissions from oil and gas activities and 12% from land transport sector emissions. The emissions from manufacturing industries and construction, and residential sector were relatively small at 3.4% and 0.8% respectively.

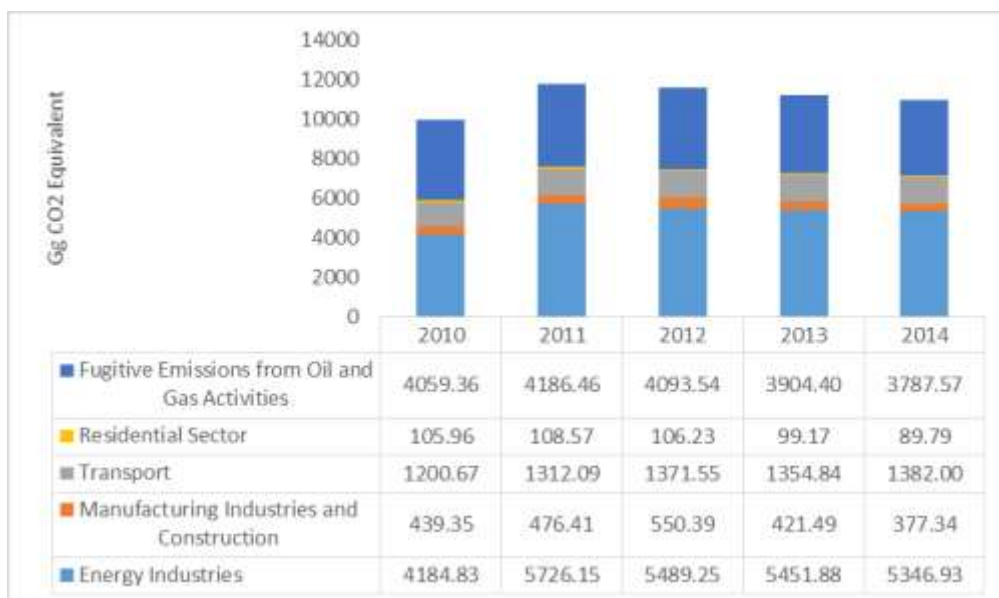


Figure 2-4. GHG Emissions from Energy Sector

Emissions from the energy sector had increased by 9.9% between 2010 and 2014. The contribution of each energy subsectors in the total emissions had slightly changed during the same period. The share of energy industries had increased from 41.8% to about 48.6% while that of the land transport sector had slightly increased from 12.0% to 12.5%. The rest of the subsectors had their shares declined (Figure 2-4).

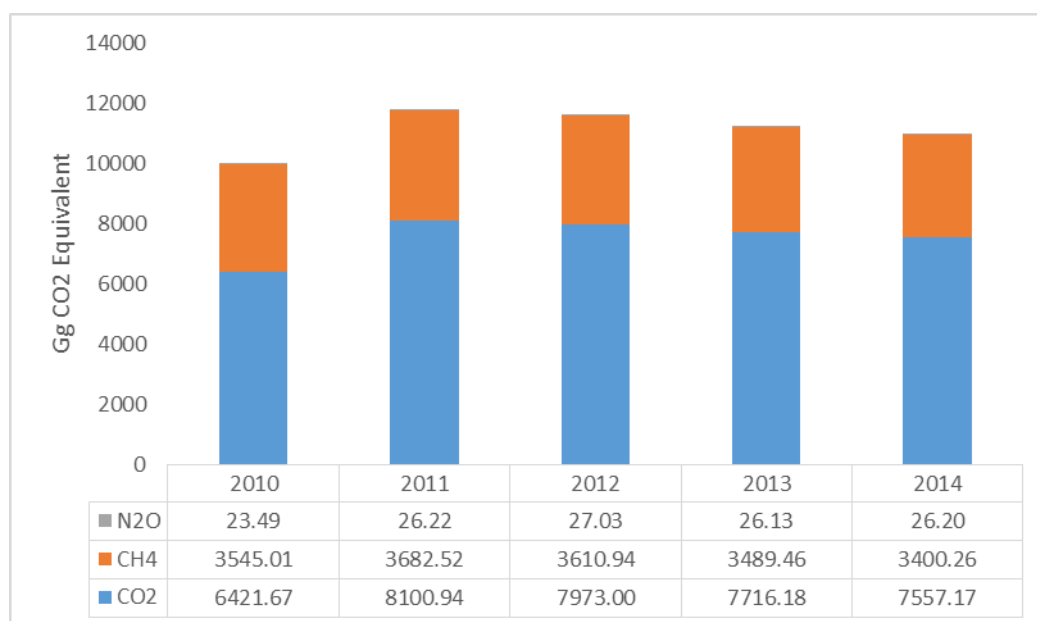


Figure 2-5. Energy Sector Emissions by GHG Type

CO₂ and CH₄ are the main GHG gases that are generated by the energy sector. CO₂ emissions reached 7,557.2 Gg of CO₂ equivalent which accounted about 68.8% of the total energy sector emissions in 2014 (Figure 2-5). CH₄ on the other hand contributed 3,400.3 Gg of CO₂ equivalent which was about 30.9% of the total emissions. CO₂ emissions are mainly from the combustion of fossil fuels while CH₄ are mainly the fugitive emissions from oil and gas production.

The share of CO₂ emissions had increased from around 64.2% in 2010 to 68.8% in 2014 while that of CH₄ had reduced from almost 35.4% to 30.9% during the same period. This is mainly due to the increase in fossil fuel consumption in power generation and road transportation while at the same time decline in the overall oil and gas production.

Energy Industries

Energy industries in Brunei Darussalam comprises mainly the combustion of natural gas and diesel for electricity and heat generations in power plants. These activities emitted 5,346.9 Gg of CO₂ equivalent in 2014, an increase of almost 28% from 2010 emissions level. CO₂ represents more than 99% of the total emissions from electricity and heat generation.

The increase in emissions were mainly due to the increase in electricity generation during this period. Electricity produced in 2014 amounted to 4,055 GWh which is an increase of about 8.9% from 2010 production level.

Land Transportation

Emissions from land transportation in 2014 totalled 1,382.1 Gg of CO₂ equivalent, an increase of around 15% from 2010 emissions. Since the emissions are generated from motor gasoline and diesel consumption, CO₂ represents more than 99% of the total emissions from the land transport sector. Gasoline consumption and diesel consumption had increased by almost 15.2% and 14.5% respectively.

Manufacturing Industries and Construction

Combustion of fuels in manufacturing industries and construction registered a total emissions of 377.3 Gg of CO₂ equivalent in 2014. This represented around 3.4% of the total energy sector emissions. Almost 100% of these emissions were CO₂ gas. The subsector emissions had declined by around 14% from 2010 emissions level due to the reduction in the overall fossil fuel consumption for combustion purpose.

Residential Sector

Residential homes utilise liquefied petroleum gas (LPG) and natural gas (town gas) for cooking purposes. In 2014, the corresponding emissions were only 89.8 Gg of CO₂ equivalent, the lowest among the other energy subsectors. These emissions are mostly CO₂ gases.

The emissions from the residential sector are mainly due to the utilisation of liquefied petroleum gas (LPG) and natural gas (town gas). The total emissions in 2014 was the lowest among the energy subsectors at 89 Gg of CO₂ equivalent. These emissions are mostly CO₂ gases.

Between 2010 and 2014, the emissions declined by around 15%. This was attributed mainly to the decline in the town gas supply. The consumption of LPG on the other remained stable during this period.

Fugitive Emissions from Oil and Gas Activities

Fugitive emissions were estimated from the production, transportation, and processing of oil and gas as well as those recorded as used under venting and flaring. The total fugitive emissions in 2014 amounted to about 3,787.6 Gg CO₂ equivalent, comprising 89.4% CH₄, 10.4% CO₂ and 0.05% N₂O.

