Antigua and Barbuda

Fourth National Communication to the United Nations Framework Convention on Climate Change

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EXECUTIVE SUMMARY

This report offers a detailed examination of Antigua and Barbuda's ongoing efforts to combat climate change, focusing on both mitigation and adaptation strategies as part of the country's Fourth National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). The document outlines the nation's geographic, socio-economic, and environmental context, providing an extensive review of greenhouse gas (GHG) emissions, mitigation actions, and vulnerability assessments, along with identifying the constraints and gaps that hinder progress.

National Context and Vulnerabilities

Antigua and Barbuda, a twin-island nation located in the West Indies, is highly vulnerable to the impacts of climate change due to its geographical characteristics and socio-economic dependencies. The islands feature a low-lying topography, making them particularly susceptible to sea-level rise, hurricanes, and other extreme weather events. The report provides a comprehensive overview of the country's geographic and topographic profile, noting that 70% of Antigua's land area is less than 30 meters above sea level, with Barbuda being even more vulnerable with most of its land lying just 3 meters above sea level.

The nation's climate is marked by high variability, with significant challenges related to water scarcity, which is exacerbated by frequent droughts and limited surface water resources. The report highlights the importance of the marine and terrestrial ecosystems, which are crucial for the country's economic sectors, particularly tourism and fisheries. However, these ecosystems are under threat from both human activities and climate change, which have led to the degradation of coral reefs, mangroves, and other vital habitats.

Greenhouse Gas Emissions Inventory

The national GHG inventory presented in the report covers the period from 2016 to 2019 and provides a sectoral breakdown of emissions. The energy sector remains the largest contributor to GHG emissions, accounting for over 77% of the total emissions due to the reliance on imported fossil fuels for electricity generation and transportation. The report details the specific contributions from various subsectors within energy, including the combustion of heavy fuel oil and the use of gasoline and diesel.

The waste sector is identified as another significant source of emissions, primarily due to the inadequate waste management infrastructure. The report emphasizes the need for improvements in waste

segregation and disposal, as well as the exploration of waste-to-energy solutions to mitigate emissions from this sector.

The inventory also includes emissions from the industrial processes and product use (IPPU) sector, agriculture, forestry, and other land use (AFOLU) sectors. Although these sectors contribute less to the overall emissions, they are still important areas of focus for mitigation efforts. The report utilizes advanced methodologies, including the IPCC guidelines and the Collect Earth tool, to ensure accurate and comprehensive data collection and analysis.

Mitigation Strategies

Antigua and Barbuda has made significant strides in developing and implementing mitigation strategies aimed at reducing GHG emissions. The report outlines the national commitment to transitioning to renewable energy, with a target of achieving 95% renewable energy in electricity generation by 2030 and in the transportation sector by 2040. Key legislative frameworks, such as the Renewable Energy Act (2015) and the Sustainable Energy Action Plan (SEAP) (2013), provide the foundation for these efforts.

The report highlights various ongoing projects, including the installation of solar photovoltaic systems, wind turbines, and the promotion of energy efficiency across multiple sectors. Despite these advances, the report acknowledges several barriers to further progress, including financial constraints, limited access to affordable financing, and low levels of awareness and understanding of renewable energy technologies.

Gender-responsive approaches are also integrated into the mitigation strategies, recognizing the differential impacts of climate change on men and women. The report stresses the importance of inclusive policies that address the needs of vulnerable groups, particularly in the context of energy access and the transition to low-carbon technologies.

Adaptation Measures

Adaptation to climate change is a critical component of Antigua and Barbuda's climate strategy, given the country's high vulnerability to extreme weather events. The report details the development of the National Adaptation Plan (NAP), which aims to enhance the resilience of key sectors such as agriculture, water resources, and infrastructure. The NAP is designed to guide national efforts in building adaptive capacity, with a focus on ecosystem-based adaptation (EbA) and improving water resource management.

The report identifies specific adaptation measures, including the upgrading of building codes to ensure structures can withstand stronger hurricanes, the promotion of water conservation practices, and the restoration of critical ecosystems such as mangroves and coral reefs. The role of local knowledge and

community-based adaptation is also emphasized, highlighting the importance of engaging local stakeholders in the design and implementation of adaptation initiatives.

Constraints and Gaps

Despite the progress made, the report candidly addresses the significant constraints and gaps that hinder the full implementation of climate action in Antigua and Barbuda. Financial limitations are a major challenge, with the estimated cost of achieving the NDC targets far exceeding the country's current financial capacity. The report calls for increased international support, particularly from global climate finance mechanisms such as the Green Climate Fund (GCF) and the Global Environment Facility (GEF).

Institutional constraints, including limited human resources and technical expertise, are also highlighted as barriers to effective climate action. The report underscores the need for capacity building and institutional strengthening to support the implementation of mitigation and adaptation measures.

This Fourth National Communication serves as both a reflection of past achievements and a roadmap for future action, underscoring the urgent need for enhanced support and collective effort in the global fight against climate change.

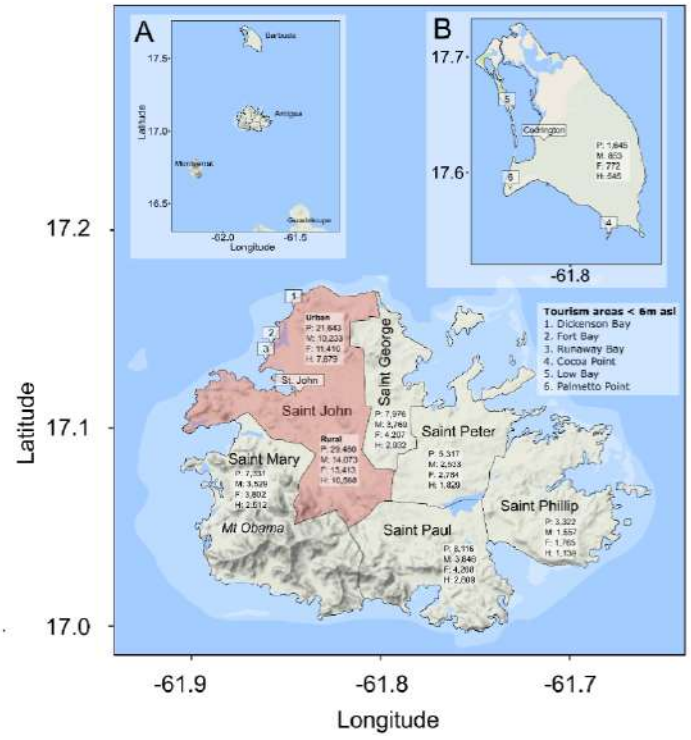
CHAPTER 1

NATIONAL CIRCUMSTANCES

Geographic and Topographic Profile

Location and Land Area

Antigua and Barbuda is a twin island state in the West Indies, lying between the Caribbean Sea and the Atlantic Ocean, and consists of several smaller uninhabited islands including the Great Bird, Green, Guiana, Maiden, Prickly Pear, York Islands, and Redonda – in addition to the privately inhabited Long Island, also known as Jumby Bay. With an exclusive economic zone of 110,071 sq. km, Antigua is located precisely at 17˚10' latitude, 61˚55' longitude, while Barbuda is located 28 miles north of Antigua at latitude 17˚35', and longitude 61˚48.



Map 1: Map of Antigua and Barbuda

Inset A: Antigua and Barbuda in relation to the islands of Guadeloupe and Montserrat. Inset B: Barbuda with its capital city, Codrington parishes

The island of Antigua is 280 km^2 (108 sq. mi), with its highest point—Boggy Peak—standing at 402 meters (1,319 ft). On the other hand, Barbuda has a relatively flat topography with some low-lying hills rising to just under 40 meters (131 ft.). Barbuda has an area of 141 km (61 sq. mi.) and houses the Codrington Lagoon, which is separated by a narrow spit of sand.

Map 1 highlights Antigua, indicating parishes, and the location of the capital city, St. John. Inset A shows Antigua and Barbuda in relation to the islands of Guadeloupe and Montserrat while Inset B depicts Barbuda with its capital city, Codrington.

The map also shows important tourism areas (points are indicated as 1–6) and their respective sea-level rise. Population numbers from the 2011 census are indicated for each parish, where P is the total parish population,

M and F are the male and female populations, and H is the number of households[1].

Topographic Profile

While the topography of the islands varies, both are low-lying with 70 percent of the land in Antigua less than 30 meters above mean sea level and most of Barbuda only 3 meters above mean sea-le-vel[2]. Antigua has three topographic zones. The first zone is the mountainous southwest volcanic region which is comprised of hard igneous rocks in the uplands and sedimentary material in associated valleys. The second zone is the relatively flat Central Plains which is characterized by the presence of some calcareous clays, typically less suited to agriculture. The third zone can be described as the rolling limestone hills and valleys of the North and East. These areas have high clay content but possess a high base structure and high base saturation with pH 8.2, making it more productive than Zone Two. However, the limestone areas in the East consist of mostly complex shallow and deep calcareous soils existing in drier climate which restricts productivity.

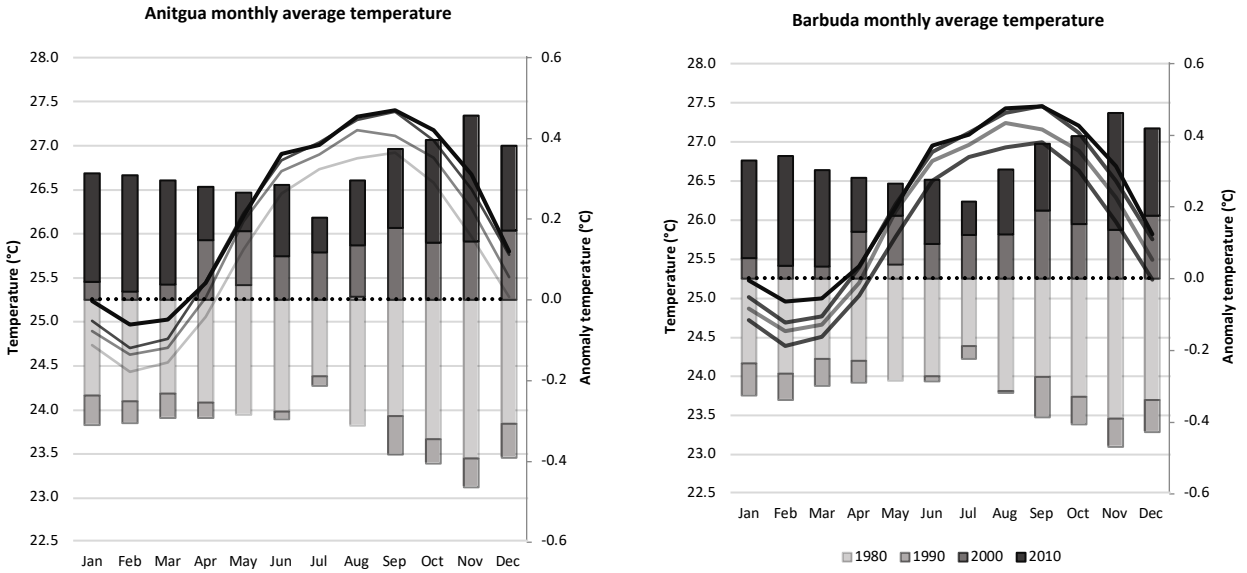
Barbuda also has three topographic zones. The first zone is the Highlands Limestone area which consists mostly of hard limestone and contains caverns and sink holes. The second zone is the Codrington Limestone region, which contains sandy and fossiliferous sediments, less crystalline than the Highland limestone. The third zone is the Palmetto Point Series which overlies the Highlands and Codrington formations in coastal areas on the western side of the island, especially between Palmetto Point and Sand Ground. It is composed of beach sands and ridges, with shelly horizons. Considerable amounts of these sandy deposits have been surface mined for use in construction.[3]

Climate and Weather

Antigua and Barbuda has a tropical savanna climate[4], with high and uniformed average daily temperatures between 24°C–30°C (Figure 1)[5]. The lowest monthly temperature ever recorded was 17.0˚C (March 2000) and the highest was 34.1˚C (May 2005)[6]. The annual average temperature range is between 25.3°C in February and 28.2°C in [7]. The country has a marked wet and dry season, characterized by dry winters and wet summers, with the average annual rainfall on Antigua varying from 580–1,660 mm and on Barbuda from 620–2,100 mm. Figure 2 shows average daily temperatures recorded by the national meteorological service for Antigua for the period 1995–2018 (Panel a); and total annual rainfall for Antigua and Barbuda from 1993–2018 (Panel b). Of this rainfall, 29 percent occurs during the dry season (between December and April) while the remaining 71 percent occurs during the wet season (between May and November)[8].

[1] Adapted from: Statistics Division. 2014. Antigua and Barbuda 2011, population and housing census. Book of statistical tables I. Ministry of Finance, the Economy, Public Administration, Public Broadcasting and Information.
[2] James P. 2001. Antigua and Barbuda Country Paper on National Climate Change Issues. Component 4: Formulation of a Policy Framework for Integrated (Adaptation) Planning and Management, Caribbean Planning for Adaptation to Climate Change.
[3] (2015) Antigua and Barbuda's 2015-2020 National Action Plan: Combatting Desertification, Land Degradation & Drought
[4] Available at: https://en.climate-data.org/north-america/antigua-and-barbuda-165/.
[5] Antigua and Barbuda Meteorological Service. 2019. Available at: http://www.antiguamet.com/Climate/
[6] Antigua and Barbuda's First Biennial Update Report (BUR1)
[7] (2020) OECS Country Analysis: Resilience to Climate Change
[8] Antigua and Barbuda Meteorological Service. 2019. Government of Antigua and Barbuda. Available at: http://www.antiguamet.com/Climate/

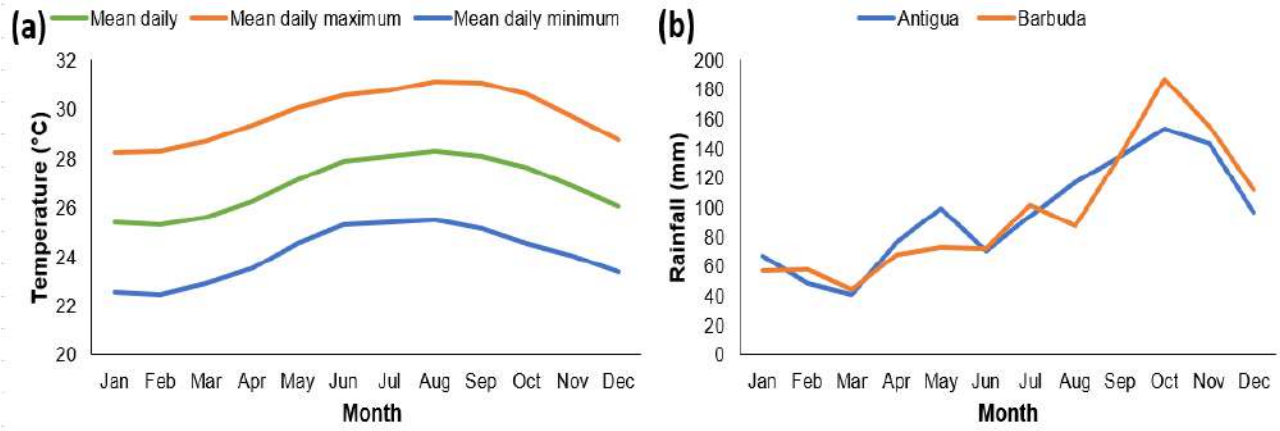
Figure 1: Monthly Average and Anomalous Temperatures



Source: Antigua and Barbuda Meteorological Service

Despite the country's tropical climate, high seasonal variability in precipitation and a limited natural surface water storage capacity have resulted in Antigua and Barbuda becoming one of the most water scarce countries per capita in the world[9]. During wet seasons, reservoirs and dams often overflow, causing much of the freshwater to flow into the sea and not be utilized[10].

Figure 2: Average Daily Temperatures (a) and Total Annual Rainfall 1995-2018 (b)

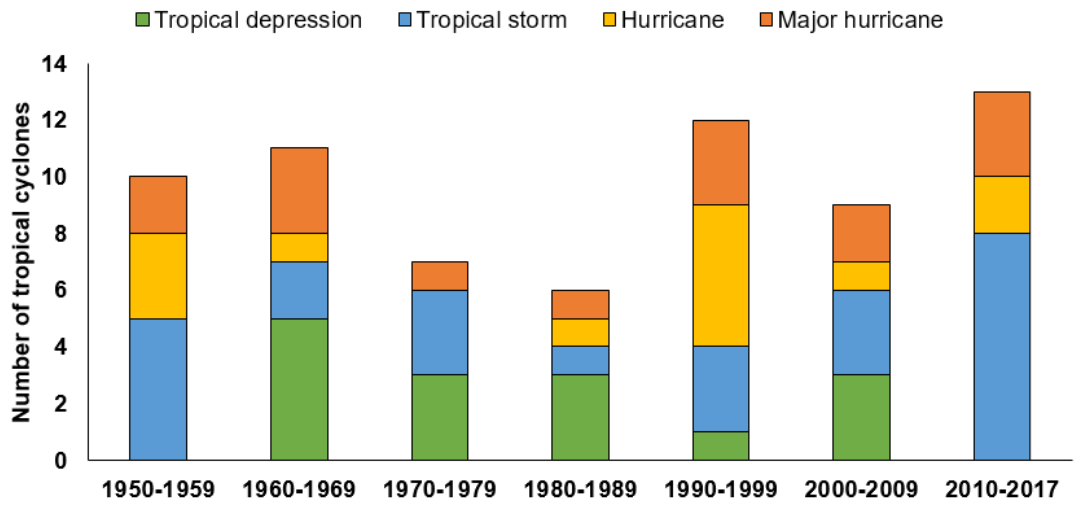


[9] Haites E. 2002. Assessment of the economic impact of climate change on CARICOM countries. Margaree Consultants, Toronto.

[10] Antigua and Barbuda: Environmental Management Strategy and Action Plan 2004–2009 (EMSAP). 2003. Government of Antigua and Barbuda.

The country's climate is influenced by several factors, namely the: i) migration of the North Atlantic sub-tropical high-pressure system; ii) eastward spreading of the tropical Atlantic warm pool; iii) easterly trade winds; and iv) tropical depressions, storms and hurricanes[11]. In addition, the temperature in Antigua and Barbuda is affected by the presence of the El Niño Southern Oscillation (ENSO), which is a periodic fluctuation in sea surface temperature (SST) and the overlying atmosphere, leading to cycles of warm and cold temperatures across the Pacific. ENSO brings about two distinct changes in weather patterns known as El Niño and La Niña, which each typically last for 9–12 months but can persist for as long as two years[12]. La Niña results in wetter and cooler conditions and weakens upper and lower-level winds, reducing wind shear and increasing hurricane activity, while El Niño causes warmer and drier conditions during the late wet season. These weather patterns, along with greater vertical wind shear and a more stable atmosphere, mean that El Niño is usually associated with less frequent hurricanes[13]. Although El Niño and La Niña mostly affect areas surrounding the Pacific, they can affect the climate in other parts of the globe as well. El Niño can negatively impact countries in the Caribbean — including Antigua and Barbuda — by increasing the likelihood and severity of droughts[14]. Partly because of the ENSO cycle, Antigua and Barbuda experiences severe droughts approximately every five to seven years[15].

Figure 1: Number of hurricanes to either brush or directly hit Antigua and Barbuda per decade from 1950–2017



[11] Government of Antigua and Barbuda. 2015. Third National Communication on Climate Change.

[12] National Oceanic and Atmospheric Administration. 2019. What are El Niño and La Niña? U.S. Department of Commerce. Available at: https://oceanservice.noaa.gov/facts/ninonina.html.

[13] National Oceanic and Atmospheric Administration. 2014. Impacts of El Niño and La Niña on the hurricane season. U.S. Department of Commerce. Available at: https://www.climate.gov/news-features/blogs/enso/impacts-el-ni%C3%B1o-and-la-ni%C3%B1a-hurricane-season.

[14] National Drought Mitigation Center. 2019. ENSO and drought forecasting. Available at: https://drought.unl.edu/Education/DroughtIn-depth/ENSO.aspx

[15] Antigua and Barbuda Meteorological Service. 2019. Droughts. Available at: http://www.antiguamet.com/Climate/STATS/anu_drought.html.

Since 1995, Antigua and Barbuda has experienced 4 tropical depressions, 14 tropical storms, and 15 hurricanes (Figure 3). Building codes in Antigua and Barbuda did not prescribe the construction methods/technologies required to withstand the impacts of a hurricane stronger than Category 3. While designing buildings to withstand up to a Category 3 hurricane was sufficient in the past, the increasing intensity and frequency of hurricanes hitting the country are having severe impacts on the country's built environment and population. Most of the damage to vegetation and buildings caused by hurricanes can be attributed to high winds, storm surges, and landslides. Moreover, access to emergency, public and electricity services is severely disrupted, often for several weeks immediately, and well--being, as well as the economic security of the country.

Until 2017, Antigua and Barbuda had only been hit by relatively low-intensity hurricanes; with those reaching hurricane status seldom strengthening above Category 3[16]. In 2017, the country had never experienced a Category 5 hurricane and two weeks later Dominic and other islands experienced the same impact (Hurricane Maria). In September 2017, Category 5 Hurricane Irma damaged 95 percent of Barbuda's buildings and infrastructure[17]. Hurricane Irma affected a total of 14 Small Island Developing States (SIDS), including Antigua and Barbuda, setting an Atlantic basin record by having sustained winds exceeding 290 kph for 36 consecutive

Figure 2: Natural Color Satellite Images of Barbuda Before (left) and After (right) Hurricane Irma

[16] The Saffir-Simpson Hurricane Wind Scale differentiates between hurricanes, tropical storms and high-intensity storms - https://www.weather.gov/mfl/saffirsimpson#:~:text=The%20Saffir%2DSimpson%20Hurricane%20Wind,loss%20of%20life%20and%20damage.

17 Hanna, Jason; Sterling, Joe; Almasy, Steve (6 September 2017). "Hurricane Irma: Powerful storm blamed for three deaths". CNN. https://edition.cnn.com/2017/09/06/us/hurricane-irma-puerto-rico-florida/index.html

hours[18]. Due to extensive damage and the additional threat posed by a second hurricane, Hurricane Jose, two days later, the entire population of Barbuda was evacuated to Antigua, leaving Barbuda uninhabited for the first time in modern history (Figure 4)[19].