Between 2010 and 2014, the total fugitive emissions declined by 6.7% due to the decline in the production of oil and gas as well as the reduction in the amount of gas recorded under venting and flaring.

2.3.2.2 Industrial Processes and Product Use (IPPU)

The emissions from industrial processes and product use were mainly due to the domestic methanol production from natural gas. The total emissions, made up of entirely CH₄ gas, from such production amounted to 29.8 Gg of CO₂ equivalent in 2014. Between 2010 and 2014, there had been fluctuation in the emissions which was influenced by the level of production operations. However an increase of 36% was recorded within this period.

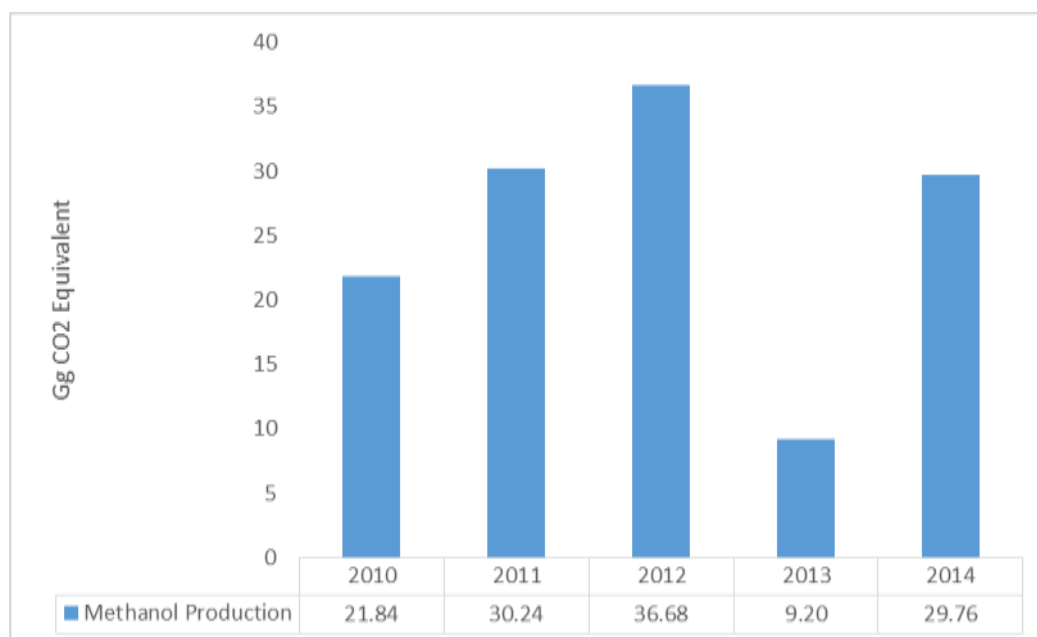


Figure 2-6. GHG Emissions from IPPU

2.3.2.3 Agriculture, Forestry and Land Use (AFOLU)

Forestry Removals

In 2014, the forest land removed about 2,839.8 Gg of CO₂ equivalent of CO₂ from the atmosphere. The sink capacity has seen an increase of 3.8% from the 2010 level, which was due to the increase in the acreage of dipterocarp plantations as well as the decrease in the commercial round wood harvesting and fuelwood production. The naturally regenerated area during this period remained constant.

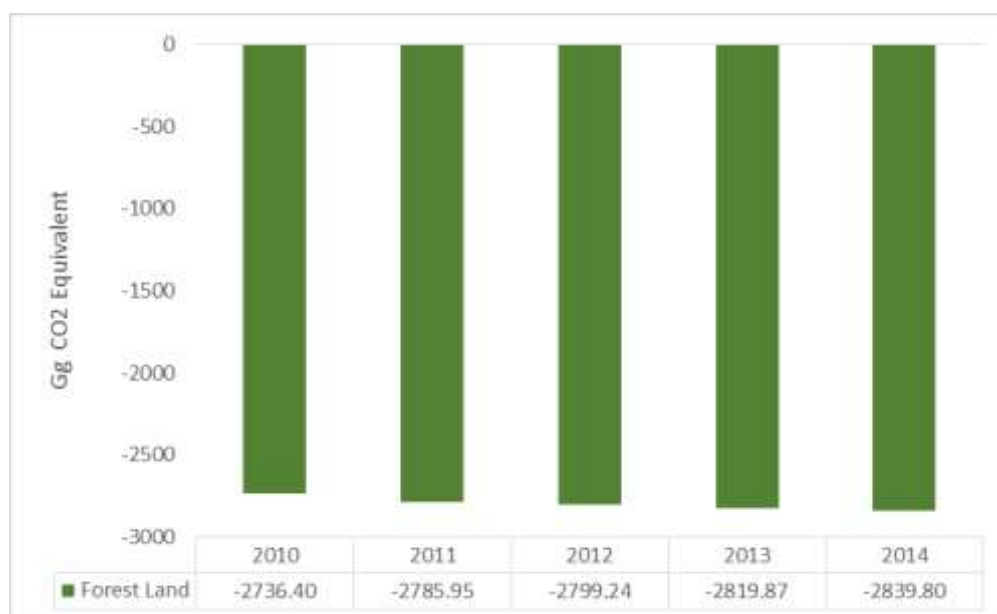


Figure 2-7: Removals from Forest Land

Non-Forestry Emissions

The non-CO₂ emissions part of this sector contributed to about 26.5 Gg of CO₂ equivalent, corresponding to an increase of 5.8% from the 2010 level. These emissions comprise CH₄ and N₂O emissions from enteric fermentation of ruminants and bacterial digestion of animal manure, CH₄ emissions from rice cultivation, and N₂O emissions from the use of nitrogen fertilisers.

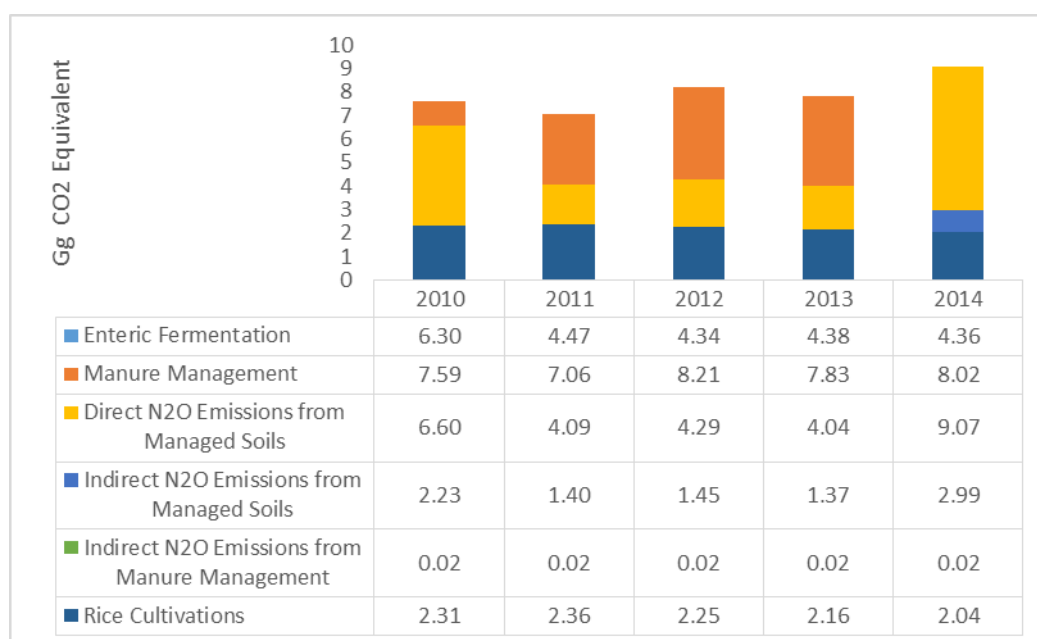


Figure 2-8. Non-Forestry GHG Emissions from AFOLU

The emissions were the following: 4.36 Gg of CO₂ equivalent of CH₄ from enteric fermentation; 8.02 Gg of CO₂ equivalent of CH₄ and N₂O from animal manure; 2.04 Gg of CO₂ equivalent of CH₄ from rice cultivation, and 12.06 Gg CO₂ equivalent of N₂O from managed soils. Very small indirect emission of 0.02 Gg CO₂ equivalent of N₂O came from manure management.