The Eastern Caribbean is also impacted by earthquakes. Particularly, the North-eastern Leeward Islands is one of the most seismically active zones within the Caribbean and frequently experiences minor earthquakes[20]. For the period 1998–2018, 398 magnitude 3, 139 magnitude 4, and 22 magnitude 5 earthquakes were recorded within a 150 km (about 93.21 mi) radius around Antigua and Barbuda[21]. Earthquakes at these scales can cause minor damage to buildings and structures[22]. Greater magnitude earthquakes of 6–7 or 7 and above have return periods of 15 and 75 years respectively[23]. Earthquakes at these magnitudes can cause moderate or considerable damage and loss of life. The last recorded high magnitude earthquake to affect Antigua and Barbuda, causing extensive damage, occurred in 1974 and had a magnitude of 7.5.

ENVIRONMENT AND NATURAL RESOURCES

Marine and Coastal Resources

In Antigua and Barbuda, a variety of marine ecosystems have been identified, including mangrove wetlands, seagrass beds, coral reefs, sandy beaches and rocky-intertidal shores. These ecosystems provide a wide variety of ecosystem services, on which many of the economic sectors depend. The services include *inter alia*: i) habitat provisioning for fisheries; ii) cultural, recreational and touristic benefits based on natural ecosystems; iii) regulatory services for flood protection, sediment retention and water purification; and iv) supporting services for primary production and nutrient cycling. Although many of the islands consist of sandy soil and shrub vegetation as a result of volcanic ash in the soil, some areas support tropical forested vegetation. These ecosystems are home to several endangered[24] and endemic species[25]. To protect these species and their habitat, seven national parks and wildlife reserves have been established in the country, covering ~19 percent of the islands' total surface area[26]. Codrington Lagoon on Barbuda, which covers

18 Shultz JM, Kossin JP, Shepherd JM, Ransdell JM, Walshe R, Kelman I & Galea S. 2018. Risks, health consequences, and response challenges for small-island-based populations: observations from the 2017 Atlantic hurricane season. Disaster Medicine and Public Health Preparedness.

19 Cangialosi JP, Latto AS & Berg R. 2018. National Hurricane Centre Hurricane Report: Hurricane Irma. National Oceanic and Atmospheric Administration.

20 National Office for Disaster Services (NODS). 2017. Country Document for Disaster Risk Reduction: Antigua and Barbuda, 2016.

21 Northern California Earthquake Data Centre (NCEDC). 2014. Historic ANSS Composite Catalogue Search. UC Berkeley Seismological Laboratory. Available at: http://www.ncedc.org/anss/catalog-search.html.

22 Encyclopedia Britannica, Inc. 2019. Earthquake magnitude. Available at: https://www.britannica.com/science/earthquake-geology/Earthquake-magnitude

23 Caribbean Catastrophe Risk Insurance Facility. Country Risk Profile: Antigua and Barbuda. Available at: https://www.ccrif.org/sites/default/files/publications/antigua_barbuda.pdf

24 For example, the Antiguan racer snake (Alsophis antiguae) was listed as the world's rarest reptile before conservation efforts increased its numbers. However, the species remains 'Critically Endangered' on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. Available at: http://www.iucnredlist.org/details/939/0..

25 For example, the Antiguan ground snake (Alsophis antillensis antiguae), dwarf woodslave (Sphaerodactylus elegantulus) and green lizard (Anolis bimaculatus leachi).

26 The World Bank. 2019. Available at: https://data.worldbank.org/indicator/ER.LND.PTLD.ZS?locations=AG.

most of the west coast of the island, has been listed as a Ramsar Wetland of International Importance and is a major tourist attraction[27]. In addition, there are 40 Marine Protected Areas (MPAs) that cover 624 km^2 of Antigua and Barbuda's territorial waters[28]. Other major tourist attractions include the islands' numerous beaches and areas of high biodiversity. The country's offshore islands are particularly biodiverse, with the island of Redonda considered a Key Biodiversity Area[29].

Mangroves

Antigua and Barbuda has one of the most extensive networks of mangrove wetlands in the Eastern Caribbean. There are 36 mangrove sites in Antigua and nine in Barbuda[30]. One of the largest mangrove sites is found in Barbuda, covering some 352 hectares and home to the Magnificent Frigate Bird Sanctuary[31]. Within the twin-island state, there are four known species of mangroves: *Rhizophora mangle* (red mangrove), *Langucularia racemosa* (white mangrove), *Avicennia germinans* (black mangrove) and *Conocarpus erectus* (buttonwood). Mangrove wetlands cover 3 percent of the land area in Antigua and 22 percent in Barbuda. As well as functioning as a sediment trap and preventing erosion, mangroves provide important nurseries, breeding and feeding grounds for both marine and terrestrial species.

Seagrass

Seagrass beds are found in shallow waters surrounding both islands and, along with stabilizing loose sand, provide shelter and food resources for numerous commercially relevant species [32]. Seagrass beds provide habitat for marine species such as the juvenile queen conch (*Strombus gigas*) and Caribbean Spiny Lobsters (*Panulirus argus*) and provide food for herbivores, including the endangered Green Sea Turtle (*Chelonia mydas*). The most common type of Seagrass is Turtle Grass (*Thalassia testudinum*), Manatee Grass (*Syringodium filforme*), variations of the *Halimeda spp* (also a source of sand for beaches) and the invasive Broad Leaf Seagrass (*Halophila stipulacea*)[33].

Coral Reefs

Forming part of the Eastern Caribbean Seascape, coral reefs are most prominent on the windward and eastern side of the country[34]. Coral reefs contribute to both the formation and protection of beaches on the two islands. However, a large percentage of the islands' reefs are no longer ecologically viable. This loss of coral reef functionality, along with the decline in the extent of mangrove wetlands and seagrass beds, is the result of frequent hurricanes, untreated sewage, sediment loading from erosion and damage from boats or dredging[35].

[27] Ramsar. 2014. Antigua and Barbuda. Available at: http://www.ramsar.org/wetland/antigua-and-barbuda.
[28] Marine Conservation Institute. 2019. Atlas of Marine Protection: Antigua and Barbuda. Available at: http://www.mpatlas.org/region/country/ATG/.
[29] Birdlife International. 2019. The World Database of Key Biodiversity Areas. Available at: http://www.keybiodiversityareas.org/site/factsheet/redonda-iba-antigua-and-barbuda.
[30] (2011) Sustainable Island Resource Management Zoning Plan for Antigua and Barbuda (SIRMZP)
[31] (2020) Antigua and Barbuda's First Biennial Update Report
[32] Antigua and Barbuda Third National Communication on Climate Change 2015.
[33] Antigua and Barbuda's First Biennial Report 2020
[34] Antigua and Barbuda: Coral Reef Report Card. 2016. The Nature Conservancy, the Department of Environment and the Federal Ministry for the Environment, Nature Conservation, Buildings and Nuclear Safety.
[35] Antigua and Barbuda Third National Communication 2015.

Terrestrial Resources

Antigua and Barbuda is vulnerable to the impact of extreme climate events like heavy rainfall events associated with hurricanes, as well as severe droughts – occurring approximately every five to seven years. These events contribute to reduced quality and availability of already limited surface water resources. The total average rainfall for both islands is estimated at 453 million m3 per year and renewable water resources are estimated at about 52 million m3 per year. There are no perennial rivers in the country, only intermittent aquifers where water flows during part of the year, which then can also be stored in ponds and reservoirs[36].

Watershed and Water Resources

Currently, freshwater demand in Antigua is met by several sources, including i) surface water storage in dams and multiple small ponds with a combined capacity of 6 mm^3; ii) groundwater aquifers; and iii) seawater desalination that provides 75 percent of the national drinking water demand. There are four desalination plants, two surface water treatment plants, and five well fields. During wet seasons, 70 percent of Antigua's daily water supply is obtained through the desalination of seawater. This amount increases to nearly 100 percent during dry seasons[37]. However, while Antigua has access to seawater desalination for its supply of fresh water, the Barbuda population relies heavily on shallow groundwater aquifers that underlie 650 hectares of sand in the Palmetto Point Area.

A total of 13 watershed groups have been identified in Antigua, covering over 11,572 hectares of land. Six of these watersheds are recognized as critical based on their agro and socio-economic values (Body Pond, Potworks, Fitches Creek, Parham, Christian Valley). These six watersheds account for 41 percent of the land area in Antigua. They sustain 50 percent of the forests and 90 percent of crops while accounting for 90 percent of surface, and 80 percent of groundwater supplies [38] . Households also employ rainwater harvesting systems (e.g. cisterns, tanks, etc.) to deal with the issue of water storage.

Threats to Terrestrial Resources

Watersheds on the islands, which tend to be small and close to the coast, feed into shallow aquifers that are vulnerable to saltwater intrusion. Small watersheds, in addition to low amounts of rainfall, are factors which contribute significantly to water insecurity across Antigua and Barbuda[39]. The country's groundwater reserves are extremely vulnerable to saltwater intrusion caused by over-extraction and rising sea levels[40]. The contamination of freshwater aquifers with saltwater can lower the water quality and cause associated boreholes and well-points to become unusable, restricting the available water supply for both drinking and agricultural purposes[41].

[36] http://www.fao.org/3/ca0429en/CA0429EN.pdf
[37] Global Water Partnership Caribbean. 2013. The Post 2015 Water Thematic Consultation: Antigua and Barbuda.
[38] Antigua and Barbuda's First Biennial Report 2020
[39] Government of Antigua and Barbuda. 2015. Third National Communication on Climate Change.
[40] James P. 2001. Antigua and Barbuda Country Paper on National Climate Change Issues. Component 4: Formulation of a Policy Framework for Integrated (Adaptation) Planning and Management, Caribbean Planning for Adaptation to Climate Change.
[41] Alfarrah N & Walraevens K. 2018. Groundwater overexploitation and seawater intrusion in coastal areas of arid and semi-arid regions. *Water*. 10: 143. doi:10.3390/w10020143.

In Barbuda, saltwater intrusion has already contaminated some shallow aquifers close to the coastline[42]. Added to this, sand mining in the Palmetto Point Area threatens Barbuda's main groundwater supply by raising the water table several feet and exposing portions of the aquifer, resulting in evaporation from some portions[43]. The supply of freshwater in Antigua and Barbuda has been further stressed because of the country's population growth and economic development. This has rapidly increased water demand to the point where it currently exceeds the available ground and surface water supply.

Figure 3: Drought hazard mapping in watersheds across Antigua and Barbuda

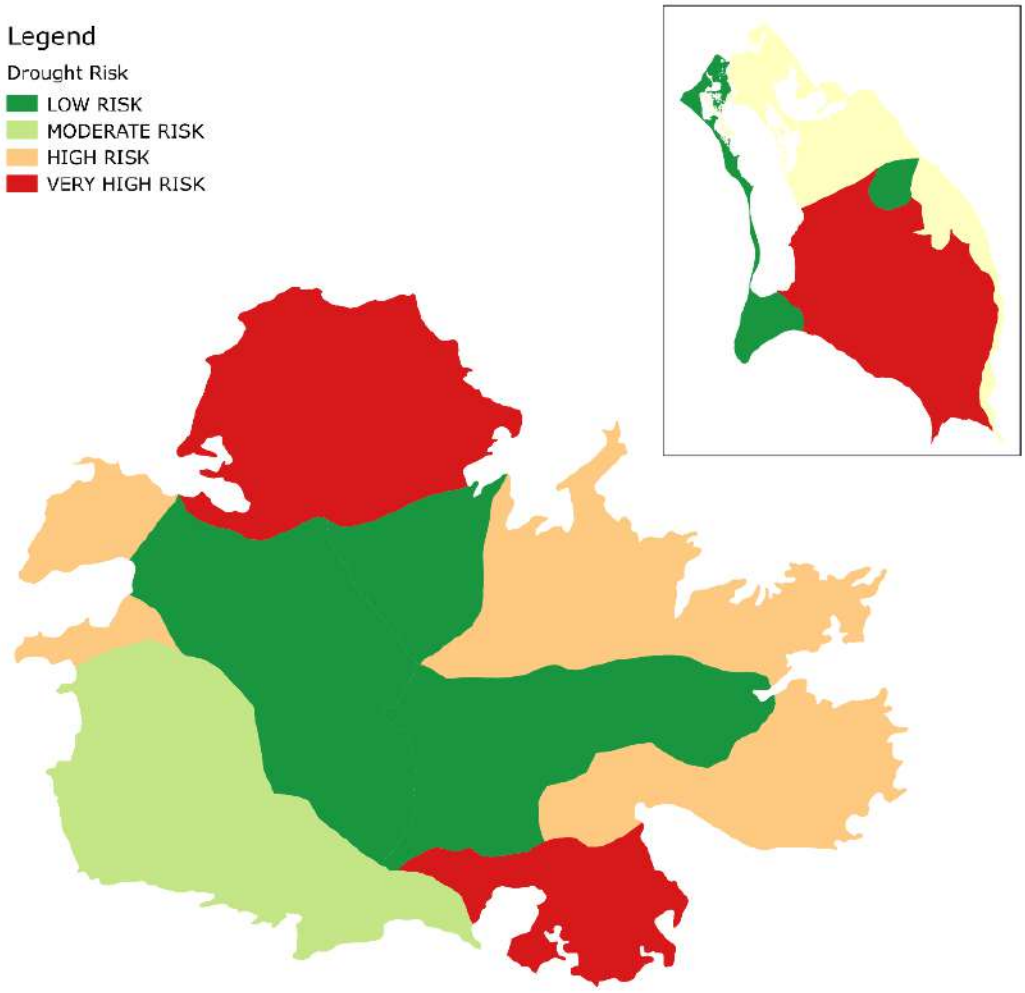


Figure 5 shows a drought risk map of watersheds within Antigua and Barbuda. The analysis takes into account both environmental and land use factors which influence the severity of droughts [44]. On

[42] Union of Concerned Scientists. 2011. "Climate hot map: global warming effects around the world — Antigua and Barbuda". Available at: http://www.climatehotmap.org/global-warming-locations/antigua-and-barbuda.html.

[43] Government of Antigua and Barbuda. 2015. Third National Communication on Climate Change.

[44] Jackson I. 2001. Antigua and Barbuda drought hazard assessment and mapping summary report. Post-Georges Disaster Mitigation Project in Antigua and Barbuda and St. Kitts and Nevis. Available at: http://www.oas.org/pgdm/hazmap/drought/abdrtsum.htm

Antigua, the areas at the highest risk of drought are in the north, east and southeast of the island. The area in the extreme southeast is particularly at risk because of i) low rainfall; ii) shallow soils; iii) exposed soils vulnerable to drying and crusting which leads to erosion and reduced infiltration; and iv) overgrazing from a large population of goats. On Barbuda, the flat lands surrounding and to the south of the western town of Codrington are at the greatest risk of droughts.

Land Use Changes

Insufficient land use planning and management have resulted in the degradation of the environment and ecosystem functioning, threatening the ecosystem services upon which the country's economic activities depend. Vast areas of watersheds have been cleared of native forest vegetation and large regions of productive agricultural land have been lost to urban expansion, while unsustainable agricultural practices such as overgrazing, land clearing, uncontrolled fires and over-application of agro-chemicals have further reduced land productivity. Residential and tourism development in the coastal zone is negatively affecting coastal ecosystems, with invasive alien species and limited management capacity further threatening terrestrial protected areas[45]. Consequently, land degradation and loss of ecosystem services have reduced the capacity of the country's natural resources to sustain livelihoods and provide basic needs such as food security and water resources to local communities. Increases in the frequency and intensity of extreme climate events — including tropical storms, hurricanes, droughts and extended dry periods, floods and rising air temperatures — are exacerbating the effects and impacts of deteriorating ecosystem functioning on vulnerable communities and the environment[46].

SOCIO-ECONOMIC PROFILE

Population

Antigua and Barbuda gained independence from British rule in 1981 and now forms part of the British Commonwealth of Nations[47]. In 2018, the country's population growth rate was 0.9 percent[48], the population density was 232 people/km^2 and the total number of inhabitants was 96,300[49]. More than 60 percent of this population lives within the coastal zone of the two islands[50]. Antigua holds most of the country's inhabitants, where the capital city of St John's alone is home to 25,000 people[51]. In contrast, the number of permanent residents on Barbuda is only 1,600[52]. This number has decreased from 1,800 in 2017 after the extensive damage caused by Hurricane Irma resulted in the

[45] Action Plan for Implementing the Program of Work on Protected Areas of the Convention on Biological Diversity. 2012. Submitted to the Secretariat of the Convention on Biological Diversity. Available at: https://www.cbd.int/doc/world/ag/ag-nbsap-powpa-en.pdf.

[46] Antigua and Barbuda. 2015. Third National Communication on Climate Change.

[47] Nationally Determined Contribution (NDC). 2015. Government of Antigua and Barbuda.

[48] https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=AG

[49] United Nations. World Population Prospects. Available at: https://population.un.org/wpp/DataQuery/.

[50] United Nations Statistics Division. 2017. UN Data: Antigua and Barbuda. Available at: http://data.un.org/CountryProfile.aspx?crName=antigua%20and%20barbuda.

[51] City Population. 2016. Antigua and Barbuda: Parishes. Available at: https://www.citypopulation.de/Antigua.html.

[52] Government of Antigua and Barbuda. 2011. Population and Housing census.

evacuation of all inhabitants from Barbuda to Antigua[53].

Human Development

The United Nations Development Program (UNDP) ranks Antigua and Barbuda 70th out of 189 countries with a score of 0.780 on its 2017 Human Development Index (HDI). This represents an increase of 0.5 percent over the last decade from 0.766 in 2005 to 0.780 in 2017, indicating an improvement in overall human development[54]. This is primarily due to the following changes between those years: life expectancy by 5.4 years, average years of schooling by 2.2 years, and expected years of schooling by 0.8 years (about 9 and a half months).

Antigua and Barbuda is considered above average within the category of "High Human Development" and its 2017 rank gives the country the highest HDI rank within the Organization of Eastern Caribbean States (OECS).

Table 1: Population, Socio-economic and Vulnerability Indicators - Antigua and Barbuda

Indicator		Value	Year
Population	Total population	~96,300 people	2018
	Population growth (per 1,000 population)	~1%	2018
	Age dependency ratio — elderly	~10%	2018
	Age dependency ratio — youth and children	~34%	2018
	Percentage of population with access to electricity	~98%	2016
	Total net enrolment in primary education (men and women)	~88%	2017
	Mean years of schooling (of adults)	~9 years	2017
Five-year indicators	Life expectancy at birth	~76 years	2017
	Average annual rate of population change	~1%	2018
	Crude death rate	~6 deaths per 1,000 population	2017
	Infant mortality rate	0.54%	2017
	Under-five mortality	~12 deaths per year	2017
	Deaths by major area, region and country for 1950–2010	~3,000 deaths	2015
Economy	Gross Domestic Product (GDP) per capita; PPP	~US$ 21,000	2014
	Gross National Income (GNI) per capita; PPP	~US$ 25,160	2018
	Inflation; consumer prices	~2%	2017
Capacity	Roads; total network	~1,160 km	2002
Vulnerability	Proportion of the population using improved drinking water sources	~98%	2015
	Global Needs Assessment (GNA) Crisis Index	0	2012
	GNA Vulnerability Index	1	2012

[53] The Guardian. 2017. The night Barbuda died: how Hurricane Irma created a Caribbean ghost town. Available at: https://www.theguardian.com/global-development/2017/nov/20/the-night-barbuda-died-how-hurricane-irma-created-a-caribbean-ghost-town.

[54] UNDP. 2018. Human Development Indices and Indicators: 2018 Statistical Update — Antigua and Barbuda. Available at: http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/ATG.pdf.

Indicator		Value	Year
	Proportion of the population using improved sanitation facilities	~91%	2011
	Per capita food supply	~2,417 kcal capita^{-1} day^{-1}	2013

Source: World Bank, Our World in Data, United Nations, Humanitarian Data Exchange

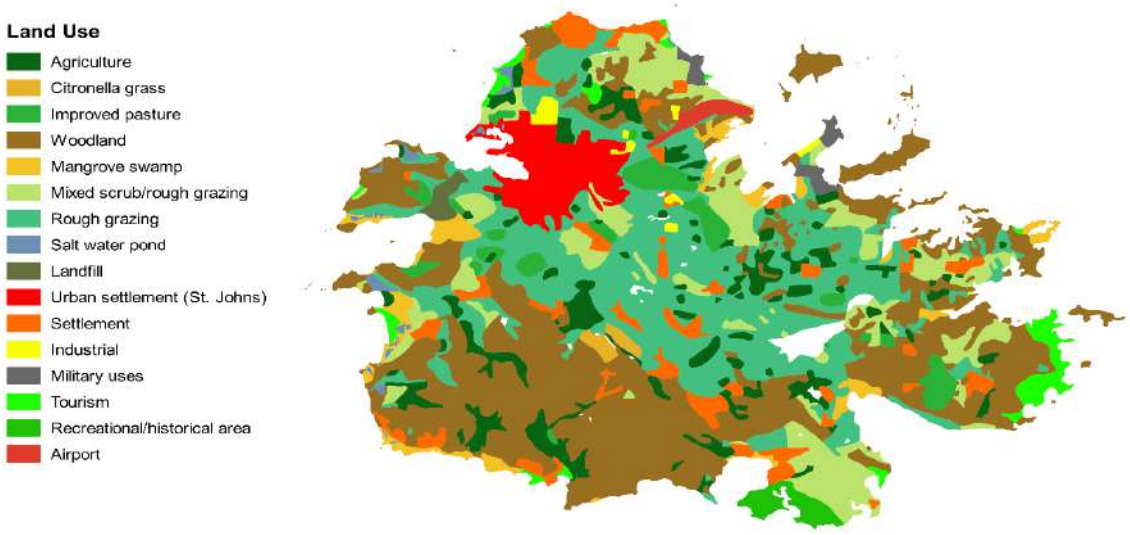
Poverty

Antigua and Barbuda, along with seven other Caribbean SIDS[55], is a high-income country because its GNI per capita is larger than US$12,376 (Table 1 above). However, despite the country's high per capita income, approximately 18 percent of the total population falls below the poverty line[56] and 14 percent is unemployed according to the World Bank. When considering the proportion of the population that is at risk of falling into poverty if there is an economic shock like an extreme weather event, the percentage rises to 28 percent. St John's is considered the poorest of the country's districts, with 22 percent of the city's urban population falling below the poverty line[57].

Economy

Historically, Antigua and Barbuda relied on an agricultural economy based on the production of sugar. However, the economy is now services-based, with the Caribbean Development Bank (CDB) estimating that tourism contributes nearly 60 percent of the Gross Domestic Product (GDP), 40 percent of investment; and employment for 70 percent of the population. Nearly one million tourists visit the country each year and, as a result, the economy is largely reliant on the influx of foreign exchange. In 2018, the World Bank reported Antigua and Barbuda's GDP growth (annual percent) at 7.389 percent. This was a significant increase from a GDP growth of 3.146 percent in 2017, which was because of devastating hurricanes in the region.

Figure 4: Map indicating land use on Antigua



[55] Including Aruba, the Bahamas, Barbados, British Virgin Islands, Puerto Rico, Saint Kitts and Nevis and Trinidad and Tobago.

[56] The poverty line is a monetary measure of the minimum amount of money a household would need to spend to meet its minimum food and non-food requirements. In Antigua and Barbuda, the poverty line is US$2,366 per annum, or an average of US$6.57 per day.

[57] Antigua and Barbuda Third National Communication on Climate Change 2015.

Tourism

Antigua and Barbuda's dependency on tourism has led the country to be sensitive to changes in the global economy. For example, in 2009, the country was severely affected by the global economic crisis, which resulted in a steep decline in tourism from 2009–2011. As a result, there was a considerable decrease in GDP from US$1.36 billion in 2008 to US$1.14 billion in 2011[58], reaching a low GDP growth rate of -12.04 percent in 2009[59]. More recently, the COVID-19 pandemic devasted global tourism, with Antigua and Barbuda recording a -17.5% decline in real GDP, largely because of shuttering of the tourism industry and the cessation of commercial flights, as the disease spread across the world[60].

Agriculture

Besides tourism, other prominent economic sectors are agriculture and industry, which contributed 2 percent and 21 percent respectively to the national GDP in 2017[61]. The greatest contributor to the agricultural sector is from fisheries exports, particularly on Barbuda. Other agricultural products include sugar and its by-products, cotton, livestock as well as various fruits and vegetables[62]. Figure 6 shows land used on Antigua for agriculture, as well as other economic sectors.

Potential negative impacts on agriculture include lowering of agricultural yields and worsening of already difficult working conditions for laborers through exposure to high temperatures and extreme climate events [63] . More frequent high-intensity hurricanes can directly contribute to agricultural losses through crop damage — particularly tree crops — and flooding [64] . Similarly, the fisheries sector is dependent on the health of ecosystems such as coral reefs, seagrasses and mangroves, all of which could be weakened by increasingly frequent Category 4 and 5 hurricanes, as well as rising temperatures and sea-levels related to climate change[65].

The agricultural sector is hampered by limited surface water supply related to droughts, damage by hurricanes and labour shortages resulting from higher wage opportunities presented by tourism and construction [66] . However, the Government's 2019 Business Plan details the ongoing strategies in place to improve the role of the agricultural sector, such as providing staff members of the veterinary and husbandry division with the opportunity to acquire agriculture techniques in livestock and farming in China, an offering provided by the Chinese Government to the technicians.

Financial Sector

Antigua and Barbuda's local sector is made up of approximately 60 institutions that include banks, credit unions, insurance companies, pension funds, and any other firm whose

[58] Trading Economics — Antigua and Barbuda GDP. Available at: https://tradingeconomics.com/antigua-and-barbuda/gdp
[59] The World Bank. 2017. Data: Antigua and Barbuda GDP growth (annual %). Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=AG&view=chart
[60] https://www.imf.org/external/datamapper/profile/ATG.
[61] Antigua and Barbuda economy — overview. Available at: https://www.indexmundi.com/antigua_and_barbuda/economy_overview.html.
[62] Government of Antigua and Barbuda. 2015. Third National Communication on Climate Change.
[63] International Labour Organization. 2014. Climate change and employment: challenges and opportunities in the Caribbean.
[64] UN Economic Commission for Latin America and the Caribbean. 2011. Caribbean Development Report Volume III: The economics of climate change in the Caribbean.
[65] International Labour Organization. 2014. Climate change and employment: challenges and opportunities in the Caribbean.
[66] Government of Antigua and Barbuda. 2015. Third National Communication on Climate Change.

operations involve financial intermediation. Furthermore, there are significant offshore financial services, through which the country domiciles over 4,200 companies. The country enjoys a relatively stable currency as a member of the Eastern Caribbean Currency Union (ECCU), regulated by the Eastern Caribbean Central Bank. [67] The value of the Eastern Caribbean dollar remains at an exchange rate of EC$ 2.7 to US$1.00. However, there have been challenges and constraints on the economy of the nation and its growth projections due to recent regional climate impacts and growing regional and international competition.

Manufacturing

The GDP statistics from the World Bank showed that manufacturing within Antigua and Barbuda is declining, as the sector contributed 2.45 percent to the national GDP in 2018, a decrease from 2.49 percent in 2017. This occurs because most of the raw materials for manufacturing must be imported. However, paints, furniture, household fittings and garments are still manufactured along with soft drinks, water, rum, and a nascent cottage agro-processing sub sector.[68]

GHG Emissions

Like many SIDS, Antigua and Barbuda has limited natural resources, including a lack of indigenous fossil fuels resources. As a consequence, the country remains heavily dependent on the importation of petroleum-based fuels as its energy source, specifically for heavy fuel oil in electricity generation; gasoline and diesel in transport; and liquefied petroleum gas (LPG) for cooking. This use of fossil fuels leads to high fuel costs and an increase in Greenhouse Gas (GHG) emissions that contribute to climate change, albeit negligibly. In 2018, Antigua and Barbuda ratified its commitment to the 2015 Paris Agreement which requires countries to play their part in achieving the objective of the agreement of limiting the global temperature increase to well below 2°C[69]. As such, the country seeks to reduce its dependence on fossil fuels for energy production and transportation, with the intention of accomplishing a number of targets, including the 85 percent transition to renewable energy in the energy and transport sectors by 2030 and 2040 respectively.

Energy

In 2015, Antigua and Barbuda's national emissions totaled 844.3 Gg CO2, of which 77 percent were derived from fuel combustion in the energy sector[70] and gasoline, which are used for generating electricity and transportation. Vehicular and aviation import averages 4,500 barrels a day, and in 2015, the estimated value of imported oil was US$160.1 million. In Antigua, the Antigua Public Utilities Authority (APUA), a government-owned agency, is responsible for the generation and transmission of the Wadadli Power Plant. The Antigua Power Company (APC), a privately-owned independent power producer which has two fossil fuel (Heavy Fuel Oil (HFO) and diesel) power plants, supplies approximately 60 percent of the electricity that APUA delivers under a Power Purchase Agreement (PPA) that runs until 2031[71].

While there is considerable scope for the use of solar and wind power for renewable energy,

[67] Antigua and Barbuda's First Biennial Report
[68] (2015) Antigua and Barbuda's 2015-2020 National Action Plan: Combatting Desertification, Land Degradation & Drought
[69] Guidance Note on the Just Transition of the Workforce
[70] A&B's National GHG Inventory Report 2015
[71] (2020) Antigua and Barbuda's First Biennial Update Report

several barriers to implementing these energy alternatives exist. These include: i) the relatively high costs as well as perceived risks of renewable energy and energy--efficient technologies; ii) insufficient access to affordable financing to implement these systems; and iii) low levels of awareness and understanding of the benefits, costs, and applications of renewable energy/energy efficient technologies. Assessments and action plans are therefore required to provide a framework for future action and development of necessary renewable energy infrastructure that is also climate-proof.

Despite these barriers, progress has been made in developing renewable energy resources. The country's achievements include: The successful installation of several 1-megawatt – 4-megawatt solar photovoltaic power plants, 4.1-mega-watt wind turbines (15 units, 275 kW each) under installment and 2-megawatt of customer owned grid-interactive solar PV in multiple locations. We have also seen the technical application of solar water heating and solar photovoltaic systems by private citizens in their homes and businesses using private installers, and through the Department of Environment's Call for Applications for the installation of renewable energy systems at schools under the DOE's *Grid-Interactive Solar PV Systems for Schools and Clinics in Antigua* (GISS) project.

Resilience and Energy Security

In 2018, during a public address post-Hurricane Irma, Minister Nicholas stated that a 1,000-cable installation of renewable energy that commenced in Barbuda was blown away during the storm. He added that it was the government's intent to ensure "Barbuda's energy consumption comes entirely from renewable resources to include wind, solar and thermal energy"[72] within the next five years. This intention highlighted by the Minister accompanies the government's commitment to establishing an 85 percent fossil fuels phase down through the implementation of projects and programs focused on reducing the country's GHG emissions in the electricity and transportation sector. In 2015, the country submitted its Intended Nationally Determined Contribution (INDC) to United Nations Framework Convention on Climate Change. The 2020 updated INDC (NDC) is currently considering these updated targets:

- *Produce 95 percent of electricity supply using renewable energy by 2031*
- *Use 95 percent renewable energy in the transportation sector by 2040*
- *Issue national standards for appliances, buildings and renewable energy equipment that ensure only energy efficient;*
- *Establish government financial, tax and other policies and regulatory pathways that support the transition to renewable energy;*
- *By 2030, Save US$80 million per annual and recoup;*
- *Change Tax Structures on gasoline by 2022;*
- *Training of 50 percent of the workforce to support the change; and*
    - *50 percent of households (particularly female headed households have backup energy systems for hurricane preparedness.*

[72] https://antiguaobserver.com/work-on-bethesda-solar-energy-plant-to-resume/

Waste

The Ministry of Health, Wellness and the Environment often contributes to the management of waste as it is an imminent health risk. This contribution has been showcased through the implementation of the plastic bag and polystyrene (Styrofoam) bans[73] in 2015 and 2017 respectively, which resulted in a significant reduction in pollution. The Government has also implemented the National Solid Waste Management Act 1995 (amended in 2005) which provides for the effective storage, collection, transport, treatment, and handling of all solid waste generated within Antigua and Barbuda. The Act established the National Solid Waste Management Authority (NSWMA), which: i) provides storage and handling facilities for solid waste; ii) converts existing and develops new landfill sites; iii) promotes recycling; iv) prepares solid waste management plans; and v) manages the OECS Waste Management Project.

In the Authority's operational procedures, the methods of disposal are outlined and are dependent on each type of waste collected: household, industrial, commercial, institutional, medical, clean bulk, bulk waste, cruise ship, street sweep, sewage and tire waste. NSWMA often collaborates with the Department of Environment (DOE), Development Control Authority (DCA), Antigua & Barbuda Public Utilities Authority (APUA), as well as other key stakeholders to assist in an advisory capacity. Based on a recent annual waste receipt communicated to the DOE, bulk waste accounts for the highest proportion of the total waste collected followed by household waste during the period January to February. Other waste types include clean bulk, waste from the industrial and commercial sectors, institutional waste, cruise ship waste, sewage, tires and street sweep.

The financial resources of the authority are quite limited thus Antigua and Barbuda is feeling the pressure of increased waste generation on its main facility at Cook's Sanitary Landfill, which is currently not at the highest standard. There is no system in place that facilitates separation among waste types, and it is the hope of the Government of Antigua and Barbuda to build the capacity of the NSWMA through national and international funding to facilitate an improved waste management system. The Country is working towards a circular economy approach to manage wastes as well as to reduce methane emissions. Under Antigua and Barbuda's Nationally Determined Contribution (NDC) targets, technical studies are currently in development with the intention of exploring the feasibility of constructing and operationalizing a waste-to-energy (WTE) plant by 2025.

[73] The External Trade (Shopping Plastic Bags Prohibition) Order, 2017, No. 83 and The External Trade (Expanded Polystyrene) (Prohibition) Order, 2018, No. 44 respectively

NATIONAL DEVELOPMENT PRIORITIES AND CLIMATE CHANGE

The Government of Antigua and Barbuda has developed several strategies and actions to address the impacts of climate change and to increase the country's sustainability and growth.

Antigua and Barbuda Nationally Determined Contribution (2021)

Antigua and Barbuda's Nationally Determined Contribution (NDC), submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015 and then updated in 2021. The NDC outlines the country's commitments to GHG mitigation (Article 2)

and adaptation (Article 4), in response to climate change and the effects on Antigua and Barbuda. Through the NDC, adaptation and mitigation targets are put forward with some being conditional on international support. The NDC's conditional adaptation target relevant to the proposed project is the increased resilience of buildings to extreme climate events. Unconditional targets that the country have committed to include enhancing the enabling legal, policy and institutional environment for a low carbon development pathway, as well as updating of the Building Code to address the projected impacts of climate change.

The cost of implementing adaptation targets has been estimated at ~US$30 million annually until 2030, while the cost of mitigation targets has been estimated at ~US$60 million annually[74]. Given the limited financial capacity of Antigua and Barbuda, meeting the targets specified in the NDC is contingent upon receiving external support through *inter alia* the GCF, GEF and the Adaptation Fund. Interventions under the proposed project are aligned with the following conditional adaptation target of the Antigua and Barbuda NDC to *"improve and prepare all buildings for resilience to extreme climate events"*. In addition, proposed project activities are aligned with two unconditional targets, namely to:

i. *"Enhance the established enabling legal, policy and institutional environment for low carbon emission development pathway to achieve poverty reduction and sustainable development"*; and
ii. *"Update the Building Code to meet the predicted impacts of climate change"*.

Third National Communication to UNFCCC

Antigua and Barbuda submitted its Third National Communication (TNC) to the UNFCCC in 2015. It outlines the country's commitments to addressing the impacts of climate change in the country and provides details on *inter alia*: i) the socio-economic and environmental situation in the country; ii) emissions statistics and mitigation targets; and iii) vulnerability, impacts of climate change and proposed adaptation measures. In addition, Antigua and Barbuda's TNC[75] identifies two major benefits associated with the early implementation of climate change adaptation measures: firstly, early action in response to climate change contributes significantly to

[74] Government of Antigua and Barbuda. Nationally Determined Contribution. 2015

[75] Antigua and Barbuda. 1993.Third National Communication on Climate Change to the United Nations Framework Convention on Climate Change (UNFCCC).

improving livelihood security and saving lives during and following extreme events; and secondly, a proactive approach in responding to climate change leads to considerable economic savings as both public and private sector services and businesses are able to prepare for, and recover from, an extreme event more rapidly than they would in the absence of effective adaptation measures. For example, preparation for flooding can decrease the damage to infrastructure and reduce the costs associate with recovery and reconstruction. Climate change adaptation priorities outlined in the TNC include:

i) improving the efficiency of water resource management;
ii) increasing resilience of natural environments through ecosystems-based adaptation (EbA); and
iii) updating the Building Code to increase the resilience of buildings to climate change impacts.

Government of Antigua and Barbuda Medium Term Development Strategy 2016–2022

The Medium-Term- Development Strategy (MTDS) outlines the strategies and actions to be undertaken from 2016–2020 to meet the national goal of becoming a developed country in 15–20 years. Within the MTDS, seven Flagship Priorities are emphasized, with two of these directly relating to improved buildings and infrastructure. The proposed project aligns with Flagship Priority One, which focuses on *inter alia* the renewal and maintenance of critical infrastructure. These Flagship Priorities have been designed to contribute directly towards achieving a Necessary Condition for attaining the Sustainable Development Goals (SDGs), namely through building the resilience of the country to climate change.

Antigua and Barbuda Country Document for Disaster Risk Reduction (2016)

The Country Document for Disaster Risk Reduction (DRR) is an analysis of the status of DRR in Antigua and Barbuda[76]. The document details strategies for the comprehensive national management of risk, with environmental protection and safeguarding human lives as the primary objectives. It was prepared in accordance with the Sendai Framework, which recognizes the role of the State as the primary entity responsible for the reduction of risk, but with comprehensive involvement of other stakeholders — including local governments and the private sector. The four primary objectives outlined by the Framework are: i) understanding disaster risk; ii) improving disaster risk management by strengthening disaster risk governance; iii) investing in DDR for increased resilience; and iv) enhancing preparedness for effective disaster response and recovery.

Sustainable Island Resource Management Zoning Plan 2012

The Sustainable Island Resource Management Zoning Plan 2012 (SIRMZP) is a strategic national spatial development framework designed to address current challenges surrounding development in Antigua and Barbuda. Specifically, this framework provides guidance on how private- and public-sector developments should be undertaken in accordance with- national policies during a 20-year period. In addition, the SIRMZP serves as

[76] NODS. 2016. Country document for disaster risk reduction: Antigua and Barbuda, 2016. Available at: http://dipecholac.net/docs/country-doc-antigua-and-barbuda.pdf

a revised National Physical Development Plan (NPDP), which meets the criteria of the Physical Planning Act[77]. The SIRZMP has the following functions, namely to: i) provide protection and sustainable management of ecosystems and associated ecosystem services; ii) promote the development of a cohesive mixed-use settlement network to offer housing options to households with centres; iv) outline proposals to improve the configuration and efficiency of road infrastructure; v) specify regulations and frameworks to guide development in line with national policy; and vi) provide a framework for the preparation of detailed plans which are aligned with national land use priorities. Moreover, the use of GIS for the application and modification of the plan allows zones to be identified on existing maps to reveal social, economic- and biophysical patterns, which can be used to inform development plans.

[77] Government of Antigua and Barbuda. Physical Planning Act. No. 6 of 2003.

CHAPTER 2

NATIONAL INVENTORY OF GREENHOUSE GASES FOR ANTIGUA AND BARBUDA

The preparation of a national Green House Gas (GHG) inventory is an integral part of the National Communication Report. The GHG inventory provides a key assessment of Antigua and Barbuda's efforts during the inventory years with respect to the level of GHG emissions, as well as to gauge the success of its adaptation and mitigation policies and programs by comparing present emissions with that of previous GHG inventories. As a non-Annex 1 party, Antigua and Barbuda has submitted three previous National Circumstances, to correspond with the inventory years 1990, 2000 and 2006 respectively. Additionally, the country submitted a Biennial Update Report which included a GHG inventory for the year 2015. This 4NC presents the GHG inventory for inventory years 2016-2019 by assessing activities within the Energy, Industrial Processes and Products Use, Agriculture, Forestry and Other Land Use, and Waste sectors.

The importation of fossil fuels predominantly powers the electricity and transportation demands, in Antigua and Barbuda, even though in recent years, solar generated electricity has been making significant strides.

The Industrial Processes and Products Use sector is very small and the main sources of emissions for this sector come from zinc production. The AFOLU sector is sub-divided into Agriculture, and Forestry and Other Land Use sectors. The main source of emissions within the Agricultural Subsector are due to enteric fermentation and manure management. Given the relatively small population of ruminants as well as the employment of traditional manure management practices, emissions from this sector remains minimal. In addition, Antigua and Barbuda continues to lose forest cover over the centuries, as the need for development has led to clearing of arable lands. The use of aerial imagery and other technologies over the last decade, has strengthened the country's ability to monitor and assess activities within this sector with greater efficiency. This has led to significant increases in reporting within this subsector. For this inventory, the Collect Earth tool was used to analyze Google Earth satellite imagery. Improvements in methodologies within the Waste Sector has led to better quality of data collection, especially in the areas of methane emissions from solid waste disposal sites.

Table 2.1: Summary of GHG emissions by Year (in Gg)

Emissions	2016	2017	2018	2019
Carbon Dioxide (CO_2)	587.165	582.554	599.414	644.610
Non Carbon Emission				
Methane (CH_4)	4.507	4.636	4.730	4.717
Nitrous Oxide (N_2O)	0.050	0.057	0.057	0.058
Non-methane volatile organic compounds (NMVOC)	0.063927	0.0612	0.0613	0.0604
Hydrofluorocarbons (HFC)	0	0	0.00174	0.066

Table 2.2: Summary of GHG emissions by Year (Gigatonnes)

Emissions	2016	2017	2018	2019
Carbon Dioxide (CO_2)	0.0005872	0.0005826	0.0005994	0.0006446
Non Carbon Emission				
Methane (CH_4)	0.000004507	0.000004636	0.000004730	0.000004717
Nitrous Oxide (N_2O)	.000000050	0.000000057	0.000000057	0.000000058
Non-methane volatile organic compounds (NMVOC)	0.0000000639	0.0000000612	0.0000000613	0.0000000604
Hydrofluorocarbons (HFC)	0.00	0.00	0.0000000017	0.000000066

Table 2.3: Summary of GHG emissions by sector in CO_2 Eq (in Gg)

Sectors	2016	2017	2018	2019
Energy	591.273	586.224	603.072	644.867
Industrial Processes and Product Use	3.386	3.5997	3.7307	2.878
Agriculture[78]	13.232	13.347	12.928	12.893
Forestry and Other Land Use	0	0	0	3.898
Waste	89.301	94.522	96.690	96.964
TOTAL	**697.20**	**697.692**	**716.422**	**761.502**

Table 2.4: Summary of GHG emissions by sector in CO_2 Eq (Gigatonnes)

Sectors	2016	2017	2018	2019
Energy	0.0005913	0.0005862	0.0006031	0.0006449
Industrial Processes and Product Use	0.000003386	0.0000035997	0.00000373	0.00000288
Agriculture[79]	0.00001323	0.00001335	0.00001293	0.00001289
Forestry and Other Land Use	0.00	0.00	0.00	0.000003898
Waste	0.00008930	0.00009452	0.00009669	0.00009696
TOTAL	**0.0006972**	**0.00069769**	**0.00071642**	**0.00076150**

[78] Inclusive of categories 3A – Livestock and 3C – Aggregate sources and non-CO2 emissions sources on land

[79] Inclusive of categories 3A – Livestock and 3C – Aggregate sources and non-CO2 emissions sources on land

Note – there was not enough information to determine the 100-year GWP of the HFCs and NMVOC; they are therefore excluded from these totals.

The uncertainty values for the individual inventory years are presented below:

- 2016: 5.1 percent
- 2017: 5.2 percent
- 2018: 5.3 percent
- 2018: 6.4 percent

The report provides a breakdown of the emissions by sector for each inventory year, i.e. 2016-2019. This can be found below in Section 1.0 Introduction.

ENERGY SECTOR

Sector Description

Globally, the energy sector contributes to more than two thirds of total greenhouse gas emissions. [80] Carbon dioxide (CO_2) is the dominant greenhouse gas emitted by energy sector activities, accounting for ~95 percent of GHGs emitted by the sector.[81] Antigua and Barbuda's greenhouse gas emissions in the energy sector are the result of combustion of secondary fossil fuels for energy production, transportation by air and road, and residential cooking. All fossil fuel products in Antigua & Barbuda are imported and sold by the West Indies Oil Company (WIOC) Ltd. As the sole supplier, WIOC provided import and sales data for all fossil fuel products over the inventory period. As there are no active refinery processes in Antigua and Barbuda, fugitive emissions from primary and secondary fossil fuel production are not considered in this inventory.

This greenhouse gas emissions estimate applied both the *2006 IPCC Guidelines*' Tier 1 Sectoral Approach and the Reference Approach. Estimated emissions were calculated using the IPCC Inventory Software[82] and IPCC Microsoft Excel Worksheets. [83] Sector categories contributing emissions in this inventory are energy industries, 1.A.1, transportation *(civil aviation 1.A.3.a[84] and road transportation 1.A.3.b)*, and other sectors/residential, 1.A.4.