Between 2010 and 2014, emissions from enteric fermentation had declined by 30.8% due to the decrease in the number of ruminants in Brunei Darussalam. This decline in number is

compensated by an increase in the importation of cattle and goat or meat from these livestock. On the other hand, emissions generated from animal manure had increased by 5.7% which could be attributed to the increase in the total number of poultry birds. Emissions from rice cultivation had decreased by 11.6% due to the decrease in the overall land devoted for rice cultivation. Despite the reduced rice cultivation area, the use of nitrogen fertilizer had increased resulting in the increase of emissions by 37% during the same period.

CH₄ accounted for about 54% while N₂O represented 46% of the total emissions in AFOLU in 2014. Between 2010 and 2014, the CH₄ emissions declined by 11% while N₂O emissions increased by 36%.

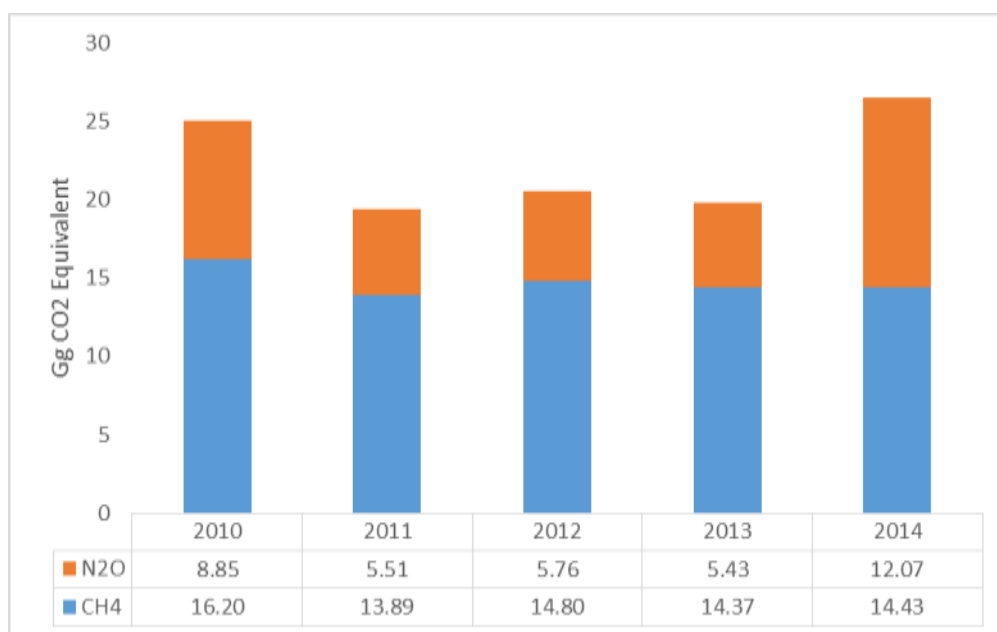


Figure 2-9. AFOLU Emissions by GHG Type

2.3.2.4 Waste Sector

The waste sector consists of emissions from solid waste disposal and wastewater treatment and discharge. The total emissions in 2014 amounted 152.2 Gg of CO₂ equivalent of which about 70.7% (107.7 Gg of CO₂ equivalent) came from solid waste disposal while the remaining share of 29.2% (44.5 Gg of CO₂ equivalent) contributed by treatment and discharge of wastewater (Figure 2-10). More than 98% of the total emissions were CH₄ gas.

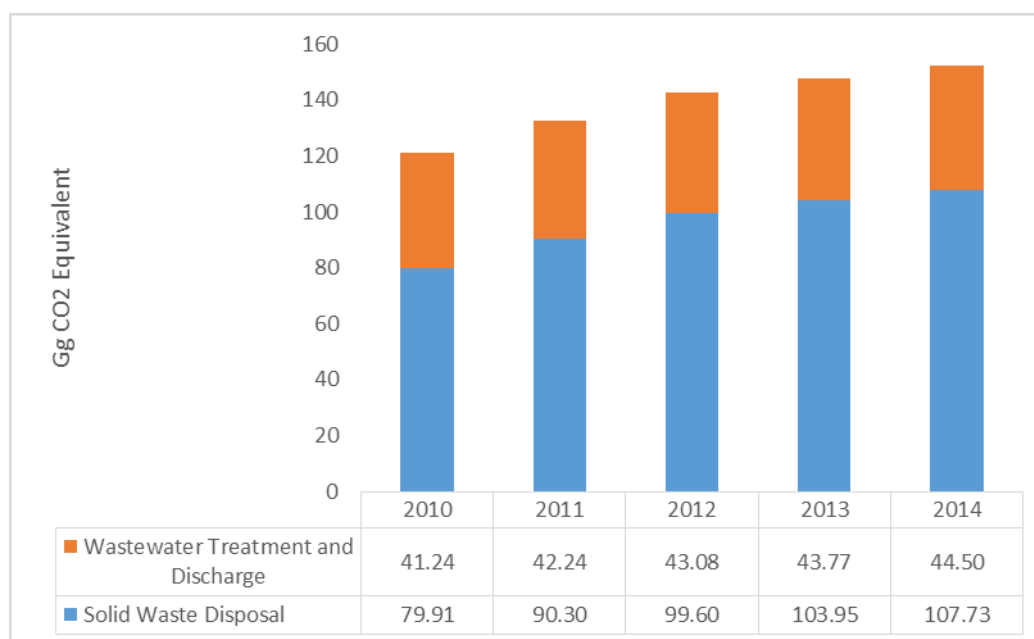


Figure 2-10. GHG Emissions from Waste Sector

Note: Emissions from solid waste disposal between 2010 and 2012 were revised based on JASTRE's actual data from 2013 to 2014.

Between 2010 and 2014, the waste sector emissions had increased by 20.4%. Emissions from the decomposition of solid waste had increased by 25.8% while that from wastewater treatment and discharge had increased by 7.3%. The growth in emissions was contributed by the increase in population, domestic and commercial waste water generation as well as the increase in the processing of meat and fish products.

Solid waste in Brunei Darussalam is disposed at a 110 hectare engineered landfill site which is equipped with odour control measures, environmental monitoring systems and leachate treatment. Domestic and commercial waste water are treated by centralized sewage treatment facility and septic tanks.

2.3.3 Comparing Reference Approach (RA) and Sectoral Approach (SA)

Over the past 5 years, the difference in the CO₂ emission estimates has been generally decreasing from 30.5% in 2010 to about 13.5% in 2014. This indicates the improvement in terms of statistical differences between the energy supply and energy consumption in the energy balance table. However, further improvements will be made in order to further reduce the difference between the reference and sectoral approaches.

Table 2-5: Comparison of the Reference and Sectoral Approaches between 2010 and 2014

GHG Emissions (Gg CO ₂ equivalent)	2010	2011	2012	2013	2014
under Reference Approach	7,701.6	8,512.1	8,291.2	7,844.4	8,130.3
under Sectoral Approach	5,899.9	7,588.6	7,481.3	7,291.9	7,160.2
Difference (%)	30.5	12.2	10.8	7.6	13.5

2.4 Key Category Analysis

A key category analysis was performed using the 2006 IPCC software for both level and trend assessment. IPCC defines key category as the emission that is prioritised within the inventory system as it brings significance influence on the country's emission inventory in terms of absolute level, the trend, or the uncertainty in emissions and removals. There are 17 key categories in the level assessment: 12 of these from the energy sector, followed by AFOLU and waste with 2 each, and 1 from IPPU.