Methodology

Data for the energy sector activities were provided by the following:

- West Indies Oil Company (WIOC) provided information on the import and sale quantities of gasoline, diesel, ultra-low Sulphur diesel (ULSD), fuel oil, jet kerosene and liquefied petroleum gas (LPG) for the inventory years.
- West Indies Oil Company provides fuel to all the Marinas, all Gas Stations and the Airport but has indicated that they do not have data that is clearly defined for them. Interviewing, some Gas Station managers and Marina managers have shown that data

[80] https://member.ghginstitute.org/ghgcourses/511_IPCC_Energy/HTML5/511e_Lesson1/index.html

[81] IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Chapter 1

[82] https://www.ipcc-nggip.iges.or.jp/software/

[83] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_x_An1_Worksheet.pdf

[84] The results do not appear in the Energy summary reports in the software however, the input data and results appear in the energy worksheets. The results are added to the final inventory results.

of quantities of fuel sold by fuel type annually is not readily available.

- Charcoal production and consumption data are not formally collected in Antigua and Barbuda. Charcoal data in pounds (lbs) for 2019 was collected by the energy sector expert through informal personal communication with Antiguan producers and has been used as an approximation for all four inventory years as no data was available for 2016, 2017 or 2018.
- Default values for emission and conversion factors were taken from the 2006 IPCC Guidelines.

Specific methodology may be found in the Appendix which has been submitted as a separate document.

Emissions Tables

Table 2.5: Energy sector emissions estimate results

	IPCC Software		Excel Worksheet	
Approach	Sectoral	Reference	Sectoral	Reference
2016	CO_2 434.47[85] CH_4 0.071[86] N_2O 0.012[87]	CO_2 565.83	CO_2 584.86 CH_4 0.072 N_2O 0.016	CO_2 565.83
2017[88]	CO_2 437.85 CH_4 0.073 N_2O 0.012	CO_2 582.83	CO_2 579.84 CH_4 0.073 N_2O 0.016	CO_2 582.83
2018[89]	CO_2 450.00 CH_4 0.076 N_2O 0.013	CO_2 585.69	CO_2 596.41 CH_4 0.076 N_2O 0.016	CO_2 585.69
2019[90]	CO_2 480.19 CH_4 0.080 N_2O 0.013	CO_2 607.82	CO_2 637.94 CH_4 0.081 N_2O 0.017	CO_2 607.82

[85] The total is 584.86 however, the energy summary results do not include the results from civil aviation, i.e. 150.39 (434.47 + 150.39 = 584.86)

[86] The total is 0.072 however, the energy summary results do not include the results from civil aviation, i.e. 0.001 (0.071 + 0.001 = 0.072)

[87] The total is 0.016 however, the energy summary results do not include the results from civil aviation, i.e. 0.004 (0.012 + 0.004 = 0.016)

[88] The same applies as with the year 2016, i.e. the results for the CO_2, CH_4 and N_2O in the software does not include the results from civil aviation. However, the results are exactly the same as the results from the excel worksheets.

[89] The same applies as with the year 2016, i.e. the results for the CO_2, CH_4 and N_2O in the software does not include the results from civil aviation. However, the results are exactly the same as the results from the excel worksheets.

[90] The same applies as with the year 2016, i.e. the results for the CO_2, CH_4 and N_2O in the software does not include the results from civil aviation. However, the results are exactly the same as the results from the excel worksheets.

INDUSTRIAL PROCESSES AND PRODUCTS USE

Sector Description

As a Small Island developing State (SIDS), Antigua and Barbuda has few light processing industries as opposed to other industrialized nations. Tourism dominates as the leading economic contributor, while the importation of goods and commodities takes precedence over the manufacture of such. Nonetheless, the few vibrant arms of the IPPU sector which do exist still need to be considered in calculating the emission of greenhouse gases in the nation.

The Fourth National Communication (4NC) aims to track these emissions through the collection and analysis of data based on the 2006 IPCC Guidelines. Data sets were collected for the inventory years from 2016 through to 2019 with the prevailing categories for this sector in the country being identified in processes related to Mineral, Metal, and Food and Beverage Industries, along with the use of Non-Energy Products, Ozone Depleting Substances (ODS) Substitutes and Other Products. These data were collected from stakeholders across varying industries and/or collection agencies which form part of, or monitor these activities.

The Biennial Update Report (BUR) to the UNFCCC served as a backdrop for this ambitious, multi-inventory year undertaking. Stakeholder engagement from this initial exercise and at the start of this present inventory proved to be critical in achieving the necessary cooperation to fulfil inventory data requirements. A similar methodological approach as was used for the BUR was applied to the Antigua and Barbuda's Fourth National Communication (4NC), i.e. the Tier 1 methodology.

An advantageous development the Fourth National Communication presents over its BUR predecessor involves the use of a multiyear inventory, which implicitly allows for the presentation of data that can be used to analyze trends occurring with regards to GHG emissions. The calculation of these emissions was computed with the use of formulas referenced in Volume 3 (IPPU Sector) IPCC 2006, which in turn formed the basis for the creation of tools such as the IPCC inventory software and Excel worksheets for Industrial Processes and Product Use sector. Both tools were employed while estimating sector emissions and the results are enclosed below.

Methodology

- Data on pottery were collected directly from local proprietors in the ceramics and pottery business (Sarah Fuller Pottery, Cedars Pottery, Arawak Art).
- Data for the metal industry were collected from Henderson Ltd.
- The data for lubricants were collected from the National Statistics Division for Antigua and Barbuda.
- The data for paraffin wax was obtained from Customs and Excise through the National Statistics Division.
- Information on Ozone Depleting Substances (ODS) was obtained from

ODS unit within the Ministry of Trade, Industry and Commerce.

- Limited end usage data is recorded at various institutional levels to include schools, hospital, clinics, and businesses.

Specific methodology may be found in the Appendix which has been submitted as a separate document.

Emissions Tables

Table 2.6: Greenhouse Gas Emissions for IPPU Sector 2016 via software tool

Inventory Year: 2016												
Categories	(Gg)			CO2 Equivalents(Gg)				(Gg)				
	CO2	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (1)	Other halogenated gases without CO2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO2
2 - Industrial Processes and Product Use	2.215684	0	0.003777	0	0	0	0	0	0	0	0.06393	0
2.A - Mineral Industry	0.000181	0	0.000000	0	0	0	0	0	0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0.000181	0	0.000000	0	0	0	0	0	0	0	0	0
2.B - Chemical Industry	0.000000	0	0.000000	0	0	0	0	0	0	0	0	0
2.C - Metal Industry	1.733519	0	0.000000	0	0	0	0	0	0	0	0	0
2.C.6 - Zinc Production	1.733519								0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use (6)	0.481984	0	0.000000	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	0.478915								0	0	0	0
2.D.2 - Paraffin Wax Use	0.003069								0	0	0	0
2.E - Electronics Industry	0	0	0.000000	0	0	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0.000000	0	0	0	0	0	0	0	0	0
2.F.1 - Refrigeration and Air Conditioning	0	0	0.000000	0	0	0	0	0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0.003777	0	0	0	0	0	0	0	0	0
2.G.3 - N2O from Product Uses	0	0	0.003777	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0.06393	0
2.H.2 - Food and Beverages Industry	0								0	0	0.06393	0

Note: The table above was exported from the IPCC software, however the cells highlighted in yellow represent the total emissions for the respective categories inclusive of results obtained from the excel spreadsheets. See detailed methodology for more information.

Table 2.7: Greenhouse Gas Emissions for IPPU Sector 2016 via Excel worksheet

Greenhouse Gases	Total in (Gg) from Excel worksheets
CO_2	2.21822
CH_4	0
N_2O	0.00378
HFCs	0
NO_X	0
CO	0
NMVOCs	0.06392727
SO_2	0

Table 2.8: Greenhouse Gas Emissions for IPPU Sector 2017 via Excel worksheet

Greenhouse Gases	Total in (Gg) from Excel worksheets
CO_2	2.49788
CH_4	0
N_2O	0.00344
HFCs	0
NO_X	0
CO	0
NMVOCs	0.0611781816
SO_2	0

Table 2.9: Greenhouse Gas Emissions for IPPU Sector 2017 via software tool

Inventory Year: 2017													
Categories	(Gg)			CO2 Equivalents(Gg)				(Gg)					
	CO2	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (1)	Other halogenated gases without CO2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO2
2 - Industrial Processes and Product Use	2.531942778	0	0.0034445	0	0	0	0	0	0	0	0.061178	0
2.A - Mineral Industry	0.000180545	0	0	0	0	0	0	0	0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0.000180545	0	0	0	0	0	0	0	0	0	0	0
2.B - Chemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal Industry	2.034072	0	0	0	0	0	0	0	0	0	0	0
2.C.6 - Zinc Production	2.034072								0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use (6)	0.497690233	0	0	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	0.490377433								0	0	0	0
2.D.2 - Paraffin Wax Use	0.0073128								0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	0	0	0	0	0	0	0	0	0
2.F.4 - Aerosols				0				0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0.0034445	0	0	0	0	0	0	0	0	0
2.G.3 - N2O from Product Uses	0	0	0.0034445	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0.061178	0
2.H.2 - Food and Beverages Industry									0	0	0.061178	0

Note: The table above was exported from the IPCC software, however the cells highlighted in yellow represent the total emissions for the respective categories inclusive of results obtained from the excel spreadsheets. See detailed methodology for more information.

Table 2.10: Greenhouse Gas Emissions for IPPU Sector 2018 via software tool

Inventory Year: 2018													
Categories	(Gg)			CO2 Equivalents(Gg)				(Gg)					
	CO2	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (1)	Other halogenated gases without CO2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO2
2 - Industrial Processes and Product Use	2.825359148	0	0.0029205	0.00174015	0	0	0	0	0	0	0.061338	0
2.A - Mineral Industry	0.000247348	0	0	0	0	0	0	0	0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0.000247348	0	0	0	0	0	0	0	0	0	0	0
2.B - Chemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal Industry	2.1884076	0	0	0	0	0	0	0	0	0	0	0
2.C.6 - Zinc Production	2.1884076								0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use (6)	0.6367042	0	0	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	0.627751667								0	0	0	0
2.D.2 - Paraffin Wax Use	0.008952533								0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	0.00174015	0	0	0	0	0	0	0	0
2.F.4 - Aerosols				0.00174015				0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0.0029205	0	0	0	0	0	0	0	0	0
2.G.3 - N2O from Product Uses	0	0	0.0029205	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0.061338	0
2.H.2 - Food and Beverages Industry									0	0	0.061338	0

Note: The table above was exported from the IPCC software, however the cells highlighted in yellow represent the total emissions for the respective categories inclusive of results obtained from the excel spreadsheets. See detailed methodology for more information.

Table 2.11: Greenhouse Gas Emissions for IPPU Sector 2018 via Excel worksheet

Greenhouse Gases	Total in (Gg) from Excel worksheets
CO_2	2.826901
CH_4	0
N_2O	0.00292
HFCs	0.001740
NO_X	0
CO	0
NMVOCs	0.0613381816
SO_2	0

Table 2.12: Greenhouse Gas Emissions for IPPU Sector 2019 via Excel worksheet

Greenhouse Gases	Total in (Gg) from Excel worksheets
CO_2	1.992620
CH_4	0
N_2O	0.00292
HFCs	0.006587
NO_X	0
CO	0
NMVOCs	0.0603563632
SO_2	0

Table 2.13: Greenhouse Gas Emissions for IPPU Sector 2019 via software tool

Inventory Year: 2019												
Categories	(Gg)			CO2 Equivalents(Gg)				(Gg)				
	CO2	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (1)	Other halogenated gases without CO2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO2
2 - Industrial Processes and Product Use	1.987745948	0	0.002871	0.0065876	0	0	0	0	0	0	0.060356	0
2.A - Mineral Industry	0.000247348	0	0	0	0	0	0	0	0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0.000247348	0	0	0	0	0	0	0	0	0	0	0
2.B - Chemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal Industry	1.4150784	0	0	0	0	0	0	0	0	0	0	0
2.C.6 - Zinc Production	1.4150784								0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use (6)	0.5724202	0	0	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	0.567745933								0	0	0	0
2.D.2 - Paraffin Wax Use	0.004674267								0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	0.0065876	0	0	0	0	0	0	0	0
2.F.4 - Aerosols				0.0065876				0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0.002871	0	0	0	0	0	0	0	0	0
2.G.3 - N2O from Product Uses	0	0	0.002871	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0.060356	0
2.H.2 - Food and Beverages Industry									0	0	0.060356	0

Note: The table above was exported from the IPCC software, however the cells highlighted in yellow represent the total emissions for the respective categories inclusive of results obtained from the excel spreadsheets. See detailed methodology for more information.

AGRICULTURE SECTOR

Sector Description

Antigua and Barbuda has been an agrarian society for centuries, consisting almost exclusively of sugar cane cultivation. By 1981, when the country became an independent twin Island nation, its reliance on sugar cane was abrogated, with tourism becoming the main industry driving the economy. Although cotton farming and animal husbandry were explored as a means of diversifying the economy, these remain small sectors. The agricultural sector consists mainly of livestock production and some fruit and vegetable production. There are some large farms across Antigua and Barbuda of several acres, and lands continue to be allocated to encourage development of this sector. Specific programs have also focused on developing backyard gardening as a means of promoting a healthy lifestyle and greater food security.

The main GHG focus of this 4th NC is methane, direct and indirect nitrous oxide, and carbon dioxide. As it relates to livestock, methane is the predominant GHG that is emitted. Ruminants, especially cattle, given their size, have high methane emissions due to their high enteric fermentation rates. Carbon dioxide emissions from livestock were considered negligible. Livestock manure produces emissions for two GHGs, namely methane and direct and indirect nitrous oxide. Methane emissions from livestock manure are small and depend on the type of livestock as well as the manure management system that is employed. The manure management system that is used in Antigua and Barbuda is still traditional. For large ruminants and livestock, manure is left in the open field to decompose. This is then utilized as fertilizer for fruits and vegetables. With technology, this manure management system is supplemented with the use of industrial fertilizers.

In the case of poultry and swine (pigs), the animals are mainly confined and intensely reared and this leads to a different manure management system. Here, housing quarters and paddocks/pens are regularly cleaned and flushed, and the liquid and solid manure are gathered and placed into pits and left open to dry. Farmers reuse the manure as a form of mulching and composting. This traditional form of manure management is widespread. However, given the small size of Antigua and Barbuda, as well as the animal population for each farmer, the manure management system is still practiced on a small scale. Even further, the quantity of manure deposited, is comparatively less than that of the larger ruminant given the size of the animals. In some cases, quicklime (calcium oxide and calcium hydroxide) is sprinkled over the manure to accelerate the decomposition process and eliminate odor however there is insufficient data to quantify emission from this approach. Carbon dioxide, methane, direct and indirect nitrous oxide emissions are also generated from agricultural soils. Liming is the process of applying calcium carbonate and magnesium carbonate to the soil to increase the pH of the soil, thereby reducing its acidity. It is used on a very small scale in Antigua and Barbuda and as a result the data is insufficient to quantify an emission for GHG gasses. In recent years, the increase in importation and use of natural and artificial fertilizers, which are high concentrations in urea, have led to meaningful and measurable sources of carbon dioxide emissions. Finally, methane emission from rice

production was nil since rice is not cultivated in Antigua and Barbuda.

Methodology

The data used to determine the GHG emissions for this sector came exclusively from the Food and Agricultural Organization (FAO). A copy of the data collected from FAO is enclosed in the Appendix below. The data was based both upon estimates and imputation methodology. The reliance on the FAO data was due to the lack of data availability from the Ministry of Agriculture. The Ministry previously advised that an animal population census should have been commissioned in 2020, however at the time of preparation of this inventory, the census was still in its preparatory stages. Consequently, there were many gaps in acquiring actual data on the ground to complete the inventory. These gaps include consistency, completeness, and accuracy. After a few consultations with the Ministry of Agriculture, it was agreed that the Ministry of Agriculture would provide expert advice on the suitability of the FAO data. The Ministry subsequently advised that the FAO data were useful and representative for Antigua and Barbuda. The expert advice was provided from:

- The Veterinary and Livestock Division – Ministry of Agriculture. They provided information on livestock population as well as manure management system.
- The Plant Protection Unit – Ministry of Agriculture. Information on managed soils, and types of fertilizers was provided as well as the use of liming of soils.
- The Agricultural Extension Division - Ministry of Agriculture provided input on the ratio of boiler chickens to layer chickens.
- Pesticide and Toxic Chemical Control Board. Provided information on types and quantity of fertilizers imported into Antigua and Barbuda for the years under consideration.
- The National Statistics Division. Provided data on livestock and fertilizer population.
- Specific methodologies may be found in the Appendix. Default and emission factors were taken from the 2006 IPCC Guidelines.

Emissions – 2016

The results include Categories 3A-Livestock and 3C-Aggregate sources and non-CO2 emission sources on land. Worksheets for each inventory year are attached below:

Table 2.14: 2016 Emission Summary

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO2
3.A - Livestock	0.000	0.564	0.004	0	0	0	0	0	0	0	0	0
3.A.1 - Enteric Fermentation		0.533							0	0	0	0
3.A.2 - Manure Management		0.031	0.004						0	0	0	0
3.B - Land	0.000	0.000	0.000	0	0	0	0	0	0	0	0	0
3.C - Aggregate sources and non-CO2 emissions sources on land	0.081	0.000	0.000	0	0	0	0	0	0	0	0	0
3.C.3 - Urea application	0.081								0	0	0	0

Table 2.15: 2017 Emission Summary

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO2
3.A - Livestock	0.000	0.565	0.004	0.0000	0	0	0	0	0	0	0	0
3.A.1 - Enteric Fermentation		0.533							0	0	0	0
3.A.2 - Manure Management		0.031	0.004						0	0	0	0
3.B - Land	0.000	0.000	0.000	0.0000	0	0	0	0	0	0	0	0
3.C - Aggregate sources and non-CO2 emissions sources on land	0.168	0.000	0.000	0	0	0	0	0	0	0	0	0
3.C.3 - Urea application	0.168								0	0	0	0

Table 2.16: 2018 Emission Summary

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO2
3.A - Livestock	0.000	0.546	0.004	0	0	0	0	0	0	0	0.0000	0
3.A.1 - Enteric Fermentation		0.516							0	0	0.0000	0
3.A.2 - Manure Management		0.030	0.004						0	0	0.0000	0
3.B - Land	0.000	0.000	0.000	0	0	0	0	0	0	0	0.0000	0
3.C - Aggregate sources and non-CO2 emissions sources on land	0.156	0.000	0.000	0	0	0	0	0	0	0	0.0000	0
3.C.3 - Urea application	0.156								0	0	0.0000	0

Table 2.17: 2019 Emission Summary

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO2
3.A - Livestock	0	0.476	0.004	0	0	0	0	0	0	0	0	0
3.A.1 - Enteric Fermentation		0.448							0	0	0	0
3.A.2 - Manure Management		0.028	0.004						0	0	0	0
3.B - Land	3.898303138	0	0	0	0	0	0	0	0	0	0	0
3.C - Aggregate sources and non-CO2 emissions sources on land	0.77022	0	0.003	0	0	0	0	0	0	0	0	0
3.C.3 - Urea application	0.77022								0	0	0	0

Table 2.18: GHG Emissions based on Excel Worksheets for the years 2016-2019

Gas	2016	2017	2018	2019	Total
Carbon Dioxide CO_2	0.081	0.168	0.156	0.770	1.175
Methane CH_4	0.564	0.564	0.546	0.476	2.150
Nitrous Oxide N_2O	0.004	0.004	0.004	0.007	0.019
Total	0.649	0.736	0.706	1.253	

FORESTRY AND OTHER LAND USE SECTOR

Sector Description

During the early colonial settlement, in Antigua and Barbuda most of the original forest was cleared to establish sugar plantations. In 1990, the reporting year for the Initial National Communication, it was reported that there was 13.45 kilohectares (kha) of forest cover. This consisted of Moist Tropical Forest (2.2 kha), Dry Tropical Forest (10.75 kha), and Mangroves (0.50 kha). It was also reported that there was 0.01 kha of Open Savannah and 12,000 non-forest trees.

In 2003, the Forestry Division, Ministry of Agriculture was able to provide some data for Antigua but not Barbuda. This data indicated that Antigua has a forest cover of 5.60kha consisting of 0.52 kha of Cactus Scrub, 1.09 kha of Deciduous Seasonal Forests, 0.57 kha of Evergreen Seasonal Forests, 0.044 kha of Littoral Woodland, 0.44 kha of Mangroves, 1.52 kha of Semi Evergreen, 1.09 kha of Thorn and 0.33 kha of Citronella.

In the Third National Communications (TNC), the data used came from 2004 and 2010. In 2009, the 2004 aerial photo imagery of Antigua and Barbuda was digitized into EIMAS (Environment Information Management and Advisory System) which is a GIS database. EIMAS was later updated using a 2010 aerial photo imagery of the country taken by the Survey & Mapping Division. Updates to this specific data within the EIMAS involved the collection of additional metadata and ground truthing. The data derived from comparing 2004 with 2010 was used in the GHG inventory of the TNC which only included the mainland of Antigua since there was no 2010 data available for Barbuda.

The 2010 EIMAS data indicated that Antigua had a forest cover of 8.7 kha. Data derived from expert judgment from the National Forestry Division indicated that approximately 20 percent was Tropical Moist deciduous Forest, 15 percent Tropical Forest dry scrubland and the remainder 65 percent is Tropical Dry Forest. In the Biennial Update Report (BUR), data was gathered using the Collect Earth application and the inventory year was set as 2015. Data derived from expert judgment from the National Forestry Division indicated that approximately 55 percent was dry mixed deciduous evergreen, 35 percent was moist mixed deciduous evergreen and 10 percent was mangrove.

Methodology

Collect Earth is a free and open-source software for land monitoring developed by the Food and Agriculture Organization (FAO). Built on Google desktop and cloud computing technologies, Collect Earth facilitates access

to multiple freely available archives of satellite imagery, including archives with very high spatial resolution imagery (Google Earth, Bing Map) and those with very high temporal resolution imagery (e.g. Google Earth Engine, Google Earth Engine Code Editor).

By altering the inputs of Collect Earth, i.e. the data collection form, sampling design and plot size, users can easily configure Collect Earth to address specific land monitoring purposes, such as landscape restoration, reporting for REDD+, national forest inventories, disaster assessments and humanitarian work, livestock and rangeland management, etc. with a multi-temporal and multi-scale approach.

Antigua and Barbuda's sample was designed to capture an entire coverage by a mesh of plots of 25 hectares each. Within these plots, the analyst would collect data on land use for 2003 and 2019 on the whole plot, followed by more specific data on the half a hectare subplot in the center. Specific methodology may be found in the Appendix which has been submitted as a separate document.

Emissions - 2019

Table 2.19: Summary Table Showing Greenhouse Gas Emission for Forestry and Other Land Use (2019 – Inventory Year; using IPCC software)

Inventory Year: 2019	
Categories	Net CO2 emissions / removals
3.B - Land	3.898303135
3.B.1 - Forest land	-65.99994012
3.B.1.a - Forest land Remaining Forest land	-53.81502632
3.B.1.b - Land Converted to Forest land	-12.1849138
3.B.1.b.i - Cropland converted to Forest Land	0.489709697
3.B.1.b.ii - Grassland converted to Forest Land	-12.5606943
3.B.1.b.iii - Wetlands converted to Forest Land	0
3.B.1.b.iv - Settlements converted to Forest Land	-0.1139292
3.B.1.b.v - Other Land converted to Forest Land	0
3.B.2 - Cropland	50.03709686
3.B.2.a - Cropland Remaining Cropland	38.872944
3.B.2.b - Land Converted to Cropland	11.16415286
3.B.2.b.i - Forest Land converted to Cropland	2.626909982
3.B.2.b.ii - Grassland converted to Cropland	8.53724288
3.B.2.b.iii - Wetlands converted to Cropland	0
3.B.2.b.iv - Settlements converted to Cropland	0
3.B.2.b.v - Other Land converted to Cropland	0
3.B.3 - Grassland	8.128975818
3.B.3.a - Grassland Remaining Grassland	0
3.B.3.b - Land Converted to Grassland	8.128975818
3.B.3.b.i - Forest Land converted to Grassland	3.854697
3.B.3.b.ii - Cropland converted to Grassland	4.082086818
3.B.3.b.iii - Wetlands converted to Grassland	0
3.B.3.b.iv - Settlements converted to Grassland	0.192192
3.B.3.b.v - Other Land converted to Grassland	0

Inventory Year: 2019	
3.B.4 - Wetlands	0
3.B.4.a - Wetlands Remaining Wetlands	0
3.B.4.a.i - Peatlands remaining peatlands	0
3.B.4.a.ii - Flooded land remaining flooded land	
3.B.4.b - Land Converted to Wetlands	0
3.B.4.b.i - Land converted for peat extraction	
3.B.4.b.ii - Land converted to flooded land	0
3.B.4.b.iii - Land converted to other wetlands	
3.B.5 - Settlements	11.73217058
3.B.5.a - Settlements Remaining Settlements	0
3.B.5.b - Land Converted to Settlements	11.73217058
3.B.5.b.i - Forest Land converted to Settlements	3.272577
3.B.5.b.ii - Cropland converted to Settlements	0.772914578
3.B.5.b.iii - Grassland converted to Settlements	7.686679
3.B.5.b.iv - Wetlands converted to Settlements	0
3.B.5.b.v - Other Land converted to Settlements	0
3.B.6 - Other Land	0
3.B.6.a - Other land Remaining Other land	
3.B.6.b - Land Converted to Other land	0
3.C - Aggregate sources and non-CO2 emissions sources on land (2)	0

Table 2.20: GHG missions from the FOLU sub-sector using Excel worksheets

	Gg
3.B.1 - Forest land	-65.99990
3.B.1.a - Forest land Remaining Forest land	-53.81500
3.B.1.b - Land Converted to Forest land	-12.18491
3.B.2 - Cropland	50.03690
3.B.2.a - Cropland Remaining Cropland	38.87280
3.B.2.b - Land Converted to Cropland	11.16410
3.B.3 - Grassland	8.13000
3.B.3.a - Grassland Remaining Grassland	0.00000
3.B.3.b - Land Converted to Grassland	8.13000
3.B.5 - Settlements	11.73164
3.B.5.a - Settlements Remaining Settlements	
3.B.5.b - Land Converted to Settlements	11.73164
3.B - Land	3.89864

WASTE SECTOR

Sector Description

The National Solid Waste Management Authority (NSWMA) is the primary manager of municipal solid waste in Antigua and Barbuda. NSWMA was established by the Solid Waste Management Act in 1995 (Amended in 2005). They use the Cooks Sanitary Landfill as the primary solid waste disposal site in Antigua. This is where the majority of waste storage, treatment, and disposal occurs. Prior to 2005, commingled waste was dumped at the Cooks Landfill and was openly burned periodically. After the revised Solid Waste Management Act was enacted in 2005, guidelines for handling, treating, and monitoring different types of waste were created. The NSWMA has since started weighing and collecting data on the amounts and types of waste dumped at Cooks Landfill, and periodically conducts waste composition studies that analyze the types of waste disposed, in more detail.

Methodology

Data from 2006 to present day, on the disposal of Municipal Solid Waste at the Cooks Landfill was obtained from the NSWMA. Historical solid waste disposal data was extrapolated using this existing annual waste data from 2006-2019, and national population statistics dating back to 1969 obtained from the Statistics Division. This was done by conducting a linear regression in excel, using the linear equation to extrapolate historical data. These figures were then plugged into the IPCC software along with regional default values to calculate emissions from Solid Waste Disposal Sites. Census data was taken from the National Statistic Division while default and emission factors were taken from the 2006 IPCC Guidelines. Detailed methodology may be found in the appendices.

Emissions – 2016

Table 2.21: Waste Sector Emissions 2016 using IPCC Software

Inventory Year: 2016							
Categories	Emissions [Gg]						
	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
4 - Waste	0.011	3.872	0.026	0.000	0.000	0.000	0.000
4.A - Solid Waste Disposal	0.000	3.304	0.000	0.000	0.000	0.000	0.000
4.A.1 - Managed Waste Disposal Sites				0.000	0.000	0.000	0.000
4.A.2 - Unmanaged Waste Disposal Sites				0.000	0.000	0.000	0.000
4.A.3 - Uncategorised Waste Disposal Sites				0.000	0.000	0.000	0.000
4.B - Biological Treatment of Solid Waste		0.205	0.012	0.000	0.000	0.000	0.000
4.C - Incineration and Open Burning of Waste	0.011	0.001	0.000	0.000	0.000	0.000	0.000
4.C.1 - Waste Incineration	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.C.2 - Open Burning of Waste	0.011	0.001	0.000	0.000	0.000	0.000	0.000
4.D - Wastewater Treatment and Discharge	0.000	0.362	0.013	0.000	0.000	0.000	0.000
4.D.1 - Domestic Wastewater Treatment & Discharge		0.362	0.013	0.000	0.000	0.000	0.000
4.D.2 - Industrial Wastewater Treatment & Discharge		0.000		0.000	0.000	0.000	0.000
4.E - Other (please specify)				0.000	0.000	0.000	0.000

Table 2.22: Waste Sector Emissions 2017 using IPCC Software

Inventory Year: 2017

Categories	Emissions [Gg]						
	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
4 - Waste	0.019	3.998	0.034	0.000	0.000	0.000	0.000
4.A - Solid Waste Disposal	0.000	3.290	0.000	0.000	0.000	0.000	0.000
4.A.1 - Managed Waste Disposal Sites				0.000	0.000	0.000	0.000
4.A.2 - Unmanaged Waste Disposal Sites				0.000	0.000	0.000	0.000
4.A.3 - Uncategorised Waste Disposal Sites				0.000	0.000	0.000	0.000
4.B - Biological Treatment of Solid Waste		0.339	0.020	0.000	0.000	0.000	0.000
4.C - Incineration and Open Burning of Waste	0.019	0.002	0.000	0.000	0.000	0.000	0.000
4.C.1 - Waste Incineration	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.C.2 - Open Burning of Waste	0.019	0.002	0.000	0.000	0.000	0.000	0.000
4.D - Wastewater Treatment and Discharge	0.000	0.367	0.014	0.000	0.000	0.000	0.000
4.D.1 - Domestic Wastewater Treatment & Discharge		0.367	0.014	0.000	0.000	0.000	0.000
4.D.2 - Industrial Wastewater Treatment & Discharge		0.000		0.000	0.000	0.000	0.000
4.E - Other (please specify)				0.000	0.000	0.000	0.000

Table 2.23: Waste Sector Emissions 2018 using IPCC Software

Inventory Year: 2018

Categories	Emissions [Gg]						
	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
4 - Waste	0.0183	4.1067	0.0336	0.0000	0.0000	0.0000	0.0000
4.A - Solid Waste Disposal	0.0000	3.4025	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.1 - Managed Waste Disposal Sites				0.0000	0.0000	0.0000	0.0000
4.A.2 - Unmanaged Waste Disposal Sites				0.0000	0.0000	0.0000	0.0000
4.A.3 - Uncategorised Waste Disposal Sites				0.0000	0.0000	0.0000	0.0000
4.B - Biological Treatment of Solid Waste		0.3294	0.0198	0.0000	0.0000	0.0000	0.0000
4.C - Incineration and Open Burning of Waste	0.0183	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000
4.C.1 - Waste Incineration	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.C.2 - Open Burning of Waste	0.0183	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000
4.D - Wastewater Treatment and Discharge	0.0000	0.3728	0.0138	0.0000	0.0000	0.0000	0.0000
4.D.1 - Domestic Wastewater Treatment & Discharge		0.3728	0.0138	0.0000	0.0000	0.0000	0.0000
4.D.2 - Industrial Wastewater Treatment & Discharge		0.0000		0.0000	0.0000	0.0000	0.0000
4.E - Other (please specify)				0.0000	0.0000	0.0000	0.0000

Table 2.24: Waste Sector Emissions 2019 using IPCC Software

Inventory Year: 2019

Categories	Emissions [Gg]						
	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
4 - Waste	0.016	4.160	0.031	0.000	0.000	0.000	0.000
4.A - Solid Waste Disposal	0.000	3.499	0.000	0.000	0.000	0.000	0.000
4.A.1 - Managed Waste Disposal Sites				0.000	0.000	0.000	0.000
4.A.2 - Unmanaged Waste Disposal Sites				0.000	0.000	0.000	0.000
4.A.3 - Uncategorised Waste Disposal Sites				0.000	0.000	0.000	0.000
4.B - Biological Treatment of Solid Waste		0.281	0.017	0.000	0.000	0.000	0.000
4.C - Incineration and Open Burning of Waste	0.016	0.002	0.000	0.000	0.000	0.000	0.000
4.C.1 - Waste Incineration	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.C.2 - Open Burning of Waste	0.016	0.002	0.000	0.000	0.000	0.000	0.000
4.D - Wastewater Treatment and Discharge	0.000	0.378	0.014	0.000	0.000	0.000	0.000
4.D.1 - Domestic Wastewater Treatment & Discharge		0.378	0.014	0.000	0.000	0.000	0.000
4.D.2 - Industrial Wastewater Treatment & Discharge		0.000		0.000	0.000	0.000	0.000
4.E - Other (please specify)				0.000	0.000	0.000	0.000

Table 2.25: GHG emissions for the Waste sector using Excel Worksheets

2016		Gg
4.B	Biological Treatment of Waste CH4	0.20513936
4.B	Biological Treatment of Waste N2O	0.01230835
4.C.2	Open Burning CO2	0.01105306
4.C.2	Open Burning CH4	0.00119012
4.C.2	Open Burning N2O	0.00002280
4.D.1	Domestic Wastewater CH4 Emission	0.36157597
4.D.1	Domestic Wastewater Indirect N2O	0.01342899
2017		Gg
4.B	Biological Treatment of Waste CH4	0.33909919
4.B	Biological Treatment of Waste N2O	0.02034595
4.C.2	Open Burning CO2	0.01855340
4.C.2	Open Burning CH4	0.00199771
4.C.2	Open Burning N2O	0.00003826
4.D.1	Domestic Wastewater CH4 Emission	0.36716300
4.D.1	Domestic Wastewater Indirect N2O	0.01363649
2018		Gg
4.B	Biological Treatment of Waste CH4	0.32943215
4.B	Biological Treatment of Waste N2O	0.01976593
4.C.2	Open Burning CO2	0.01830096
4.C.2	Open Burning CH4	0.00197053
4.C.2	Open Burning N2O	0.00003774
4.D.1	Domestic Wastewater CH4 Emission	0.37278535
4.D.1	Domestic Wastewater Indirect N2O	0.01384530
2019		Gg
4.B	Biological Treatment of Waste CH4	0.28072407
4.B	Biological Treatment of Waste N2O	0.01684344
4.C.2	Open Burning CO2	0.01582716
4.C.2	Open Burning CH4	0.00170417
4.C.2	Open Burning N2O	0.00003264
4.D.1	Domestic Wastewater CH4 Emission	0.37843123
4.D.1	Domestic Wastewater Indirect N2O	0.01405499

Key Category Analysis

In line with Volume 1 Chapter 4 of the 2006 IPCC Guidelines, "it is good practice to identify key categories by performing a quantitative analysis of the relationships between level and the trend of each category's emissions and removals and total national emissions and removals". The Key Category Analysis emphasizes those areas in the GHG inventory that contribute most significantly to the GHG emissions. In the tables below, key categories are those that, when summed together in descending order of magnitude, add up to 95 percent of the total in Column G (2006 IPCC Guidelines pg. 4.15, Vol. 4, Chap 4).

Presented below is the Key Category Analysis that was performed for the last GHG inventory of 2015 (Table 2-2) and also the similar analysis on the present GHG inventory 2016-2019 (Table 2-3, 2-4, 2-5 and 2-6)). Approach 1 was used in the Key Category Analysis since it was the most suitable to the current national conditions. The Key category Analyses for the inventory years are enclosed below. Note, the conversion applied for CO_2 equivalent is the following:

Table 2.26. Global Warming Potential for the Greenhouse Gases

Greenhouse Gas	Formula	100-year GWP
Carbon dioxide	CO_2	1*
Methane	CH_4	21*
Nitrous Oxide	N_20	310*
Hydroflouro Carbons	HFCs	n/a
Non-methane volatile organic compounds	NMVOC	n/a

*-values obtained from the IPCC Software, n/a – there was not enough information to determine the 100-year GWP of the HFCs and NMVOC.

Table 2.27: Approach 1 Level Assessment for GHG Inventory 2016 in Key Category Analysis (Key Categories are in red)

IPCC Category code	IPCC Category	Greenhouse gas	2016 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.3.b	Road Transportation	Carbon dioxide (co2)	358.0685479	358.0685479	0.513580415	0.513580415
1.A.1	Energy Industries - Liquid Fuels	Carbon dioxide (co2)	209.8627934	209.8627934	0.301007785	0.814588201
4.A	Solid Waste Disposal	Methane (ch4)	69.38596488	69.38596488	0.099520812	0.914109013
1.A.4	Other Sectors - Liquid Fuels	Carbon dioxide (co2)	16.92653814	16.92653814	0.024277861	0.938386874
3.A.1	Enteric Fermentation	Methane (ch4)	11.193105	11.193105	0.016054355	0.954441229
4.D	Wastewater Treatment and Discharge	Methane (ch4)	7.593095348	7.593095348	0.010890834	0.965332062
1.A.3.b	Road Transportation	Nitrous oxide (n2o)	4.391900467	4.391900467	0.006299336	0.971631398
4.B	Biological Treatment of Solid Waste	Methane (ch4)	4.307926549	4.307926549	0.006178891	0.97781029
4.D	Wastewater Treatment and Discharge	Nitrous oxide (n2o)	4.16298578	4.16298578	0.005971002	0.983781292
4.B	Biological Treatment of Solid Waste	Nitrous oxide (n2o)	3.815592086	3.815592086	0.005472732	0.989254024
2.C.6	Zinc Production	Carbon dioxide (co2)	1.7335192	1.7335192	0.0024864	0.991740424
3.A.2	Manure Management	Nitrous oxide (n2o)	1.316302087	1.316302087	0.001887982	0.993628406
1.A.3.b	Road Transportation	Methane (ch4)	1.301876751	1.301876751	0.001867292	0.995495697
2.G	Other Product Manufacture and Use	Nitrous oxide (n2o)	1.170715	1.170715	0.001679165	0.997174863
3.A.2	Manure Management	Methane (ch4)	0.64212288	0.64212288	0.000921002	0.998095865
1.A.1	Energy Industries - Liquid Fuels	Nitrous oxide (n2o)	0.504321442	0.504321442	0.000723352	0.998819217
2.D	Non-Energy Products from Fuels and Solvent Use	Carbon dioxide (co2)	0.481984	0.481984	0.000691313	0.99951053
1.A.1	Energy Industries - Liquid Fuels	Methane (ch4)	0.170818553	0.170818553	0.000245006	0.999755536
3.C.3	Urea application	Carbon dioxide (co2)	0.080600667	0.080600667	0.000115606	0.999871142
1.A.4	Other Sectors - Liquid Fuels	Methane (ch4)	0.029116017	0.029116017	4.17613E-05	0.999912904
4.C	Incineration and Open Burning of Waste	Methane (ch4)	0.024992473	0.024992473	3.58469E-05	0.999948751
4.C	Incineration and Open Burning of Waste	Carbon dioxide (co2)	0.011053001	0.011053001	1.58534E-05	0.999964604
1.A.4	Other Sectors - Liquid Fuels	Nitrous oxide (n2o)	0.009899645	0.009899645	1.41991E-05	0.999978803
4.C	Incineration and Open Burning of Waste	Nitrous oxide (n2o)	0.007066553	0.007066553	1.01356E-05	0.999988939
1.A.4	Other Sectors - Biomass	Methane (ch4)	0.007013731	0.007013731	1.00598E-05	0.999998999
1.A.4	Other Sectors - Biomass	Nitrous oxide (n2o)	0.00051768	0.00051768	7.42513E-07	0.999999741
2.A.4	Other Process Uses of Carbonates	Carbon dioxide (co2)	0.000180545	0.000180545	2.58957E-07	1
1.A.1	Energy Industries - Solid Fuels	Carbon dioxide (co2)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2016 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.1	Energy Industries - Solid Fuels	Methane (ch4)	0	0	0	1
1.A.1	Energy Industries - Solid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	Methane (ch4)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	Methane (ch4)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.1	Energy Industries - Peat	Carbon dioxide (co2)	0	0	0	1
1.A.1	Energy Industries - Peat	Methane (ch4)	0	0	0	1
1.A.1	Energy Industries - Peat	Nitrous oxide (n2o)	0	0	0	1
1.A.1	Energy Industries - Biomass	Carbon dioxide (co2)	0	0	0	1
1.A.1	Energy Industries - Biomass	Methane (ch4)	0	0	0	1
1.A.1	Energy Industries - Biomass	Nitrous oxide (n2o)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	Methane (ch4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Solid Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction -Solid Fuels	Methane (ch4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Solid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction -Gaseous Fuels	Methane (ch4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	Carbon dioxide (co2)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2016 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	Methane (ch4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Peat	Carbon dioxide (co2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Peat	Methane (ch4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Peat	Nitrous oxide (n2o)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	Carbon dioxide (co2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	Methane (ch4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	Nitrous oxide (n2o)	0	0	0	1
1.A.3.a	Civil Aviation	Carbon dioxide (co2)	0	0	0	1
1.A.3.a	Civil Aviation	Methane (ch4)	0	0	0	1
1.A.3.a	Civil Aviation	Nitrous oxide (n2o)	0	0	0	1
1.A.3.c	Railways	Carbon dioxide (co2)	0	0	0	1
1.A.3.c	Railways	Methane (ch4)	0	0	0	1
1.A.3.c	Railways	Nitrous oxide (n2o)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	Methane (ch4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.3.d	Water-borne Navigation - Solid Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Solid Fuels	Methane (ch4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Solid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	Methane (ch4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	Methane (ch4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.3.d	Water-borne Navigation - Peat	Carbon dioxide (co2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Peat	Methane (ch4)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2016 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.3.d	Water-borne Navigation - Peat	Nitrous oxide (n2o)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	Carbon dioxide (co2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	Methane (ch4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	Nitrous oxide (n2o)	0	0	0	1
1.A.3.e	Other Transportation	Carbon dioxide (co2)	0	0	0	1
1.A.3.e	Other Transportation	Methane (ch4)	0	0	0	1
1.A.3.e	Other Transportation	Nitrous oxide (n2o)	0	0	0	1
1.A.4	Other Sectors - Solid Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.4	Other Sectors - Solid Fuels	Methane (ch4)	0	0	0	1
1.A.4	Other Sectors - Solid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	Methane (ch4)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	Methane (ch4)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.4	Other Sectors - Peat	Carbon dioxide (co2)	0	0	0	1
1.A.4	Other Sectors - Peat	Methane (ch4)	0	0	0	1
1.A.4	Other Sectors - Peat	Nitrous oxide (n2o)	0	0	0	1
1.A.4	Other Sectors - Biomass	Carbon dioxide (co2)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	Methane (ch4)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	Methane (ch4)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.5	Non-Specified - Gaseous Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.5	Non-Specified - Gaseous Fuels	Methane (ch4)	0	0	0	1
1.A.5	Non-Specified - Gaseous Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	Carbon dioxide (co2)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	Methane (ch4)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	Nitrous oxide (n2o)	0	0	0	1
1.A.5	Non-Specified - Peat	Carbon dioxide (co2)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2016 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.5	Non-Specified - Peat	Methane (ch4)	0	0	0	1
1.A.5	Non-Specified - Peat	Nitrous oxide (n2o)	0	0	0	1
1.A.5	Non-Specified - Biomass	Carbon dioxide (co2)	0	0	0	1
1.A.5	Non-Specified - Biomass	Methane (ch4)	0	0	0	1
1.A.5	Non-Specified - Biomass	Nitrous oxide (n2o)	0	0	0	1
1.B.1	Solid Fuels	Carbon dioxide (co2)	0	0	0	1
1.B.1	Solid Fuels	Methane (ch4)	0	0	0	1
1.B.1	Solid Fuels	Nitrous oxide (n2o)	0	0	0	1
1.B.2.a	Oil	Carbon dioxide (co2)	0	0	0	1
1.B.2.a	Oil	Methane (ch4)	0	0	0	1
1.B.2.a	Oil	Nitrous oxide (n2o)	0	0	0	1
1.B.2.b	Natural Gas	Carbon dioxide (co2)	0	0	0	1
1.B.2.b	Natural Gas	Methane (ch4)	0	0	0	1
1.B.2.b	Natural Gas	Nitrous oxide (n2o)	0	0	0	1
1.C	Carbon dioxide Transport and Storage	Carbon dioxide (co2)	0	0	0	1
2.A.1	Cement production	Carbon dioxide (co2)	0	0	0	1
2.A.2	Lime production	Carbon dioxide (co2)	0	0	0	1
2.A.3	Glass Production	Carbon dioxide (co2)	0	0	0	1
2.B.1	Ammonia Production	Carbon dioxide (co2)	0	0	0	1
2.B.2	Nitric Acid Production	Nitrous oxide (n2o)	0	0	0	1
2.B.3	Adipic Acid Production	Nitrous oxide (n2o)	0	0	0	1
2.B.4	Caprolactam, Glyoxal and Glyoxylic Acid Production	Nitrous oxide (n2o)	0	0	0	1
2.B.5	Carbide Production	Carbon dioxide (co2)	0	0	0	1
2.B.5	Carbide Production	Methane (ch4)	0	0	0	1
2.B.6	Titanium Dioxide Production	Carbon dioxide (co2)	0	0	0	1
2.B.7	Soda Ash Production	Carbon dioxide (co2)	0	0	0	1
2.B.8	Petrochemical and Carbon Black Production	Carbon dioxide (co2)	0	0	0	1
2.B.8	Petrochemical and Carbon Black Production	Methane (ch4)	0	0	0	1
2.B.9	Fluorochemical Production	SF6, pfcs, hfcs and other halogenated gases	0	0	0	1
2.C.1	Iron and Steel Production	Carbon dioxide (co2)	0	0	0	1
2.C.1	Iron and Steel Production	Methane (ch4)	0	0	0	1
2.C.2	Ferroalloys Production	Carbon dioxide (co2)	0	0	0	1
2.C.2	Ferroalloys Production	Methane (ch4)	0	0	0	1
2.C.3	Aluminium production	Carbon dioxide (co2)	0	0	0	1
2.C.3	Aluminium production	Pfcs (pfcs)	0	0	0	1
2.C.4	Magnesium production	Carbon dioxide (co2)	0	0	0	1
2.C.4	Magnesium production	Sulphur hexafluoride (sf6)	0	0	0	1
2.C.5	Lead Production	Carbon dioxide (co2)	0	0	0	1
2.E	Electronics Industry	SF6, pfcs, hfcs & other halogenated gases	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2016 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
2.F.1	Refrigeration and Air Conditioning	Hfcs, pfcs	0	0	0	1
2.F.2	Foam Blowing Agents	Hfcs (hfcs)	0	0	0	1
2.F.3	Fire Protection	Hfcs, pfcs	0	0	0	1
2.F.4	Aerosols	Hfcs, pfcs	0	0	0	1
2.F.5	Solvents	Hfcs, pfcs	0	0	0	1
2.F.6	Other Applications (please specify)	Hfcs, pfcs	0	0	0	1
2.G	Other Product Manufacture and Use	SF6, pfcs	0	0	0	1
2.H	Other	Carbon dioxide (co2)	0	0	0	1
3.B.1.a	Forest land Remaining Forest land	Carbon dioxide (co2)	0	0	0	1
3.B.1.b	Land Converted to Forest land	Carbon dioxide (co2)	0	0	0	1
3.B.2.a	Cropland Remaining Cropland	Carbon dioxide (co2)	0	0	0	1
3.B.2.b	Land Converted to Cropland	Carbon dioxide (co2)	0	0	0	1
3.B.3.a	Grassland Remaining Grassland	Carbon dioxide (co2)	0	0	0	1
3.B.3.b	Land Converted to Grassland	Carbon dioxide (co2)	0	0	0	1
3.B.4.a.i	Peatlands remaining peatlands	Carbon dioxide (co2)	0	0	0	1
3.B.4.a.i	Peatlands remaining peatlands	Nitrous oxide (n2o)	0	0	0	1
3.B.4.b	Land Converted to Wetlands	Nitrous oxide (n2o)	0	0	0	1
3.B.4.b	Land Converted to Wetlands	Carbon dioxide (co2)	0	0	0	1
3.B.5.a	Settlements Remaining Settlements	Carbon dioxide (co2)	0	0	0	1
3.B.5.b	Land Converted to Settlements	Carbon dioxide (co2)	0	0	0	1
3.B.6.b	Land Converted to Other land	Carbon dioxide (co2)	0	0	0	1
3.C.1	Emissions from biomass burning	Methane (ch4)	0	0	0	1
3.C.1	Emissions from biomass burning	Nitrous oxide (n2o)	0	0	0	1
3.C.2	Liming	Carbon dioxide (co2)	0	0	0	1
3.C.4	Direct N2O Emissions from managed soils	Nitrous oxide (n2o)	0	0	0	1
3.C.5	Indirect N2O Emissions from managed soils	Nitrous oxide (n2o)	0	0	0	1
3.C.6	Indirect N2O Emissions from manure management	Nitrous oxide (n2o)	0	0	0	1
3.C.7	Rice cultivation	Methane (ch4)	0	0	0	1
3.D.1	Harvested Wood Products	Carbon dioxide (co2)	0	0	0	1
Total			697.2005498	697. 2005498	1	