Table 2-6. Key Category Analysis for 2014 Inventory – Approach 1 Level Assessment

Sector	Source Categories	GHG	Total Absolute Emissions (Gg CO ₂ equivalent)	Individual Contribution	Cumulative Contribution
Energy	Energy industries – gaseous fuel	CO ₂	5,276.4	35.7%	35.7%
Energy	Fugitive emissions – natural gas	CH ₄	3,249.7	22.0%	57.8%
AFOLU	Forest Land	CO ₂	2,839.7	19.2%	77.0%
Energy	Land transportation	CO ₂	1,352.5	9.2%	86.2%
Energy	Manufacturing industries and construction – liquid fuels	CO ₂	376.2	2.6%	88.8%
Energy	Fugitive emissions – oil	CO ₂	356.7	2.418%	91.2%
Energy	Fugitive emissions – oil	CH ₄	139.0	0.942%	92.1%
Waste	Solid Waste Disposal	CH ₄	67.2	0.456%	92.5%
Energy	Energy industries – liquid fuels	CO ₂	65.5	0.444%	93.0%
Energy	Residential sector – liquid fuels	CO ₂	44.9	0.305%	93.3%
Energy	Residential sector – gaseous fuel	CO ₂	44.7	0.303%	93.6%
Energy	Fugitive emissions – natural gas	CO ₂	40.3	0.273%	93.9%
Waste	Wastewater Treatment and Discharge	CH ₄	35.8	0.243%	94.1%
IPPU	Methanol production	CH ₄	29.8	0.202%	94.3%
Energy	Land transportation	N ₂ O	20.3	0.138%	94.5%
Energy	Land transportation	CH ₄	9.1	0.062%	94.5%
AFOLU	Managed soils	N ₂ O	9.1	0.061%	94.6%

In terms of trend assessment, there are nine key categories, with eight of them coming from the energy sector and only one from the AFOLU.

Table 2-7: Key Category Analysis for 2014 Inventory – Approach 1 Trend Assessment

Sector	Source Categories	GHG	Year 2010 Absolute Emissions (Gg CO ₂ equivalent)	Year 2014 Absolute Emissions (Gg CO ₂ equivalent)	Contribution to Trend	Cumulative Total Trend
Energy	Energy industries – gaseous fuels	CO ₂	4,108.8	5,276.4	28.8%	28.8%
Energy	Fugitive emissions – natural gas	CH ₄	3,348.7	3,249.7	24.9%	53.8%
AFOLU	Forest land	CO ₂	2,736.4	2,839.8	21.4%	75.2%
Energy	Fugitive emissions – oil	CO ₂	479.2	356.7	8.6%	83.8%

Energy	Manufacturing industries and construction – liquid fuels	CO ₂	438.1	376.2	5.5%	89.3%
Energy	Fugitive emissions – oil	CH ₄	186.3	138.9	3.3%	92.7%
Energy	Residential sector	CO ₂	63.4	44.7	1.2%	93.9%
Energy	Land transportation	CO ₂	1,175.2	1,352.5	1.0%	94.9%
Energy	Energy industries – liquid fuels	CO ₂	72.0	65.5	0.7%	95.6%

3 Vulnerability and Adaptation

3.1 Climate Change Projections

The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) shows that Southeast Asia will experience an increase in mean surface temperature by 3 – 5 degree Celsius by the year 2100. In addition, the sea level is projected to rise by 0.4 – 0.6 metres during the same period of time, and that it is very likely that the sea level will rise in 95% of the ocean area within Southeast Asia. A study by the Asian Development Bank (ADB) concluded that climate variability and extreme weather events would become more significant within the Brunei Darussalam-Indonesia-Malaysia-Philippines East ASEAN Growth Area (BIMP-EAGA) in the coming decades.

A preliminary study by the Brunei Darussalam Meteorological Department (BDMD) concluded that the country experienced a rise in average temperature by 0.6 degree Celsius between 1970 and 2014. An increase in the average annual rainfall was also recorded between 2005 and 2015.

Key results of climate change studies in the region which covers Brunei Darussalam are the following:

- An average mean surface temperature of 1 to 1.5°C by mid-century (2040-2060);
- Increase risk of the occurrence of heat waves and considerable increase in the 'hot' days frequency in the present climate;
- Overall increase in rainfall, enhanced variability of rainfall that could increase the occurrence and duration of dry periods, and higher intensities of rainfall that could increase the risk of flooding and landslides.

3.2 Climate Change Impacts

Brunei Darussalam is vulnerable to the impacts of climate change. The country is exposed to higher temperatures during the dry season and higher rainfall intensities during the wet season. As most of the population are living within 5 to 10 kilometres from the coastline and estuarine settlements, sea level rise effects is also of concern given some areas of the country are up to 12 meters below sea level. The socio-economic activities, including the hydrocarbon resources are also concentrated along the coastal areas.

Potential climate change impacts in Brunei Darussalam include the following:

- Flooding, landslides and strong winds;
- Loss of forestry and biodiversity;
- Loss of agricultural and fisheries production; and
- Public health impact from the resurgence of diseases.

3.2.1 Flooding, Landslides and Strong Winds

Flooding and landslides are the two most frequent natural disasters that occurs annually in Brunei Darussalam and common during the Northeast Monsoon season. This season normally lasts in between the months of October to January. January is the wettest and generally brings high intensity rainfall that can cause flash flood in the low-lying areas as well as flood in most flood plain areas particularly in Tutong and Belait Districts. These flood plain inundations normally recede after two weeks.

In January 2014, 115 reported cases of flooding in Tutong District were recorded. Two metres of flood waters affected over 1,283 residents and damaged 15 houses in the district. In January 2015, rapid rise of river water from high intensity rainfall caused flood logs from

Temburong District upstream river channel to flow towards downstream at a fast rate, thus damaging bridges, disrupting river navigation and damage residential assets.

Similar to flooding, localised landslides also had occurred severely in Brunei Darussalam in January 2009, 2011, 2014 and 2015. Out of 154 landslide cases reported in January 2014, 21 were classified as 'dangerous', 121 as 'moderate' while 11 cases were identified as 'not dangerous'. Most of the severe landslides occurred in the Brunei-Muara district, the most urbanized and densely populated district of the country.

Although Brunei Darussalam is not in the typhoon-belt zone, strong winds can occur regularly due to the tail-end effect of typhoon activities during the southwest monsoon. Strong winds are also common during the northeast cold surges and heavy thunderstorms. Recently in July 2015, strong wind with speed reaching 56 kilometres per hour brought by Typhoon Chan-hom ripped off the roofs of about 50 houses in Brunei Darussalam and left many fallen trees, disrupting power lines and road transportation.

3.2.2 Loss of Forestry and Biodiversity

Reduced precipitation during the dry period from February to March, coupled with increasing temperature can result in incidences of forest and bush fires affecting forests cover and quality of air.

The rise in sea level may cause intrusion of seawater into the ecosystems, especially the endangered peat swamp forest ones. Increase in salinity from the seawater coupled with waterlogging may disturb and reduce the productivity and hence deteriorate wetland species.

Corals in the Brunei Darussalam coastal waters which are dependent on a certain temperature range in order to grow may also be affected by the increase of sea temperature resulting from the climate change impacts. The increased frequency and intensity of storms from climate change may also be able to damage coral formation. Ocean acidification due to the uptake of carbon dioxide from the atmosphere over an extended period time may also affect the growth of corals.

3.2.3 Loss of Agricultural and Fisheries Production

Rice and other agricultural production in the country are mainly dependent on rain-fed irrigation for supply of water over the production period. Increased temperature paired with decreased amount of rain during the relatively drier periods in Brunei (February to April) can affect crops yield while the heavy rainfall can damage crops. Furthermore, a study by Asian Development Bank (ADB, 2009) stated that the delayed rainy season and extreme climate events as a result from the El Niño Southern Oscillation (ENSO) as well as increased soil salinity may also affect agricultural production.

The study by ADB (2015) also reported that projected sea level rise as a result from climate change may also likely to result in important losses to coastal ecosystems that support fisheries. This could affect the fisheries industry in Brunei.

3.2.4 Public Health Impacts from the Resurgence of Diseases

Vector-borne diseases, particularly dengue fever, are the most common type of climate-sensitive diseases. In 2015, there were 317 dengue cases reported in the country.

The poor quality of air due to forest and bush fires during prolonged dry conditions can give rise to increase in respiratory-related illness such as asthma and respiratory infections, especially among those who have heart or lung conditions.

3.3 Adaptation Measures

3.3.1 Strategic National Action Plan for Disaster Risk Reduction 2012-2025 (SNAP)

Brunei Darussalam remains committed towards building a disaster resilient nation with resilient communities by continuing to engage with relevant regional and international stakeholders in disaster management as well as disaster risk reduction particularly under the ASEAN Committee on Disaster Management and the United Nations International Strategy for Disaster Reduction.

The Strategic National Action Plan for Disaster Reduction 2012-2025 (SNAP) prioritises investment in disaster preparedness, mitigation and response to support our endeavour towards meeting this commitment. With the support of all relevant stakeholders, accomplishments have been made in various priority areas in the SNAP.

Brunei Darussalam continues to periodically review and align its strategies in adaptation to disasters with the AADMER Work Programme as well as the 2015 Sendai Framework for Disaster Risk Reduction.

3.3.2 Coastal and Flood Protection

The Department of Drainage and Sewerage (DDS) has planned and implemented both structural and non-structural measures in order to mitigate floods and coastal erosion. Structural measures are built around flood mitigation and coastal protection. The planning and implementation measures include: flood walls (levees); retention ponds; drainage improvement system; energy efficient pumping station; barrages; coastal protection e.g. headlands; outflow channels; flood forecasting and early warning system.

Non-structural measures consist of collaboration and integration, development control, integrated flood data information system, organizational, financial support. The non-structural measures include: housing/property relocations; floodplain land use and environmental protection zoning and land acquisition; development controls for storm water (acts and guidelines); full coverage of asset management system; early forecasting and flood early warning system (collaboration with research institutes); education/awareness (every stakeholders involved); change management (human and system readiness); and collaboration and integration (i.e. agriculture, research institutes/university, road, water).

3.3.3 Safeguarding Forestry and Biodiversity

Some of the forest types of rainforest in Brunei Darussalam (mangroves, beach-type forest) have natural adaptation strategies against storm and waves thus helps to prevent flooding. Mangroves has the ability to dampen storm surges and strong wind associated with storms, as well as buffers against river bank erosion. Moreover, peat swamp forest also helps in raising the ground level in Brunei by the accumulation of peat in forest floors because the ground level in the country is below sea level (some places are up to 12 metres). This will eventually prevent flooding and the intrusion of salt water into freshwater river. It is very important therefore for Brunei Darussalam to safeguard its pristine forest and biodiversity in order to adapt the effects from climate change especially flooding and landslides.

At a national level, Brunei Darussalam has come up with the National Biological Resources (biodiversity) Policy and Strategic Plan of Action that outlines the strategic plans for conserving biodiversity in the country. At the international level, Brunei is also committed to participate in the initiatives aimed at protecting rainforest such as by ratifying the Convention of Biological Diversity of the United Nations.

Apart from these initiatives, the country is now moving into land use optimisation strategy through the adoption of vertical development in the country's housing scheme in order to minimise the rate of deforestation as a result in the increasing demand for housing development. Moreover, there are also restrictions and reduced-scale of logging such as by restricting cutting of trees in areas close to rivers in order to prevent flooding and soil erosion. Monitoring and random patrol of forest areas as well as border inspection are carried out by aerial resources in order to ensure the protection of the forest can be achieved. In addition, awareness raising campaigns in schools and with communities regarding the importance of forest protection are also carried out. More research regarding biodiversity and climate change are also being undertaken by Universiti Brunei Darussalam (UBD) and the oil and gas industry in the country is also supportive on the research and development in carbon sequestration and forest conservation.

Brunei Darussalam is also endowed with rich marine biodiversity. The coastal waters of Brunei are characterized with a series of shallow shoals and patch reefs that provide habitat for corals, fish, molluscs, crustaceans and echinoderms. Important marine resources are protected under the Fisheries law (1972) which is known as the Marine Protected Areas (MPA) which covers about 182.53 square kilometres of which 3 of these contain coral reef as the dominant habitat. Coral reefs are one of the biggest sources of carbon sinks that could absorb carbon dioxide in the atmosphere, thus provides a co-benefit for climate change mitigation.

3.3.4 Protecting Water Resources

Brunei Darussalam is endowed with freshwater resources from its own rivers. The drought that occurred in 1997 due to El Niño in many parts of the world did not affect the country's clean water supply. Throughout that period, the Department of Water Services (DWS) did not require to implement water supply rationing activities. By having the regulating dam at Benutan in Tutong District, the DWS was able to provide sufficient water supply for the population of the country. However, with the increasing concern from the climate change impacts, it is important that Brunei Darussalam should come up with contingency plans to ensure sufficient water supply for the whole population during prolonged dry-spell. The DWS thus has addressed the adaptation strategies for climate change effects on the availability of water resources in Brunei Darussalam. Some of the adaptation strategies are the following:

- Development of Ulu Tutong and Ulu Belait Dams with storage capacity of 100 million cubic metres, each are currently under construction and planning stage respectively. Alongside the completed 13 million cubic metres Kargu Dam and the rest of the dams, the total storage capacity would be 287 million cubic metres and hence securing raw water supply until 2035;
- Construction of 2 barrages at main river source to prevent saline intrusion and regulate river flow during long drought;
- New infrastructures for water system are being built which include dams, treatment plants, reservoirs and pipe mains to cater for growing demand. This includes 3 newly completed treatment plants adding production capacity of 156 million litres per day to the existing 430 million litres per day of water production;

In addition, the DWS is also implementing water conservation initiatives by proactively promoting water efficiency saving devices for domestic facilities and encouraging the implementation of rainwater harvesting facilities especially for government projects as well as by reviewing the water pricing policy taking into account the element of affordability to consumer. The Department also carries out public awareness programme to instil the culture of appreciating the value of water. In addition, water resources in the country can be boosted through:

- Restoration of forests and grasslands that have already been lost or damaged and that have been sending erosion into Brunei Darussalam waters.

- Equipping farmers with practical ways to protect groundwater from contamination through Agricultural Best Management Practices; and
- Floodplains restoration that act as sponges and send water down into groundwater supplies and filter pollution out of rivers

3.3.5 Managing Food Security

Since 2009, the government has been increasing its efforts towards improving the national food security especially in local rice production and other agricultural products as well as in fisheries.

Rice, as a staple food of Brunei Darussalam remains the main focus of national food security initiatives. One of the strategies to increase domestic rice production is the improvement of farm productivity through the use of modern, high yielding paddy varieties. The Department of Agriculture and Agrifood (DAA) is actively conducting varietal trials which focus on breeding for high yielding varieties as well as varieties that display drought tolerance characteristics. Due to irregular rainfall patterns, the drought tolerance varieties will minimise farmers' risks of crop failure as a result of insufficient water supply in the rain-fed rice production area thus making the rice production in Brunei Darussalam more climate-resilient. Furthermore, the Department of Agriculture and Agrifood is also actively promoting sustainable technology such as Alternate Wetting and Drying (AWD) to the farmers through the Farmers Field School.

Brunei Darussalam has adequate domestic supply of fish and seafood together with fish imported from Sabah. However, it is still important for the country to manage its fishery sector in order to ensure food security as the effects from climate change may affect the environment and population of the marine habitat.