Note: The table above was exported from the IPCC software. The cells highlighted in yellow represent the total emissions for the respective categories inclusive of results obtained from the excel spreadsheets. See detailed methodology for more information. Additionally, the emissions from category 1.A.4 was not complete, and the figure presented above in the table is amended to include the total emissions for that category (cell highlighted in orange).

Key category Analysis 2017

Table 2.28: Approach 1 Level Assessment for GHG Inventory 2017 in Key Category Analysis (Key Categories in red)

IPCC Category code	IPCC Category	Greenhouse gas	2017 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	345.047801640	345.0478016	0.4945557238	0.4945557238
1.A.1	Energy Industries - Liquid Fuels	CARBON DIOXIDE (CO2)	216.610773120	216.6107731	0.3104674111	0.8050231349
4.A	Solid Waste Disposal	METHANE (CH4)	69.083031913	69.08303191	0.0990164513	0.9040395862
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	18.177098110	18.17709811	0.0260531667	0.9300927530
3.A.1	Enteric Fermentation	METHANE (CH4)	11.199720000	11.19972	0.0160525168	0.9461452698
4.D	Wastewater Treatment and Discharge	METHANE (CH4)	7.710423036	7.710423036	0.0110513205	0.9571965903
4.B	Biological Treatment of Solid Waste	METHANE (CH4)	7.121078973	7.121078973	0.0102066159	0.9674032061
4.B	Biological Treatment of Solid Waste	NITROUS OXIDE (N2O)	6.307241376	6.307241376	0.0090401455	0.9764433516
1.A.3.b	Road Transportation	NITROUS OXIDE (N2O)	4.308061742	4.308061742	0.0061747288	0.9826180804
4.D	Wastewater Treatment and Discharge	NITROUS OXIDE (N2O)	4.227311786	4.227311786	0.0060589902	0.9886770706
2.C.6	Zinc Production	CARBON DIOXIDE (CO2)	2.034072000	2.034072	0.0029154278	0.9915924984
1.A.3.b	Road Transportation	METHANE (CH4)	1.334316396	1.334316396	0.0019124707	0.9935049691
3.A.2	Manure Management	NITROUS OXIDE (N2O)	1.318092700	1.3180927	0.0018892173	0.9953941864
2.G	Other Product Manufacture and Use	NITROUS OXIDE (N2O)	1.067795000	1.067795	0.0015304666	0.9969246530
3.A.2	Manure Management	METHANE (CH4)	0.661274250	0.66127425	0.0009478019	0.9978724549
1.A.1	Energy Industries - Liquid Fuels	NITROUS OXIDE (N2O)	0.520537517	0.520537517	0.0007460845	0.9986185394
2.D	Non-Energy Products from Fuels and Solvent Use	CARBON DIOXIDE (CO2)	0.497690233	0.497690233	0.0007133375	0.9993318769
1.A.1	Energy Industries - Liquid Fuels	METHANE (CH4)	0.176311094	0.176311094	0.0002527060	0.9995845830
3.C.3	Urea application	CARBON DIOXIDE (CO2)	0.168043333	0.168043333	0.0002408559	0.9998254388
4.C	Incineration and Open Burning of Waste	METHANE (CH4)	0.041951991	0.041951991	0.0000601296	0.9998855685
1.A.4	Other Sectors - Liquid Fuels	METHANE (CH4)	0.031196981	0.031196981	0.0000447145	0.9999302830
4.C	Incineration and Open Burning of Waste	CARBON DIOXIDE (CO2)	0.018553402	0.018553402	0.0000265925	0.9999568755
4.C	Incineration and Open Burning of Waste	NITROUS OXIDE (N2O)	0.011861810	0.01186181	0.0000170015	0.9999738770

IPCC Category code	IPCC Category	Greenhouse gas	2017 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.4	Other Sectors - Liquid Fuels	NITROUS OXIDE (N2O)	0.010514025	0.010514025	0.0000150697	0.9999889467
1.A.4	Other Sectors - Biomass	METHANE (CH4)	0.007013580	0.00701358	0.0000100525	0.9999989993
1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	0.000517669	0.000517669	0.0000007420	0.9999997412
2.A.4	Other Process Uses of Carbonates	CARBON DIOXIDE (CO2)	0.000180545	0.000180545	0.0000002588	1
1.A.1	Energy Industries - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.1	Energy Industries - Solid Fuels	METHANE (CH4)	0	0	0	0
1.A.1	Energy Industries - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.1	Energy Industries - Gaseous Fuels	METHANE (CH4)	0	0	0	0
1.A.1	Energy Industries - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.1	Energy Industries - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.1	Energy Industries - Other Fossil Fuels	METHANE (CH4)	0	0	0	0
1.A.1	Energy Industries - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.1	Energy Industries - Peat	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.1	Energy Industries - Peat	METHANE (CH4)	0	0	0	0
1.A.1	Energy Industries - Peat	NITROUS OXIDE (N2O)	0	0	0	0
1.A.1	Energy Industries - Biomass	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.1	Energy Industries - Biomass	METHANE (CH4)	0	0	0	0
1.A.1	Energy Industries - Biomass	NITROUS OXIDE (N2O)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	METHANE (CH4)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Solid Fuels	METHANE (CH4)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	0

IPCC Category code	IPCC Category	Greenhouse gas	2017 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	METHANE (CH4)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	METHANE (CH4)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Peat	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Peat	METHANE (CH4)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Peat	NITROUS OXIDE (N2O)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Biomass	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Biomass	METHANE (CH4)	0	0	0	0
1.A.2	Manufacturing Industries and Construction - Biomass	NITROUS OXIDE (N2O)	0	0	0	0
1.A.3.a	Civil Aviation	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.a	Civil Aviation	METHANE (CH4)	0	0	0	0
1.A.3.a	Civil Aviation	NITROUS OXIDE (N2O)	0	0	0	0
1.A.3.c	Railways	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.c	Railways	METHANE (CH4)	0	0	0	0
1.A.3.c	Railways	NITROUS OXIDE (N2O)	0	0	0	0
1.A.3.d	Water-borne Navigation - Liquid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.d	Water-borne Navigation - Liquid Fuels	METHANE (CH4)	0	0	0	0
1.A.3.d	Water-borne Navigation - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.3.d	Water-borne Navigation - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.d	Water-borne Navigation - Solid Fuels	METHANE (CH4)	0	0	0	0
1.A.3.d	Water-borne Navigation - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.3.d	Water-borne Navigation - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.d	Water-borne Navigation - Gaseous Fuels	METHANE (CH4)	0	0	0	0
1.A.3.d	Water-borne Navigation - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	0

IPCC Category code	IPCC Category	Greenhouse gas	2017 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	METHANE (CH4)	0	0	0	0
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.3.d	Water-borne Navigation - Peat	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.d	Water-borne Navigation - Peat	METHANE (CH4)	0	0	0	0
1.A.3.d	Water-borne Navigation - Peat	NITROUS OXIDE (N2O)	0	0	0	0
1.A.3.d	Water-borne Navigation - Biomass	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.d	Water-borne Navigation - Biomass	METHANE (CH4)	0	0	0	0
1.A.3.d	Water-borne Navigation - Biomass	NITROUS OXIDE (N2O)	0	0	0	0
1.A.3.e	Other Transportation	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.3.e	Other Transportation	METHANE (CH4)	0	0	0	0
1.A.3.e	Other Transportation	NITROUS OXIDE (N2O)	0	0	0	0
1.A.4	Other Sectors - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.4	Other Sectors - Solid Fuels	METHANE (CH4)	0	0	0	0
1.A.4	Other Sectors - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.4	Other Sectors - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.4	Other Sectors - Gaseous Fuels	METHANE (CH4)	0	0	0	0
1.A.4	Other Sectors - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.4	Other Sectors - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.4	Other Sectors - Other Fossil Fuels	METHANE (CH4)	0	0	0	0
1.A.4	Other Sectors - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.4	Other Sectors - Peat	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.4	Other Sectors - Peat	METHANE (CH4)	0	0	0	0
1.A.4	Other Sectors - Peat	NITROUS OXIDE (N2O)	0	0	0	0
1.A.4	Other Sectors - Biomass	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.5	Non-Specified - Liquid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.5	Non-Specified - Liquid Fuels	METHANE (CH4)	0	0	0	0
1.A.5	Non-Specified - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.5	Non-Specified - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.5	Non-Specified - Solid Fuels	METHANE (CH4)	0	0	0	0
1.A.5	Non-Specified - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	0

IPCC Category code	IPCC Category	Greenhouse gas	2017 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.5	Non-Specified - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.5	Non-Specified - Gaseous Fuels	METHANE (CH4)	0	0	0	0
1.A.5	Non-Specified - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.5	Non-Specified - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.5	Non-Specified - Other Fossil Fuels	METHANE (CH4)	0	0	0	0
1.A.5	Non-Specified - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.A.5	Non-Specified - Peat	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.5	Non-Specified - Peat	METHANE (CH4)	0	0	0	0
1.A.5	Non-Specified - Peat	NITROUS OXIDE (N2O)	0	0	0	0
1.A.5	Non-Specified - Biomass	CARBON DIOXIDE (CO2)	0	0	0	0
1.A.5	Non-Specified - Biomass	METHANE (CH4)	0	0	0	0
1.A.5	Non-Specified - Biomass	NITROUS OXIDE (N2O)	0	0	0	0
1.B.1	Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	0
1.B.1	Solid Fuels	METHANE (CH4)	0	0	0	0
1.B.1	Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	0
1.B.2.a	Oil	CARBON DIOXIDE (CO2)	0	0	0	0
1.B.2.a	Oil	METHANE (CH4)	0	0	0	0
1.B.2.a	Oil	NITROUS OXIDE (N2O)	0	0	0	0
1.B.2.b	Natural Gas	CARBON DIOXIDE (CO2)	0	0	0	0
1.B.2.b	Natural Gas	METHANE (CH4)	0	0	0	0
1.B.2.b	Natural Gas	NITROUS OXIDE (N2O)	0	0	0	0
1.C	Carbon dioxide Transport and Storage	CARBON DIOXIDE (CO2)	0	0	0	0
2.A.1	Cement production	CARBON DIOXIDE (CO2)	0	0	0	0
2.A.2	Lime production	CARBON DIOXIDE (CO2)	0	0	0	0
2.A.3	Glass Production	CARBON DIOXIDE (CO2)	0	0	0	0
2.B.1	Ammonia Production	CARBON DIOXIDE (CO2)	0	0	0	0
2.B.2	Nitric Acid Production	NITROUS OXIDE (N2O)	0	0	0	0
2.B.3	Adipic Acid Production	NITROUS OXIDE (N2O)	0	0	0	0
2.B.4	Caprolactam, Glyoxal and Glyoxylic Acid Production	NITROUS OXIDE (N2O)	0	0	0	0
2.B.5	Carbide Production	CARBON DIOXIDE (CO2)	0	0	0	0
2.B.5	Carbide Production	METHANE (CH4)	0	0	0	0
2.B.6	Titanium Dioxide Production	CARBON DIOXIDE (CO2)	0	0	0	0

IPCC Category code	IPCC Category	Greenhouse gas	2017 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
2.B.7	Soda Ash Production	CARBON DIOXIDE (CO2)	0	0	0	0
2.B.8	Petrochemical and Carbon Black Production	CARBON DIOXIDE (CO2)	0	0	0	0
2.B.8	Petrochemical and Carbon Black Production	METHANE (CH4)	0	0	0	0
2.B.9	Fluorochemical Production	SF6, PFCs, HFCs and other halogenated gases	0	0	0	0
2.C.1	Iron and Steel Production	CARBON DIOXIDE (CO2)	0	0	0	0
2.C.1	Iron and Steel Production	METHANE (CH4)	0	0	0	0
2.C.2	Ferroalloys Production	CARBON DIOXIDE (CO2)	0	0	0	0
2.C.2	Ferroalloys Production	METHANE (CH4)	0	0	0	0
2.C.3	Aluminium production	CARBON DIOXIDE (CO2)	0	0	0	0
2.C.3	Aluminium production	PFCs (PFCs)	0	0	0	0
2.C.4	Magnesium production	CARBON DIOXIDE (CO2)	0	0	0	0
2.C.4	Magnesium production	Sulphur Hexafluoride (SF6)	0	0	0	0
2.C.5	Lead Production	CARBON DIOXIDE (CO2)	0	0	0	0
2.E	Electronics Industry	SF6, PFCs, HFCs and other halogenated gases	0	0	0	0
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	0	0	0	0
2.F.2	Foam Blowing Agents	HFCs (HFCs)	0	0	0	0
2.F.3	Fire Protection	HFCs, PFCs	0	0	0	0
2.F.4	Aerosols	HFCs, PFCs	0	0	0	0
2.F.5	Solvents	HFCs, PFCs	0	0	0	0
2.F.6	Other Applications (please specify)	HFCs, PFCs	0	0	0	0
2.G	Other Product Manufacture and Use	SF6, PFCs	0	0	0	0
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.1.b	Land Converted to Forest land	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.2.a	Cropland Remaining Cropland	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.3.a	Grassland Remaining Grassland	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.3.b	Land Converted to Grassland	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.4.a.i	Peatlands remaining peatlands	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.4.a.i	Peatlands remaining peatlands	NITROUS OXIDE (N2O)	0	0	0	0
3.B.4.b	Land Converted to Wetlands	NITROUS OXIDE (N2O)	0	0	0	0

IPCC Category code	IPCC Category	Greenhouse gas	2017 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.B.4.b	Land Converted to Wetlands	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.5.a	Settlements Remaining Settlements	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.5.b	Land Converted to Settlements	CARBON DIOXIDE (CO2)	0	0	0	0
3.B.6.b	Land Converted to Other land	CARBON DIOXIDE (CO2)	0	0	0	0
3.C.1	Emissions from biomass burning	METHANE (CH4)	0	0	0	0
3.C.1	Emissions from biomass burning	NITROUS OXIDE (N2O)	0	0	0	0
3.C.2	Liming	CARBON DIOXIDE (CO2)	0	0	0	0
3.C.4	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	0	0	0	0
3.C.5	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	0	0	0	0
3.C.6	Indirect N2O Emissions from manure management	NITROUS OXIDE (N2O)	0	0	0	0
3.C.7	Rice cultivation	METHANE (CH4)	0	0	0	0
3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO2)				
Total			697.69246422	697.69246422	1	

Note: The table above was exported from the IPCC software, however the cells highlighted in yellow represent the total emissions for the respective categories inclusive of results obtained from the excel spreadsheets. See detailed methodology for more information.

2018 Key Category Analysis

Table 2.29: Approach 1 Level Assessment for GHG Inventory 2018 in Key Category Analysis (Key Categories in red)

IPCC Category code	IPCC Category	Greenhouse gas	2018 Ex,t (Gg CO2 Eq)	lEx,tl(Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	363.07279879	363.0727988	0.5067863061	0.5067863061
1.A.1	Energy Industries - Liquid Fuels	CARBON DIOXIDE (CO2)	215.28181512	215.2818151	0.3004958681	0.8072821742
4.A	Solid Waste Disposal	METHANE (CH4)	71.45293500	71.452935	0.0997358357	0.9070180099
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	18.05979804	18.05979804	0.0252083284	0.9322263383
3.A.1	Enteric Fermentation	METHANE (CH4)	10.83768000	10.83768	0.0151275112	0.9473538494
4.D	Wastewater Treatment and Discharge	METHANE (CH4)	7.82849226	7.828492262	0.0109272099	0.9582810593
4.B	Biological Treatment of Solid Waste	METHANE (CH4)	6.91807525	6.91807525	0.0096564265	0.9679374858
4.B	Biological Treatment of Solid Waste	NITROUS OXIDE (N2O)	6.12743808	6.127438078	0.0085528349	0.9764903207