3.3.6 Strengthening Resilience in Public Health

The Ministry of Health (MoH) recognizes the importance of the link between climate and health and supports the recommendation by the global community to be fully committed and to take a firm action on enhancing a health system that is prepared in addressing any impacts of climate change on public health. In responding to the cases of dengue and other vector-borne diseases in Brunei Darussalam, MoH through its Public Health Services remain committed to carry out activities that reduce and prevent the spread of diseases.

Several activities to prevent and reduce the impact of climate change and spread of vector borne diseases have been implemented. These include the following:

- Implement public health strategies and vector borne diseases control consisting of various initiatives, action plans and organized programs for the vigilance, elimination, control and prevention and management of diseases;
- Application of an integrated vector management (IVM) and to get more efficient, cost effective, ecologically sound and sustainable vector control; and
- Combatting vector-borne diseases through Malaria Vigilance Programme; Entomology Programme, Vector Control Programme which entails mosquito, virus and human surveillance' public education and awareness; law enforcement and research.
- Strengthen existing infrastructure and interventions, including human resource capacity, particularly surveillance, monitoring and response systems and risk communication, to reduce the burden of climate-sensitive health outcomes.
- Increase activities for awareness of health consequences of climate change among the medical professional and educational institutions.
- Strengthen public health systems and disaster/emergency preparedness and rapid response activities, through increased collaboration and cooperation across sectors.

These include training, exercise, documentation, sharing and evaluation of the effectiveness of local knowledge and practices.

4 Mitigation

While the core focus and emphasis of key sectoral policies is to manage and utilise the country's resources efficiently to meet its long-term developmental objectives, policy measures and regulatory frameworks being pursued by various government agencies have directly contributed to the reduction of emissions and removal of GHGs from the atmosphere.

4.1 Energy Sector Targets

The Energy White Paper (EWP) launched in 2014 recognizes the role of the energy sector in achieving the country's sustainable development. The EWP set development targets related to energy efficiency and renewable energy technology deployment which have direct contribution in mitigating GHG emissions from the energy sector. These are:

- 45% reduction in energy intensity through energy efficiency and conservation (EEC) initiatives, and
- 10% share of renewable energy generation in the overall power generation mix by 2035.

In addition, Brunei Darussalam is targeting a reduction of 63% in the total energy consumption (TEC) by 2035 as announced during the Climate Change Summit in New York in September, 2014.

To achieve these targets, the EWP outlines strategies and measures to be pursued in the short to medium terms.

4.1.1 Energy Efficiency and Management

Electricity consumption represented around one-fifth of the total energy consumption in Brunei Darussalam in 2014. In almost all of the energy consuming sectors, space cooling contributes the biggest share of end-use electricity consumption. Air conditioners and other cooling units have accounted for almost 60% to 70% of electricity consumption in buildings.

The residential and commercial sectors are the largest electricity end-users in the country. Measures such as the adoption and use of high efficiency technologies in buildings such as air-conditioners with 'inverter' technology, chillers, lighting equipment (i.e., compact fluorescent lamps, LEDs) and lighting system controls, automatic control equipment occupancy sensors, etc. would help reduce energy consumption. Measures to improve energy efficiency of end-use technologies would represent the major source of abating greenhouse gas emissions at the demand-side.

Based on the study carried out by EIDPMO in 2011, promoting energy efficiency and conservation measures in the residential sector could result in a 50% reduction in energy consumption from Business-As-Usual (BAU) case in 2035, with three-quarters of the reduction coming from high efficiency air conditioners and 7% from high efficiency lamps. Similar measures in commercial buildings could result in up to 44% reduction in energy consumption from BAU case in 2035, with half of the total reduction contributed by high efficiency air conditioners and a quarter of the total savings from high efficiency chillers.

In a recent review of the Wawasan 2035 target, it was estimated that about 15.2% of the total energy consumption can be reduced by main legislative measures such as standards and labelling for residential air conditioners, EEC Building Guideline for Non-Residential Buildings and energy management system. The reduction is expected to substantially increase when other legislative measures would be implemented which include energy management policy, fuel economy regulation, financial incentive and awareness raising policies.

On the other hand, energy efficiency initiatives to improve operational efficiencies implemented by oil and gas industry operators have also contributed in the reduction of greenhouse gas emissions.

EIDPMO currently pursues key strategies to improve energy efficiency, promote energy conservation and achieve the energy efficiency targets. These are:

- Energy Management;
- Energy Efficiency and Conservation (EEC) Building Guidelines for Non-Residential Buildings;
- EEC Standards and Labelling Order; and
- Electricity Tariff Reform.

Energy Management

Brunei Darussalam is considering to adopt an Energy Management System that is compatible with the ISO 50001. A preparatory study will be carried out in 2016 and expected to be implemented by 2018. The policy will require each government agency to establish an energy management action plan, submit an energy audit report, and appoint energy managers and energy focal points for each facility.

EEC Building Guidelines for Non-residential Buildings

The Ministry of Development in collaboration with EIDPMO launched the EEC building guidelines for non-residential buildings in May 2015 with an objective to establish energy efficiency and conservation standards and a regulatory mechanism for buildings in Brunei Darussalam. These guidelines are currently mandatory for all government premises and voluntary for all commercial buildings. It is envisaged that these measures will become mandatory for all buildings in the next phases of policy roll-out.

EEC Standards and Labelling Order

Currently EIDPMO in collaboration with BNERI is finalising the Standards and Labelling Order for electrical appliances, with the objective to restrict and potentially halt the importation of inefficient technologies. The Order aims to educate and encourage consumers to purchase and utilise more energy efficient appliances and products, and is programmed to be implemented in 2017.

A series of consultations and roadshows with stakeholders will be carried out nationwide to determine the potential financial incentives that could be provided by the government to accelerate market transformation once the Order has been endorsed.

Electricity Tariff Reform

A new progressive electricity tariff structure for residential sector was introduced in January 2012 replacing the previous regressive tariff structure. Under the progressive tariff structure, consumers who uses more electricity pay higher rates. The progressive structure embeds the element of energy savings into the public's consumption habit. In addition to this, the government has also installed prepaid electricity meters in place of the old post-paid meters in residential houses and commercial buildings to improve electricity payment collection.

4.1.2 Supply-Side Efficiency

On the supply-side, EIDPMO is pursuing a policy of improving conversion efficiencies of existing power plants while allowing only more efficient power generating technologies for capacity expansion.

The government recently upgraded the Lumut cogeneration power plant, adding 66 MW capacity that comes from two GE Frame 6 units which deliver exhaust heat across the fence to the BLNG. The project is expected to increase the plant efficiency to 60% and generate a yearly savings of USD 92.5 million in terms of fuel costs. On the other hand, BPC is currently installing GE's ORegen organic rankine waste-heat recovery system on four of its existing fourteen gas turbines. The system will increase the capacity by 14 MW and improve the overall efficiency of the affected units to 45%. Additional phases, which could add an additional capacity of 42 MWs, will be considered later.

On the other hand, more efficient combined cycle gas turbines (CCGTs) are recommended for new generating facilities. The newest capacity addition, the Bukit Panggal Power Station, uses CCGT technology. The plant has a designed thermal efficiency of 47% compared to other single-cycle power plants that have an average efficiency of only 28%.

4.1.3 Deployment of Renewable Energies

The Energy White Paper (EWP) commits to achieve 10% of the total power generation mix from renewable energy sources by 2035. This target corresponds to 954,000 MWh of renewable electricity generation.

A study commissioned by the government identified solar, wind and waste-to-energy as possible sources for renewable power generation, although solar energy is seen to have the highest potential for commercial deployment.

To meet this renewable energy deployment target and contribute in the reduction of greenhouse gas emissions, EIDPMO has laid out four main strategies in the EWP:

- Introduction of Renewable Energy Policy and Regulatory Framework;
- Boost Market Deployment of Solar PV and Promote Waste-to-Energy Technologies;
- Raise Awareness and Promote Human Capacity Development; and
- Advocate Research, Development and Demonstration (RD&D) and Technology Transfer

Introduction of Renewable Energy Policy and Regulatory Framework

The introduction of policies and regulatory frameworks will form a backbone to the development of renewable energy in Brunei and at the same time support and stimulate private sector investments in renewable energy technologies. In addition, renewable energy grid access rules are also paramount for easier integration of renewable energy technologies into Brunei's national grid system.

EIDPMO and BNERI have carried out studies on alternative renewable energy regulatory frameworks for Brunei such as feed-in tariff, net metering and renewable energy certificates and have drafted legal frameworks and government directives.

Boost Market Deployment of Solar PV and Promote Waste-to-Energy Technologies

The current 1.2 MWp Tenaga Suria Brunei solar PV demonstration power plant has shown that Brunei is capable of harnessing large-scale electricity from solar energy. To expand domestic solar PV development, EIDPMO and BNERI have carried out studies for utility scale solar PV projects in the restored dump site in Sungai Akar (20-25 MWp), expansion of Tenaga Suria Brunei (20-30 MWp), and possibility of hybridizing the Temburong diesel power plant with solar PV (6-12 MWp).

With respect to waste-to-energy (WtE), EIDPMO is evaluating options for the adoption of the most efficient and state-of-art technologies. Around 10 – 15 MW grid-connected WtE plant is being proposed in at the Sungai Paku Engineered Landfill, Tutong District. In addition to

electricity generation, this would greatly reduce the volume of domestic waste being disposed of at the landfill by 80 to 90%, therefore lengthening its lifespan. Currently EIDPMO is in collaboration with the Brunei Economic Development Board (BEDB) to attract investors through public private partnership arrangement to build, operate and maintain the plant.

Raise Awareness and Promote Human Capacity Development

To promote and increase awareness on renewable energy among the local communities, EIDPMO will be holding public awareness programs through roadshows, forums and exhibitions. In addition, the existing Tenaga Suria Brunei will be used as a training facility for capacity building development. The training will include the management, operation and maintenance of a typical on-grid solar PV plant. The Department is also looking at strengthening renewable energy education in higher learning institutions and industry stakeholders for further capacity buildings and entrepreneurships.

Advocate Research, Development and Demonstration (RD&D) and Technology Transfer

To further strengthen renewable energy industry in Brunei, EIDPMO is also looking into promoting RD&D of renewable energy technologies that are capable for domestic commercialization and for exports. This can be done through collaboration between local and international research institutions on technology transfer.

4.1.4 Other Measures

Other initiatives are also being outlined to accelerate the deployment of energy efficiency and renewable energy technologies.

Financial Incentives

To foster the adoption of energy efficient technology and renewable energy, EIDPMO in association with the Ministry of Finance will identify suitable financial incentives which can be introduced. These may be in the form of tax exemptions, tax reductions or rebate schemes on energy-efficient appliances and products.

The aim of the financial support is to address the high capital cost that may be incurred when purchasing more energy efficient equipment and renewable energy technologies. EIDPMO and the Ministry of Communications are also exploring several options to provide appropriate financial incentives in the transportation sector, in particular for hybrid cars and fuel efficient vehicles.

Public Awareness and Education

EIDPMO will continuously be conducting the Awareness Raising Programmes (ARP) to all community level by organizing energy expos and roadshows, workshops and seminars on capacity building and also educate younger generation through the establishment of Energy Clubs at schools. EIDPMO also from time to time conducting seminars on energy savings to newly appointed government officers and staff, organized by the Public Service Institute, Prime Minister's Office. The seminar on energy saving has been extended to rural communities so that they will be given an equal opportunity to learn both EEC and RE.

Furthermore, EIDPMO in collaboration with the Science, Technology and Environment Partnership (STEP) Centre, Ministry of Education will be setting up EEC curriculum in the national education system in order to inculcate the importance of energy efficiency & conservation at the grass-root level.

4.2 Land Transportation

In 2014, the Ministry of Communications launched the Land Transport White Paper which identifies transport policy framework, strategies, facilities, infrastructure, and services required

to serve the nation's long-term land transportation system up to 2035. It also sets measures to address the many challenges that the country faced ranging from bottlenecks, poor provision of public transport services, transport cost and inefficient connectivity. The document also intends to shape the development of transport corridor and Brunei Darussalam's connectivity with neighbouring States and the sub-region for the movement of people, goods and services as well as to facilitate businesses and development of transport industries. Its overall aim is to develop sustainable land transportation system for Brunei Darussalam towards accelerating socioeconomic development and improving the quality of life.

To achieve the above, the White Paper outlines four key strategies as follows:

- Reducing car dependency;
- Keep traffic moving;
- Achieving sustainable society; and
- Strengthening governance

4.2.1 Strengthening governance Reduction in Car Dependency

The key proposal to reduce car dependency include the following:

- Development of four Bus Rapid Transit Lines (BRT). The BRT development will form a backbone to the public transport system in Brunei. Four BRT lines will be built with a total length of 48 km.
- Development of Park and Ride facilities (PnR). Several Park and Ride facilities were identified in the Brunei-Muara District. Such facilities are expected to reduce the highway congestion by shifting from private vehicles to public transport. In addition, several Passenger Transport Interchanges (PTIs) are being proposed in the District.
- Expanding the bus fleet. The number of buses is expected to increase from 105 in 2012 to 275 in 2035, which will accommodate 8,000 passengers during morning peak hours and more than 66,000 passengers throughout the day.
- Expansion of the number of taxis. The number of taxis will be increased from 50 in 2012 to 200 by 2018 and 400 by 2025. Along the line, a new taxi franchise system is to be established, with the objective of providing sufficient number of taxis in all areas in the country.

4.2.2 Keep Traffic Moving

To reduce road congestion, the strategy targets for expanding domestic road capacity. New roads of 140 km length are proposed to be built, along with the upgrade of the existing 25 km roads. Daily car trips will be limited to 750,000 by 2035, which will see the reduction in road congestion. Infrastructure developments will also work with the Heart of Borneo Initiative to reduce unconstrained highway construction into rural areas.

4.2.3 Achieving a Sustainable Society

Key proposals to achieve a sustainable society are the following:

- Vehicles to be green and environmentally friendly. All diesel vehicles, including public buses, are expected to be in line with Euro V standard, which will reduce the GHG emission by 74% from the current Euro I standard vehicles. To promote electric vehicles, 10% of the total vehicles in Brunei will be electric-powered by 2035. These initiatives will see the emissions from CO₂ and NO_x to be 66,000 kg and 6,000 kg respectively.

- Establishment of a Green Labelling Program on private vehicles. A green labelling program is expected to be enforced on new vehicles and second hand vehicles. This will help consumers decide on the choices in terms of vehicle emission characteristics, etc. The creation of the program will be in line with the road transport fuel economy regulation, which is being proposed by EIDPMO in collaboration with the Land Transport Department.

4.2.4 Strengthening Governance

Establishment of Transport for Brunei (TfB). Transport for Brunei (TfB) will be the new authority for the country covering all land transport infrastructure and services, both existing and planned, across Brunei. The functions of TfB will include:

- Planning and regulation of the public transport system, and potential future public transport modes such as the BRT and LRT.
- Planning, design and construction, operation, and maintenance of road facilities.
- Traffic, parking and travel demand management.

4.3 Agriculture

The Department of Agriculture and Agrifood is promoting practices that enhance agricultural production and reduce greenhouse gas emissions. This includes:

- Indigenous fruit crops planting programme
- Recycling of paddy straw into the soil
- Good Agriculture Practice
- Alternate wetting and drying water regime
- Developing drought-tolerant rice varieties

4.3.1 Indigenous Fruit Crops Planting Programme

The main objective of this programme is for the conservation of indigenous fruits. At the same time, this program also promotes farmers in the Suburban Agricultural Development Farms (SADFs) to manage their farms in a proper and systematic manner to optimize yield. This programmed aimed to plant 20,000 fruit crops per year.