IPCC Category code	IPCC Category	Greenhouse gas	2018 Ex,t (Gg CO2 Eq)	lEx,tl(Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.3.b	Road Transportation	NITROUS OXIDE (N2O)	4.51907149	4.519071488	0.0063078357	0.9827981564
4.D	Wastewater Treatment and Discharge	NITROUS OXIDE (N2O)	4.29204435	4.292044347	0.0059909454	0.9887891017
2.C.6	Zinc Production	CARBON DIOXIDE (CO2)	2.18840760	2.1884076	0.0030546353	0.9918437371
1.A.3.b	Road Transportation	METHANE (CH4)	1.39809605	1.398096053	0.0019514983	0.9937952353
3.A.2	Manure Management	NITROUS OXIDE (N2O)	1.29890709	1.298907087	0.0018130478	0.9956082831
2.G	Other Product Manufacture and Use	NITROUS OXIDE (N2O)	0.90535500	0.905355	0.0012637177	0.9968720008
2.D	Non-Energy Products from Fuels and Solvent Use	CARBON DIOXIDE (CO2)	0.63670420	0.6367042	0.0008887280	0.9977607288
3.A.2	Manure Management	METHANE (CH4)	0.63614838	0.63614838	0.0008879522	0.9986486810
1.A.1	Energy Industries - Liquid Fuels	NITROUS OXIDE (N2O)	0.51734390	0.517343897	0.0007221219	0.9993708029
1.A.1	Energy Industries - Liquid Fuels	METHANE (CH4)	0.17522938	0.175229384	0.0002445897	0.9996153925
3.C.3	Urea application	CARBON DIOXIDE (CO2)	0.15574533	0.155745333	0.0002173933	0.9998327858
4.C	Incineration and Open Burning of Waste	METHANE (CH4)	0.04138119	0.041381188	0.0000577609	0.9998905468
1.A.4	Other Sectors - Liquid Fuels	METHANE (CH4)	0.03069310	0.030693096	0.0000428422	0.9999333890
4.C	Incineration and Open Burning of Waste	CARBON DIOXIDE (CO2)	0.01830096	0.018300962	0.0000255450	0.9999589339
4.C	Incineration and Open Burning of Waste	NITROUS OXIDE (N2O)	0.01170042	0.011700417	0.0000163317	0.9999752657
1.A.4	Other Sectors - Liquid Fuels	NITROUS OXIDE (N2O)	0.00994163	0.009941626	0.0000138768	0.9999891424
1.A.4	Other Sectors - Biomass	METHANE (CH4)	0.00701358	0.00701358	0.0000097897	0.9999989322
1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	0.00051767	0.000517669	0.0000007226	0.9999996547
2.A.4	Other Process Uses of Carbonates	CARBON DIOXIDE (CO2)	0.00024735	0.000247348	0.0000003453	1
1.A.1	Energy Industries - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.1	Energy Industries - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Peat	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.1	Energy Industries - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Biomass	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Biomass	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Inc Construction - Li	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and	METHANE (CH4)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2018 Ex,t (Gg CO2 Eq)	lEx,tl(Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
	Construction - Liquid Fuels					
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Peat	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.a	Civil Aviation	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.a	Civil Aviation	METHANE (CH4)	0	0	0	1
1.A.3.a	Civil Aviation	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.c	Railways	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.c	Railways	METHANE (CH4)	0	0	0	1
1.A.3.c	Railways	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Solid Fuels	METHANE (CH4)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2018 Ex,t (Gg CO2 Eq)	lEx,tl(Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.3.d	Water-borne Navigation - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Peat	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.e	Other Transportation	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.e	Other Transportation	METHANE (CH4)	0	0	0	1
1.A.3.e	Other Transportation	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.4	Other Sectors - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.4	Other Sectors - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.4	Other Sectors - Peat	METHANE (CH4)	0	0	0	1
1.A.4	Other Sectors - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Gaseous Fuels	METHANE (CH4)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2018 Ex,t (Gg CO2 Eq)	lEx,tl(Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.5	Non-Specified - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Peat	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Biomass	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Biomass	NITROUS OXIDE (N2O)	0	0	0	1
1.B.1	Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.B.1	Solid Fuels	METHANE (CH4)	0	0	0	1
1.B.1	Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.B.2.a	Oil	CARBON DIOXIDE (CO2)	0	0	0	1
1.B.2.a	Oil	METHANE (CH4)	0	0	0	1
1.B.2.a	Oil	NITROUS OXIDE (N2O)	0	0	0	1
1.B.2.b	Natural Gas	CARBON DIOXIDE (CO2)	0	0	0	1
1.B.2.b	Natural Gas	METHANE (CH4)	0	0	0	1
1.B.2.b	Natural Gas	NITROUS OXIDE (N2O)	0	0	0	1
1.C	Carbon dioxide Transport and Storage	CARBON DIOXIDE (CO2)	0	0	0	1
2.A.1	Cement production	CARBON DIOXIDE (CO2)	0	0	0	1
2.A.2	Lime production	CARBON DIOXIDE (CO2)	0	0	0	1
2.A.3	Glass Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.1	Ammonia Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.2	Nitric Acid Production	NITROUS OXIDE (N2O)	0	0	0	1
2.B.3	Adipic Acid Production	NITROUS OXIDE (N2O)	0	0	0	1
2.B.4	Caprolactam, Glyoxal and Glyoxylic Acid Production	NITROUS OXIDE (N2O)	0	0	0	1
2.B.5	Carbide Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.5	Carbide Production	METHANE (CH4)	0	0	0	1
2.B.6	Titanium Dioxide Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.7	Soda Ash Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.8	Petrochemical and Carbon Black Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.8	Petrochemical and Carbon Black Production	METHANE (CH4)	0	0	0	1
2.B.9	Fluorochemical Production	SF6, PFCs, HFCs and other halogenated gases	0	0	0	1
2.C.1	Iron and Steel Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.C.1	Iron and Steel Production	METHANE (CH4)	0	0	0	1
2.C.2	Ferroalloys Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.C.2	Ferroalloys Production	METHANE (CH4)	0	0	0	1
2.C.3	Aluminium production	CARBON DIOXIDE (CO2)	0	0	0	1
2.C.3	Aluminium production	PFCs (PFCs)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2018 Ex,t (Gg CO2 Eq)	lEx,tl(Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
2.C.4	Magnesium production	CARBON DIOXIDE (CO2)	0	0	0	1
2.C.4	Magnesium production	Sulphur Hexafluoride (SF6)	0	0	0	1
2.C.5	Lead Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.E	Electronics Industry	SF6, PFCs, HFCs and other halogenated gases	0	0	0	1
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	0	0	0	1
2.F.2	Foam Blowing Agents	HFCs (HFCs)	0	0	0	1
2.F.3	Fire Protection	HFCs, PFCs	0	0	0	1
2.F.4	Aerosols	HFCs, PFCs	0	0	0	1
2.F.5	Solvents	HFCs, PFCs	0	0	0	1
2.F.6	Other Applications (please specify)	HFCs, PFCs	0	0	0	1
2.G	Other Product Manufacture and Use	SF6, PFCs	0	0	0	1
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.1.b	Land Converted to Forest land	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.2.a	Cropland Remaining Cropland	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.3.a	Grassland Remaining Grassland	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.3.b	Land Converted to Grassland	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.4.a.i	Peatlands remaining peatlands	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.4.a.i	Peatlands remaining peatlands	NITROUS OXIDE (N2O)	0	0	0	1
3.B.4.b	Land Converted to Wetlands	NITROUS OXIDE (N2O)	0	0	0	1
3.B.4.b	Land Converted to Wetlands	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.5.a	Settlements Remaining Settlements	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.5.b	Land Converted to Settlements	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.6.b	Land Converted to Other land	CARBON DIOXIDE (CO2)	0	0	0	1
3.C.1	Emissions from biomass burning	METHANE (CH4)	0	0	0	1
3.C.1	Emissions from biomass burning	NITROUS OXIDE (N2O)	0	0	0	1
3.C.2	Liming	CARBON DIOXIDE (CO2)	0	0	0	1
3.C.4	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	0	0	0	1
3.C.5	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	0	0	0	1
3.C.6	Indirect N2O Emissions from manure management	NITROUS OXIDE (N2O)	0	0	0	1
3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO2)	0	0	0	1
3.C.7	Rice cultivation	METHANE (CH4)	0	0	0	1
Total			716.4218812	716.4218812	1	

Note: The table above was exported from the IPCC software. Cells highlighted in yellow represent the total emissions for the respective categories inclusive of results obtained from the excel spreadsheets. See detailed methodology for more information.

2019 Key Category Analysis

Table 2.30: Approach 1 Level Assessment for GHG Inventory 2019 in Key Category Analysis (Key Categories in red)

IPCC Category code	IPCC Category	Greenhouse gas	2019 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	383.5493854	383.5493854	0.4278704544	0.4278704544
1.A.1	Energy Industries - Liquid Fuels	CARBON DIOXIDE (CO2)	234.9191239	234.9191239	0.2620652154	0.6899356699
4.A	Solid Waste Disposal	METHANE (CH4)	73.4823572	73.48235716	0.0819736147	0.7719092846
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-53.8150263	53.81502632	0.0600336245	0.8319429091
3.B.2.a	Cropland Remaining Cropland	CARBON DIOXIDE (CO2)	38.8729440	38.872944	0.0433649091	0.8753078181
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	19.4699262	19.46992615	0.0217197745	0.8970275926
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	14.4675898	14.46758979	0.0161393929	0.9131669855
3.B.1.b	Land Converted to Forest land	CARBON DIOXIDE (CO2)	-13.3526831	13.35268308	0.0148956531	0.9280626385
3.B.5.b	Land Converted to Settlements	CARBON DIOXIDE (CO2)	11.3435630	11.343563	0.0126543690	0.9407170075
3.A.1	Enteric Fermentation	METHANE (CH4)	9.4041360	9.404136	0.0104908314	0.9512078390
4.D	Wastewater Treatment and Discharge	METHANE (CH4)	7.9470558	7.947055846	0.0088653783	0.9600732172
3.B.3.b	Land Converted to Grassland	CARBON DIOXIDE (CO2)	6.9592600	6.95926	0.0077634376	0.9678366549
4.B	Biological Treatment of Solid Waste	METHANE (CH4)	5.8952055	5.89520547	0.0065764262	0.9744130811
4.B	Biological Treatment of Solid Waste	NITROUS OXIDE (N2O)	5.2214677	5.221467702	0.0058248347	0.9802379158
1.A.3.b	Road Transportation	NITROUS OXIDE (N2O)	4.6547550	4.654754966	0.0051926354	0.9854305512
4.D	Wastewater Treatment and Discharge	NITROUS OXIDE (N2O)	4.3570479	4.357047945	0.0048605268	0.9902910781
1.A.3.b	Road Transportation	METHANE (CH4)	1.4676958	1.4676958	0.0016372955	0.9919283735
2.C.6	Zinc Production	CARBON DIOXIDE (CO2)	1.4150784	1.4150784	0.0015785979	0.9935069714
3.A.2	Manure Management	NITROUS OXIDE (N2O)	1.1900332	1.190033205	0.0013275476	0.9948345189
3.C.4	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	0.9308534	0.9308534	0.0010384182	0.9958729372
2.G	Other Product Manufacture and Use	NITROUS OXIDE (N2O)	0.8900100	0.89001	0.0009928552	0.9968657923
3.C.3	Urea application	CARBON DIOXIDE (CO2)	0.7702200	0.77022	0.0008592228	0.9977250151
3A.2	Manure Management	METHANE (CH4)	0.5984616	0.59846157	0.0006676168	0.9990311982
2.D	Non-Energy Products from Fuels and Solvent Use	CARBON DIOXIDE (CO2)	0.5724202	0.5724202	0.0006385662	0.9983635814
1.A.1	Energy Industries - Liquid Fuels	NITROUS OXIDE (N2O)	0.5645343	0.564534329	0.0006297691	0.9996609673
1.A.1	Energy Industries - Liquid Fuels	METHANE (CH4)	0.1912132	0.19121324	0.0002133089	0.9998742762
4.C	Incineration and Open Burning of Waste	METHANE (CH4)	0.0357876	0.035787556	0.0000399230	0.9999141992
1.A.4	Other Sectors - Liquid Fuels	METHANE (CH4)	0.0328575	0.032857535	0.0000366544	0.9999508536
4.C	Incineration and Open Burning of Waste	CARBON DIOXIDE (CO2)	0.0158272	0.015827161	0.0000176561	0.9999685097
1.A.4	Other Sectors - Liquid Fuels	NITROUS OXIDE (N2O)	0.0103308	0.010330815	0.0000115246	0.9999800343
4.C	Incineration and Open Burning of Waste	NITROUS OXIDE (N2O)	0.0101188	0.010118833	0.0000112881	0.9999913224
1.A.4	Other Sectors - Biomass	METHANE (CH4)	0.0070137	0.007013731	0.0000078242	0.9999991466
1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	0.0005177	0.00051768	0.0000005775	0.9999997241

IPCC Category code	IPCC Category	Greenhouse gas	2019 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
2.A.4	Other Process Uses of Carbonates	CARBON DIOXIDE (CO2)	0.0002473	0.000247348	0.0000002759	1
1.A.1	Energy Industries - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.1	Energy Industries - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Peat	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.1	Energy Industries - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.1	Energy Industries - Biomass	METHANE (CH4)	0	0	0	1
1.A.1	Energy Industries - Biomass	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Peat	CARBON DIOXIDE (CO2)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2019 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.2	Manufacturing Industries and Construction - Peat	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	METHANE (CH4)	0	0	0	1
1.A.2	Manufacturing Industries and Construction - Biomass	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.a	Civil Aviation	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.a	Civil Aviation	METHANE (CH4)	0	0	0	1
1.A.3.a	Civil Aviation	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.c	Railways	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.c	Railways	METHANE (CH4)	0	0	0	1
1.A.3.c	Railways	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Peat	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	METHANE (CH4)	0	0	0	1
1.A.3.d	Water-borne Navigation - Biomass	NITROUS OXIDE (N2O)	0	0	0	1
1.A.3.e	Other Transportation	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.3.e	Other Transportation	METHANE (CH4)	0	0	0	1
1.A.3.e	Other Transportation	NITROUS OXIDE (N2O)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2019 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
1.A.4	Other Sectors - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.4	Other Sectors - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.4	Other Sectors - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.4	Other Sectors - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.4	Other Sectors - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.4	Other Sectors - Peat	METHANE (CH4)	0	0	0	1
1.A.4	Other Sectors - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.4	Other Sectors - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Liquid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Gaseous Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Gaseous Fuels	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Gaseous Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Other Fossil Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Peat	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Peat	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Peat	NITROUS OXIDE (N2O)	0	0	0	1
1.A.5	Non-Specified - Biomass	CARBON DIOXIDE (CO2)	0	0	0	1
1.A.5	Non-Specified - Biomass	METHANE (CH4)	0	0	0	1
1.A.5	Non-Specified - Biomass	NITROUS OXIDE (N2O)	0	0	0	1
1.B.1	Solid Fuels	CARBON DIOXIDE (CO2)	0	0	0	1
1.B.1	Solid Fuels	METHANE (CH4)	0	0	0	1
1.B.1	Solid Fuels	NITROUS OXIDE (N2O)	0	0	0	1
1.B.2.a	Oil	CARBON DIOXIDE (CO2)	0	0	0	1
1.B.2.a	Oil	METHANE (CH4)	0	0	0	1
1.B.2.a	Oil	NITROUS OXIDE (N2O)	0	0	0	1
1.B.2.b	Natural Gas	CARBON DIOXIDE (CO2)	0	0	0	1
1.B.2.b	Natural Gas	METHANE (CH4)	0	0	0	1
1.B.2.b	Natural Gas	NITROUS OXIDE (N2O)	0	0	0	1
1.C	Carbon dioxide Transport and Storage	CARBON DIOXIDE (CO2)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2019 Ex,t (Gg CO2 Eq)	lEx,tl (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
2.A.1	Cement production	CARBON DIOXIDE (CO2)	0	0	0	1
2.A.2	Lime production	CARBON DIOXIDE (CO2)	0	0	0	1
2.A.3	Glass Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.1	Ammonia Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.2	Nitric Acid Production	NITROUS OXIDE (N2O)	0	0	0	1
2.B.3	Adipic Acid Production	NITROUS OXIDE (N2O)	0	0	0	1
2.B.4	Caprolactam, Glyoxal and Glyoxylic Acid Production	NITROUS OXIDE (N2O)	0	0	0	1
2.B.5	Carbide Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.5	Carbide Production	METHANE (CH4)	0	0	0	1
2.B.6	Titanium Dioxide Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.7	Soda Ash Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.8	Petrochemical and Carbon Black Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.B.8	Petrochemical and Carbon Black Production	METHANE (CH4)	0	0	0	1
2.B.9	Fluorochemical Production	SF6, PFCs, HFCs and other halogenated gases	0	0	0	1
2.C.1	Iron and Steel Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.C.1	Iron and Steel Production	METHANE (CH4)	0	0	0	1
2.C.2	Ferroalloys Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.C.2	Ferroalloys Production	METHANE (CH4)	0	0	0	1
2.C.3	Aluminium production	CARBON DIOXIDE (CO2)	0	0	0	1
2.C.3	Aluminium production	PFCs (PFCs)	0	0	0	1
2.C.4	Magnesium production	CARBON DIOXIDE (CO2)	0	0	0	1
2.C.4	Magnesium production	Sulphur Hexafluoride (SF6)	0	0	0	1
2.C.5	Lead Production	CARBON DIOXIDE (CO2)	0	0	0	1
2.E	Electronics Industry	SF6, PFCs, HFCs and other halogenated gases	0	0	0	1
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	0	0	0	1
2.F.2	Foam Blowing Agents	HFCs (HFCs)	0	0	0	1
2.F.3	Fire Protection	HFCs, PFCs	0	0	0	1
2.F.4	Aerosols	HFCs, PFCs	0	0	0	1
2.F.5	Solvents	HFCs, PFCs	0	0	0	1
2.F.6	Other Applications (please specify)	HFCs, PFCs	0	0	0	1
2.G	Other Product Manufacture and Use	SF6, PFCs	0	0	0	1
3.B.3.a	Grassland Remaining Grassland	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.4.a.i	Peatlands remaining peatlands	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.4.a.i	Peatlands remaining peatlands	NITROUS OXIDE (N2O)	0	0	0	1
3.B.4.b	Land Converted to Wetlands	NITROUS OXIDE (N2O)	0	0	0	1
3.B.4.b	Land Converted to Wetlands	CARBON DIOXIDE (CO2)	0	0	0	1
3.B.5.a	Settlements Remaining Settlements	CARBON DIOXIDE (CO2)	0	0	0	1

IPCC Category code	IPCC Category	Greenhouse gas	2019 Ex,t (Gg CO2 Eq)	IEx,tI (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.B.6.b	Land Converted to Other land	CARBON DIOXIDE (CO2)	0	0	0	1
3.C.1	Emissions from biomass burning	METHANE (CH4)	0	0	0	1
3.C.1	Emissions from biomass burning	NITROUS OXIDE (N2O)	0	0	0	1
3.C.2	Liming	CARBON DIOXIDE (CO2)	0	0	0	1
3.C.5	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	0	0	0	1
3.C.6	Indirect N2O Emissions from manure management	NITROUS OXIDE (N2O)	0	0	0	1
3.C.7	Rice cultivation	METHANE (CH4)	0	0	0	1
3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO2)	0	0	0	1
Total			762.0793288	896.4147476	1	

Note: The table above was exported from the IPCC software, however the cells highlighted in yellow represent the total emissions for the respective categories inclusive of results obtained from the excel spreadsheets. See detailed methodology for more information.

DATA UNCERTAINTIES

Energy Sector

There are several sources of qualitative uncertainty in the energy sector GHG emissions estimate:

- *Lack of completeness:* Local charcoal production and use data are not formally collected in Antigua and Barbuda. Data to inform this emissions estimate was sourced directly from Antiguan charcoal producers for inventory year 2019. Data for the remaining inventory years were not available, and 2019 production was therefore assumed to be representative of the entire period. Data was not available on Barbudan charcoal production.
- *Measurement error:* Measurement error is inherent in any GHG emissions estimate. It is caused by errors in measuring, recording and transmitting information, instrument resolution, inconsistent standards and reference materials, and inexact values of constants and other parameters. This GHG estimate applied the Tier 1 methodology and default emissions factors from the IPCC Guidelines, introducing error from inexact parameter values.
- *Lack of representativeness of data:* The fishing and yachting industries, agriculture and construction machinery, and back-up energy represent significant gasoline and diesel fuel consumption in Antigua and Barbuda. In this emissions estimate, the variations in combustion efficiencies of these machines are not accounted for since disaggregated motor gasoline and diesel use data were not available. All gasoline and diesel fuel sales are therefore assumed for road transport. Similarly, an account and understanding of the types and quantities of family and commercial vehicles in use in Antigua and Barbuda would further reduce the uncertainty.

- *Misreporting or misclassification:* All fuel data used in this estimate for both the reference and sectoral approach was provided by the West Indies Oil Company Ltd. There is no entity that collects and compiles national energy statistics for use in validation of this data. While it is not expected that there are misreporting or misclassification errors in this data, there is also no way to rule it out.

Industrial Processes and Products Use

The gaps and constraints associated with the IPPU sector is mainly associated with the quality and availability of data for this sector. The following are important factors in the sector:

- HFC emissions prove to be the leading contributor of GHG emissions for IPPU. The limited availability of data on sales in this sector presents a gap. Additionally, the lack of data for 2016 has skewed results obtained in this sector. Also, the inability to calculate actual uncertainties in emissions associated with this key category may introduce further discrepancies. Improved data recording techniques by stakeholders and the development of national emission factors.
- For N_2O use in various medical applications, the calculation of uncertainties was omitted as the uncertainty estimates should be obtained from manufacturers and distributors or by expert judgment according to the IPCC 2006 guidelines as per section 8.4.3.2 on p. 8.38. This would require distributors on island to proactively obtain this information from manufacturer/suppliers in order to mitigate this gap.
- There are high levels of uncertainties introduced by using the default factors outlined in the 2006 IPCC Guidelines for emission factors (50 percent and 100 percent) for non-energy product use.

Agriculture

There are several sources of qualitative uncertainty in the agriculture sub-sector GHG emissions estimate:

- There was heavy reliance on the default emission factors provided by the 2006 IPCC Guidelines. These factors for the most part are quite general and specific species, which may be unique for the Caribbean, including Antigua and Barbuda, may not necessarily be catered for in the emissions factors.
- With regard to the activity data, uncertainties came mainly from the point and origin of the data source. The unavailability of consistent, accurate and complete data, coupled with the absence of quality assurance and quality control at the data source, contributed to the uncertainty. Custodians at the data source were often hindered by lack of resources as well as the need for ongoing training to collect and manage the data specific to the preparation of the GHG inventory.
- Uncertainties within the Agriculture Sector are usually associated with activity and emissions data. The exclusive dependence upon the FAO, although useful with expert advice, is not the accurate picture of the animal population in Antigua and Barbuda. It means that the data are based upon estimates and not the actual population of livestock. In addition, the exact species and full population of each species is not cataloged for Antigua and Barbuda. This too introduced errors in activity data.

- It is noticed that the default emission factor for breeding cows of 72 Kg head year^{-1} assumes that there is a specific daily milk production. The breeding cows for Antigua and Barbuda do not produce such quantities and this introduces errors in estimating the methane emissions from enteric fermentation. Similarly, it is also assumed that the average live weight for sheep and goats are 45 Kg and 40 Kg respectively. However, the actual average live weights nationally are closer to 30 kg and 26kg respectively, according to expert advice from the Ministry of Agriculture. This also introduces errors in estimation.
- In calculating the direct N2O emissions from Manure Management, default Nitrogen excretion rate values were used for poultry that assumed that 90 percent of the swine population is market swine and 10 percent is breeding swine. However, according to expert advice from the Ministry of Agriculture the ratio of Layers to boilers for Antigua and Barbuda is closer to 80 percent to 20 percent respectively. It is possible that this will affect the accuracy of the N2O emissions calculated.
- The Typical Animal Mass (TAM) was needed for the calculation of direct N2O emissions. However, the TAM for Deer was unavailable from the IPCC Guidelines. In addition, there were no national data on Typical Animal Mass, so the values used were exclusively from default IPCC Guidelines. This is a source of activity data and could introduce errors in emission estimate.
- As part of the calculation of direct N2O emissions, the fraction of total annual nitrogen excretion managed in MMS for each species/livestock was determined using default factors from countries that had similar conditions.
- The data used for the livestock population were based upon those provided by the FAO website, which was accessed as recently as March 25, 2021 to verify the figures. Ideally it would have been better to obtain actual data from the various departments within the Ministry of Agriculture. Consequently, upon consultation with the Ministry of Agriculture, it was decided that expert advice would be provided from experts within the Ministry of Agriculture to assess how the estimated figures from FAO are representative for Antigua and Barbuda. These figures for animal population introduced some uncertainties since the methodology used by FAO was estimates and imputation methodology. However, there was expert opinion provided on the dataset for Antigua and Barbuda within the Ministry of Agriculture and this is within the acceptable standard as regulated by the UNFCCC.
- Antigua and Barbuda for the most part still uses a traditional form of manure management. The absence of a developed manure management system led to a best guess approach, and this could affect the calculation of nitrous oxide and methane from manure management.
- The total annual figure for urea was determined from the total annual fertilizer imports for Antigua and Barbuda. Two key assumptions were made. First, that all of the fertilizer imported were applied to soils, and secondly, all of the fertilizer was exclusively urea notwithstanding other constituents that comprised the fertilizer. This allowed for the easy calculation of the

amount of urea in tons for the GHG inventory.