4.3.2 Recycling Of Paddy Straw into the Soil

A more intensive rice production requires a proper crop residue management system. In the past, some farmers opted to burn the field as a way to manage paddy straw quickly and effectively. This not only leads to air pollution but it also results in loss of soil organic matter and huge losses of nitrogen, phosphorus, potassium and silica. However, to curb this practice and reduce air pollution, open burning has been banned as stipulated in Laws of Brunei Penal Code, 2001, c.22. Recycling of paddy straw encourages the decomposition of biomass back into the field which will re-fertilize the soil.

4.3.3 Good Agricultural Practice

The Department of Agriculture and Agrifood actively promotes the adoption of Good Agriculture Practices (GAP) to farmers. GAP is an integrated management system whereby various cropping management techniques are combined in order to increase yield, focusing on the production of a high quality products that are also safe for consumption. In addition to

product quality and safety, GAP also focuses on the welfare and safety of workers as well as environmental health.

4.3.4 Alternate Wetting and Drying Water Regime

In order to manage water more effectively in irrigated areas, DAA recommends the adoption of alternate wetting and drying water regime. Alternate wetting and drying (AWD) is a water-saving technique whereby farmers periodically dry and re-flood the paddy field. The farmers practicing AWD will actively monitor the water table through the use of a field water tube. This practice will not only reduce water requirement without causing any significant yield decrease but also reduces methane emission. The use of AWD is promoted through the Rice Farmers Field School. The use of AWD is limited to irrigated areas since it requires the ability to manage water flow into the field. The overall contribution of this methane emission reduction practice is significant since irrigated areas represent around 45% of all rice production areas in Brunei.

4.3.5 Developing Drought-Tolerant Rice Varieties

A large proportion of rice production areas in Brunei Darussalam is still lacking irrigation and drainage infrastructure and so the rice production are grown under rain-fed condition. In recent years, the rainfall patterns have been unpredictable and this has affected rice production in these areas. As an effort towards increasing farm productivity and at the same time reducing farmer's risks to crop failure, the DAA has increased its effort in rice research and development in breeding for drought tolerance varieties. The DAA are currently testing several breeding lines in the major rain-fed areas in order to assess its suitability.

4.4 Forestry

4.4.1 No-Logging Policy and Sustainable Harvesting

The forest reserve of Brunei Darussalam are classified under five categories: protection forest, production forest, recreational forest, conservation forest, and national park. The government has issued a no-logging policy in pristine peatland areas. This policy is implemented in phases of three years. By the end of 2017, there will be no logging activities conducted in these areas. Apart from this policy, the government also had introduced a reduced-cut policy whereby annual timber extraction is limited to 100,000 cubic metres in production forests. This policy results in an increase of forest conservation area for the country. Reduction of impacts of logging on carbonization has been observed. Furthermore, these policies result in an increase of forest conservation area for the country.

Harvesting of domestic timber supply is only allowed in production forest. . The harvesting of timber in designated logging compartments is under strict supervision of Forestry Department to ensure that harvesting activities are conducted in accordance to Brunei Selective Felling System (BSFS) which maintained Sustainable Forest Management approach.

4.4.2 The Heart of Borneo Initiative

The Heart of Borneo (HoB) Initiative is a trilateral transboundary forest conservation initiative by the three governments in the Borneo Island that is Brunei Darussalam, Indonesia (Kalimantan) and Malaysia (Sabah and Sarawak). The Brunei HoB has set policy directions for effective efforts in the protection and conservation of the country's forest estate.

Brunei Darussalam designated 58% of the total land area under the HoB initiative which has been recognised and incorporated into the 2006-2025 National Land Use Masterplan by the Ministry of Development.

The Brunei HoB supports and monitors the no-logging policy in gazetted forest areas and pristine peatland areas. In addition, Brunei HoB has undertaken various studies, projects and

other activities in partnership with universities, the private sector and international governmental and non-governmental organizations related to the protection, conservation and sustainable management of forest resources.

4.5 Waste Management

Mitigation strategies for reduction of GHGs emissions from solid waste area part of the government's overall integrated waste management system and these include:

- Waste prevention or minimisation to reduce the generation of waste.
- Recycling of waste to reduce the amount of waste disposed of at landfills. The Government is targeting a 15% recycling rate by 2020.
- Proper landfill management to ensure GHG emissions from disposal sites are properly captured for flaring or recovery
- Development of waste-to-energy facility which would greatly reduce the volume of waste being disposed at landfill and the emissions of methane from the site

4.6 Environmental Protection

The government is in the process of finalising the Environmental Protection and Management Order, which will provide for the prevention, control and abatement of pollution and environmental harm and for the conservation, preservation, protection, enhancement and management of the environment.

In addition, to balance the country's growth and environmental protection, environmental sustainability must be mainstreamed and integrated in the country's development policy and process. To this end, Ministry of Development, through the Department of Environment, Parks and Recreation, requires proponent for development projects and activities that pose significant environmental impacts to submit Environmental Impacts Assessment. Through this process, necessary measures to prevent, monitor and mitigate environmental degradation and pollution are built in as integral part of development project planning and implementation.

The Pollution Control Guidelines for Industrial Development introduced in 2003 has been used to mitigate environmental impacts in industrial and commercial development sites. The guidelines provide standards and limits for emissions and discharges for industrial development in Negara Brunei Darussalam to prevent pollution and ensure a good quality environment.

5. Abbreviations and Units of Measurement

5.1. Abbreviations

ADB	The Asian Development Bank
AWD	Alternate Wetting and Drying Water Regime
BEDB	Brunei Economic Development Board
BIMP-EAGA	Brunei-Indonesia-Malaysia-Philippines East ASEAN Growth Area
BMC	Brunei Methanol Company
BND	Brunei Dollar
BNERI	Brunei National Energy Research Institute
BNSC	Brunei National Road Safety Council
BRT	Bus Rapid Transit Lines
BPC	Berakas Power Company
BSP	Brunei Shell Petroleum
CH ₄	Methane
CO ₂	Carbon Dioxide
DAA	Department of Agriculture and Agrifood, Ministry of Primary Resources and Tourism
DES	Department of Electrical Services, Prime Minister's Office
DWS	Department of Water Services, Public Works Department, Ministry of Development
EEC	Energy Efficiency and Conservation
EIDPMO	Energy and Industry Department, Prime Minister's Office
EWP	Energy White Paper
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
HoB	The Heart of Borneo
INDC	Intended Nationally Determined Contribution
INC	Initial National Communications
IPCC	Intergovernmental Panel on Climate Change
JASTRe	Department of Environment, Parks and Recreation
MoD	Ministry of Development
MoH	Ministry of Health

N ₂ O	Nitrous Oxide
NDMC	National Disaster Management Centre
NOX	Oxides of Nitrogen
SADFs	Suburban Agricultural Development Farms
SNAP	Strategic National Action Plan for Disaster Risk Reduction
STEP	Science, Technology and Environment Partnership
TfB	Transport for Brunei
TSB	Tenaga Suria Brunei
UNFCCC	United Nations Framework Convention for Climate Change
UBD	Universiti Brunei Darussalam
USD	US Dollar
WHO	World Health Organisation
WtE	Waste-to-Energy

5.2. Units of Measurement

°C	Degree Celsius
bpd	Barrels per Day
Gg CO ₂ Equivalent	Gigagram of CO ₂ Equivalent
kg	Kilogram
kWh	Kilowatt Hour
MW	Megawatt
MWh	Megawatt Hour
MWp	Megawatt Peak
TJ	Terajoule

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