- As part of the calculation of methane and direct N_2O emissions from poultry, the excretion rate factor for boilers was used. However, the range of poultry in Antigua and Barbuda includes, ducks, pullets, hens and chickens reared for egg production. This could affect the final calculation given that each sub-category carries different excretion rates.

Forestry and Other Land Use

The analysis of land use change between 2003 and 2019 was conducted using the software Collect Earth and this was applied to both Antigua and Barbuda. This is an improvement from the land use analysis conducted in the Biennial Update Report when only mainland Antigua was assessed. For this assessment, a consultant was contracted who conducted the analysis. Similarly, expert judgment of the Forestry staff was used to determine percentages of the forests sub-categories. Resources need to be invested into developing the capacity of the Forestry Unit in using the Collect Earth, or other appropriate land use analysis tools. This would improve the accuracy of the data collection.

Waste

There are several sources of uncertainty in the waste sector:

- The lack of historical data on the amount and composition of waste at Solid Waste Disposal Sites (SWDS) is a significant source of uncertainty. Waste data from 2006-2019, and population data dating back to 1969 was used to extrapolate historical waste amounts. In addition to waste data over such a significant period being extrapolated, prior to 2006 the amounts, composition, and practices of waste treatment were unmonitored. Consequently, the accuracy of extrapolated data cannot be determined. However, despite these issues with accuracy, it was important to estimate these waste amounts to estimate the delayed release of greenhouse gases from waste over time.
- There are several uncertainties that can be attributed to the First Order Decay (FOD) method that was used to estimate emissions from Solid Waste Disposal Sites[91] .
    a. The FOD method does not account for the fact that the decay of carbon compounds may not follow a first order decay reaction. The type of reaction that occurs as waste breaks down at SWDS is dependent on the conditions at the site. This was not taken into consideration in the calculations.
    b. The FOD method introduced uncertainty in the decay rates of historical waste. The rate at which waste decays over time is dependent on conditions within the site, and these conditions are not taken into consideration in the calculations.
- Regional default values had to be used to estimate the emissions from open burning of waste in the community. Although it is recognized that this practice is carried out in Antigua and Barbuda, data on the practice is not collected. An assumption was made that 10 percent of the population partakes in the open burning of waste. This

[91] "Section 3.7.2.1, Chapter 3: Solid Waste Disposal." 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

value was chosen for the sake of consistency with previous emissions calculations. However, without country specific activity data, this may be an under or over-estimation of the percentage of the population that partakes in this practice.

- Uncertainty may have been introduced if the population numbers do not match the population whose waste is collected and taken to Cook's Landfill. This may be an issue especially in rural homes, whose waste may not get collected.
- There are significant sources of uncertainty associated with the default parameters [92] .Higher uncertainty is associated with the use of regional default values. Default values for parameters, such as emission factors among several others, introduced a higher level of uncertainty than country-specific parameters.

RECOMMENDATIONS

Energy Sector

It is recommended that fossil fuel distributors, energy services providers (WIOC, APUA) and charcoal producers are encouraged to provide accurate and timely data and information to the National Statistics Division. This practice would allow the National Statistics Division to fulfil their mandate of compiling and disseminating official statistics. It would also allow for a reduction in uncertainty in future analysis, as well as a secondary source of data and a means of verification. Ultimately, an increase in the consumption of alternative energy solutions by the population would greatly reduce Antigua and Barbuda's carbon footprint.

Industrial Products and Products Use

- The country should also seek expert advice regarding emissions uncertainty tailored for Antigua and Barbuda as stipulated in the 2006 IPCC Guidelines.
- The Food and Beverage industry presents constraints from the lack of information in the 2006 IPCC Guidelines for calculating emissions such as NMVOCs and dealing with uncertainties. This should be addressed in the guidelines for future tabulations.
- The country should look at the feasibility of developing national emission factors particularly for key categories which are major emission contributors and categories with high uncertainties to improve the data quality for reporting inputs
- Involve the ODS Unit in the preparation of the GHG Inventory and collaborate on collecting and validating data for the ODS categories.

Agriculture Sector

In an effort to improve the quality of data collected for future inventories, a list of recommendations is provided below for the agriculture sector. The goal is to also decrease the levels of uncertainties, which could become a reality if the recommendations are implemented. Finally, it would be to the benefit of the country to implement a system

[92] "Section 3.7.2.2, Chapter 3: Solid Waste Disposal." 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

for the continuous collection of GHG-related data, thereby making trend analysis possible in the future.

- The Ministry of Agriculture has planned a livestock population census in conjunction with the FAO to commence by the year 2020. At the time of the preparation of this inventory, consultation with the Ministry of Agriculture revealed that the census was yet to commence. The census will seek to obtain information on animal species, population and more specifically the population of breeders in each species. This according to the Ministry of Agriculture should be commenced shortly. It is envisioned that the results of this census will bolster accurate and complete data that will greatly assist with the calculation of future GHG inventories.
- The Ministry of Agriculture should prepare an inventory of the total amount of land assigned and cultivated for farming. Each farmer could report to the Ministry of Agriculture that amount of land under cultivation and the location of the said lands. This allows for quantifying the amount of soils that are limed so that an estimate of emission could be determined.
- Additionally, it is suggested that the Ministry of Agriculture develop protocols for regular data collection and adequate data storage systems to enable more efficient management of this sector, as well as to facilitate a more proficient analysis of the GHG emissions.
- Ministry of Agriculture could collaborate with the Department of Environment to develop a data management and collection protocols.
- Antigua and Barbuda should continue to collaborate with the UNFCCC and other international and regional agencies to develop national emission factors. Regular meetings with regional and international consultants along with national stakeholders have been convened. This is a very remarkable and commendable accomplishment for the Department of Environment and more of the same is encouraged.
- The legislative framework is established to have farmers be responsible to register and report data on their livestock, if this is not already in place, with the necessary penalties for not reporting the same. Meanwhile there is also a need to capture and archive the data for stray animals.
- There were inconsistencies in the data gathering process in that the data at the sources, for example, the Ministry of Agriculture did not always correspond with that at the Statistical Department. There is therefore a need to strengthen the data sharing platform so that there is a central repository where data can be easily accessed.
- The establishment of a quality control body to ensure the highest standards are employed for data methodology to be instituted at the data source and a secondary mechanism for quality control and quality assurance at the level of the central repository. This ensures that data necessary for a multiple of projects as well as data for reporting to international agencies are as accurate as possible and stored in the necessary format for reporting.
- With regards to the situation in Barbuda, getting accurate numbers of deer and wild pigs proved difficult without the necessary capacity. However, advice may be obtained

from agencies such as World Society of Protection of Animals (WSPA) among others, that have extensive experience in accurately estimating wild livestock populations.

Forestry and other land Use Sector

- More accurate data can be obtained if additional resources are invested into developing the capacity of the Forestry Unit and other relevant agencies in using the Collect Earth, or other appropriate land use analysis tools, to delineate and classify the forest types, crop types and grassland types in Antigua and Barbuda.
- There was no clear way of distinguishing perennial crops from annual crops or to distinguish herbaceous and woody grassland. A suggestion would be to work with the Ministry of Agriculture to develop a crop and grassland type shapefile and use this layer when conducting the Collect Earth Analysis.
- The emissions from biomass loss due to fires has not been estimated due to a lack of activity data. The Fire Department still only keeps data on number of fires. It is recommended that an agreement is developed with the Fire Department to provide resources and training to assist them in collecting this data. This gap that was also mentioned in previous reports, the TNC and BUR.
- The lack of nationally generated emission factors would also influence the accuracy of the calculations. In all cases, the default factors had to be used and this may not result in accurate calculations of emissions. It is recommended that options be explored where possible for the development of national, or even regional, emission factors.

Waste Sector

- Collaborate with Antigua and Barbuda Fire Department to develop a methodology or guidelines on collecting data regarding open burning of waste. The availability of this data will provide country-specific data on this practice and will eventually enable the use of a higher tiered method in regard to the open burning of waste.
- Collaborate with the Statistics Division to include data collection on domestic wastewater practices, and other practices that may provide country-specific data to calculate emissions from the waste sector.
- Collaborate with private stakeholders, such as hotels and resorts with wastewater and waste management plants, to develop guidelines for data collection on waste treatment and disposal practices. This data should then be collected and included in future estimations of emissions from the waste sector.
- Collaborate with representatives from the solid waste disposal site located on Barbuda to collect waste disposal data. This data should then be included in future estimations of emissions from the waste sector.
- Collaborate with waste management authorities in Barbuda to gain access to data on waste practice on the island, and include this data in future estimations of emissions from the waste sector.
- Collaborate with the Central Board of Health to develop guidelines and methodologies to collect data on the practice of illegal dumping of waste that

may be contributing to emissions from the waste sector.

- Collaborate with the incineration facility at Mount St. John's hospital to ensure that they are accurately collecting data that can be included in future emissions calculations for the waste sector.

Policies

In its Third National Communication, Antigua and Barbuda identified a quantified economy wide emissions reduction limit to reduce its GHG emissions by 25 percent by 2020 compared to a 1990 baseline, a commitment under the Copenhagen Accord. However, in developing the revised National Determined Contributions of 2021, Antigua and Barbuda's mitigation priorities were refocused towards a 'policies and measures'-based approach, as indicated by the targets that were set. The Conditional Mitigation targets presented in the NDCs that would have a direct impact on the GHG emissions are:

- By 2030, achieve an energy matrix with 50 MW of electricity from renewable sources both on and off-grid in the public and private sectors
- By 2030, all remaining wetlands and watershed areas with carbon sequestration potential are protected as carbon sinks

Antigua and Barbuda have recently provided the revised NDCs which contain a number of targets that would have direct impact on the GHG emissions. The revised targets can be accessed at this link[93]. The existing policies in Antigua and Barbuda that contribute to the reduction of GHG emissions and/or improving GHG removal potential are:

- Environmental Protection and Management Act, 2019
- Renewable Energy Act, 2015
- National Energy Policy, 2011
- Interconnection Policy, 2011
- Regional Energy Efficient Building Code, 2018 111

CHAPTER CONCLUSION

A summary of the national GHG emissions for the inventory years 2016-2019 are provided below:

Table 2.31: Summary of GHG emissions by Year

Green House Gases	Total in Gg			
Emissions	2016	2017	2018	2019
Carbon Dioxide (CO_2)	587.165	582.554	599.414	644.610
Non Carbon Emission				
Methane (CH_4)	4.507	4.636	4.730	4.717
Nitrous Oxide (N_2O)	0.050	0.057	0.057	0.058
Non-methane volatile organic compounds (NMVOC)	0.063927	0.0612	0.0613	0.0604
Hydrofluorocarbons (HFC)	0	0	0.00174	0.066

[93] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Antigua%20and%20Barbuda%20First/ATG%20-%20UNFCCC%20NDC%20-%202021-09-02%20-%20Final.pdf

Table 2.32: Summary of GHG emissions by Year (Gigatonnes)

Green House Gases	Total in GT			
Emissions	2016	2017	2018	2019
Carbon Dioxide (CO_2)	0.0005872	0.0005826	0.0005994	0.0006446
Non Carbon Emission				
Methane (CH_4)	0.000004507	0.000004636	0.000004730	0.000004717
Nitrous Oxide (N_2O)	.000000050	0.000000057	0.000000057	0.000000058
Non-methane volatile organic compounds (NMVOC)	0.0000000639	0.0000000612	0.0000000613	0.0000000604
Hydrofluorocarbons (HFC)	0.00	0.00	0.0000000017	0.000000066

Table 2.33: Summary of GHG emissions by sector in CO_2 Eq

Green House Gases	Total in Gg			
Sectors	2016	2017	2018	2019
Energy	591.273	586.224	603.072	644.867
Industrial Processes and Product Use	3.386	3.5997	3.7307	2.878
Agriculture[94]	13.232	13.347	12.928	12.893
Forestry and Other Land Use	0	0	0	3.898
Waste	89.301	94.522	96.690	96.964
TOTAL	697.20	697.692	716.422	761.502

Table 2.34: Summary of GHG emissions by sector in CO_2 Eq (Gigatonnes)

Green House Gases	Total in Gg			
Sectors	2016	2017	2018	2019
Energy	0.0005913	0.0005862	0.0006031	0.0006449
Industrial Processes and Product Use	0.000003386	0.0000035997	0.00000373	0.00000288
Agriculture[95]	0.00001323	0.00001335	0.00001293	0.00001289
Forestry and Other Land Use	0.00	0.00	0.00	0.000003898
Waste	0.00008930	0.00009452	0.00009669	0.00009696
TOTAL	0.0006972	0.00069769	0.00071642	0.00076150

[94] Inclusive of categories 3A – Livestock and 3C – Aggregate sources and non-CO2 emissions sources on land

[95] Inclusive of categories 3A – Livestock and 3C – Aggregate sources and non-CO2 emissions sources on land

Note – The 100-year GWP of the HFCs and NMVOC are excluded from these totals due to data availability issues.

The uncertainty values for the individual inventory years are presented below:

- 2016: 5.1 percent
- 2017: 5.2 percent
- 2018: 5.3 percent
- 2018: 6.4 percent

It is important to note that there are efforts in place to significantly reduce GHG emissions by 2025. Additionally, data from this Inventory may be used to provide evidence of the present-day situation so that solutions can be encouraged to reduce emissions and point the way forward towards renewable energy sources and energy efficiency.

CHAPTER 3

MITIGATION ACTIONS

Context

This 4NC chapter was developed with the support of the NDC partnership and IRENA. Over 1700 persons were interviewed and significant amount of data collected. The Department of the Environment coordinated this process and asked that two independent studies were completed and for the first time these included the element of backup energy within the energy systems. The process took about 12 months and culminated in the Government publishing the updated NDC 2021 which is available in the UNFCCC website. This chapter provide detailed analysis on the process and findings since it is important to understand the strategy for the way forward for energy transition in a manner that respects the current energy systems and the need for backup energy in each and every home as an adaptation measure.

Students install solar panels at their school

Background

Globally, emissions of greenhouse gases have increased by approximately 75 percent since 1970. Over the last two decades, a particularly striking pattern has been the globalization of production and trade of manufactured goods (IPCC, 2014). As global greenhouse gas

emissions have continued to increase each year, many small island developing states (SIDS), particularly Antigua and Barbuda, have committed to preparing strategies, plans and actions for low greenhouse gas emissions development. As such, the twin-island state accounts for its emissions and removals, despite its miniscule contribution to global greenhouse gas emissions.


Devastation in Barbuda following Cate gory 5+++ Hurricane Irma in 2017

Antigua and Barbuda have signed onto several important international agreements and to undertake actions to ensure that the twin-island state can move towards becoming a sustainable, low-carbon economy will be largely dependent on the country's ability to reduce its dependency on fossil fuels which is the country's main source of energy for transportation, electricity, and domestic uses, primarily, cooking. The movement towards renewables is also an adaptation measure in this Island that is prone to hurricanes and droughts.


Increasing use of renewable energy

Antigua and Barbuda's economy is primarily service based, with tourism accounting for the majority of economic activity. The projected GDP for 2020 is EC$3.7 billion or US$1.37 billion, representing a sharp decline from the 2019 value of EC$4.5 billion or US$1.6 billion [96] . The current account balance for 2020 is -24.7 percent of GDP[97], accentuated by the country's high dependence on imports. The reduced GDP can be attributed to the severe impacts of the COVID-19 pandemic on the global economy. GDP growth is expected to return to 3.7 percent for 2021. Below is a

[96] Statistics Division

[97] IMF Data Mapper

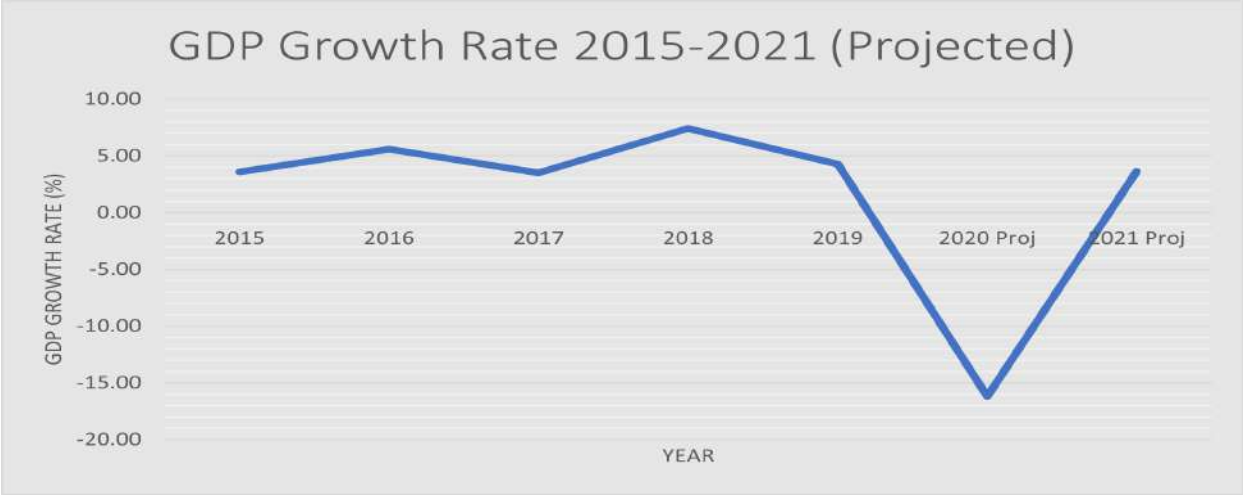
Reduced energy use through energy efficiency farming

graph showing GDP growth rates over the past 5 years. Future growth prospects are highly dependent on global economic recovery efforts and the management of the pandemic. The resumption of free-flowing international travel is essential for an improvement in the economic situation moving forward. Passenger arrivals have fallen since the onset of the pandemic in March of 2020, with arrivals for the month of October 2020 (6,937) down 65 percent from the value in 2019 (19,971)[98].

The current population (2020) is 97,895 persons[99], and is expected to grow at 1 percent for the period 2021-2026. The gradual increase in population is expected to lead to an increased energy demand. This is verified by APUA's projections of future energy generation, shown in the graph below.

Since the Third National Communication, Antigua and Barbuda have improved its ability to access assistance from bilateral and international lenders. The country established a legislative and financing framework for climate action through the enactment of the EPMA in 2019. The Department of Environment (DOE) has been accredited to the Green Climate Fund (GCF) and AF, which has enhanced opportunities for international finance to support projects. The pegging of the EC Dollar to the USD and participation in the Eastern Caribbean Central Bank (ECCB) guarantees a degree of exchange rate stability and no risks of capital flow restrictions. This monetary policy further strengthens the country's position as a low-risk option for development assistance. Antigua and

Figure 3.1: GDP Growth Rate for the Period 2015-2021



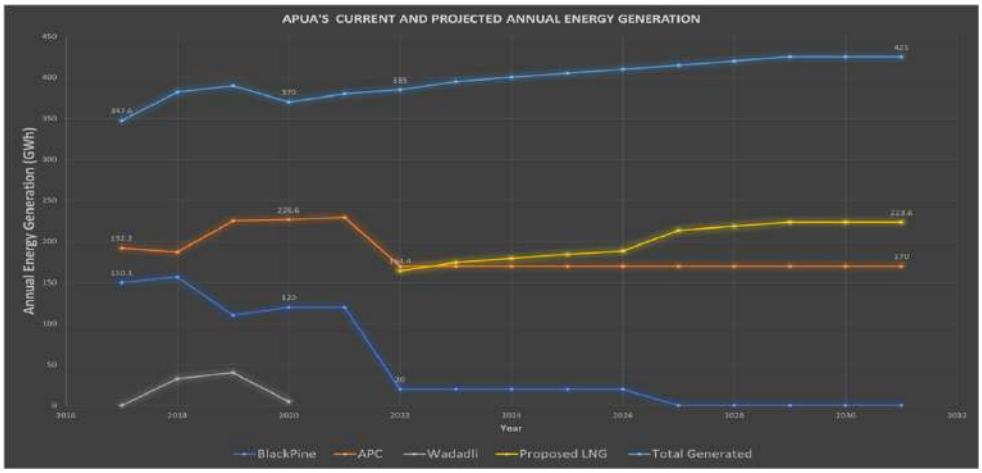
[98] Statistics Division

[99] Statistics Division 2020

Barbuda however is considered a high risk jurisdiction for AML/CTF and therefore has to provide additional external assurances to ensure that the country can continue access low cost financing. Most current flows go toward adaptation projects, however, there is a distinct need for prioritization of decarbonization of the energy sector as a means to reduce GHG emissions. Decarbonization can serve as a pathway to resilience for the sector by reducing reliance on importation of fossil fuels, providing much needed energy security.

Taking all the above into consideration, there is a need to design projects and policies take into consideration economic and population growth, hurricanes, drought, climate change mitigation as well as social and gender policies.

Figure 3.2: APUA's Current and Projected Annual Energy Generation



Sectorial Approaches and methods to Mitigation Assessment– Data Collection and Analysis by Specific Sectors

- Backup energy sector paper
- Transport and Government fleet
- IRENA Road Map
- GHG Reduction Report
- Simplified Mitigation Pathways
- Gender analysis of the Mitigation Pathways

Backup Energy Sector

From a study conducted by the DOE in 2020, it was established that the capacity of backup diesel generators within Antigua and Barbuda is at least 36,526 kW (36.52 MW), which equates to approximately 45 percent of the grid's present generating capacity [100] . Considering the limitations of this study and the response rate of the survey (only 50 percent of hotels submitted responses), conservative projections for the complete standby diesel generator capacity for the country would be upwards of 60 percent – 70 percent of the generating capacity of Antigua and Barbuda's utility and Independent Power Producers (IPPs) (i.e., 48 MW – 56 MW).

[100] In September 2020 the Wadadli Power Plant was closed, as such generation capacity within Antigua decreased from approximately 110,000 kW (110 MW) to 80,000 kW (80 MW).

Methodology

Major sectors throughout Antigua and Barbuda were identified to participate in a study of the backup energy sector. The results of the study are provide in Table 3.1 below.

Table 3.2: Backup Energy Survey Results

Sector	Targeted Participants	Actual Number of Participants	Response Percentage	Percentage with a diesel generator	Standby Generation Capacity (kW)	Total Diesel Stored On-Site (US Gallons)
Hotel	60	30	50.00%	83.33%	23,863	141,870
Private Business	12	10	83.33 %	90.00%	5,845	15,409
Restaurant	14	3	21.43%	66.67%	152	240
Banks	11	3	27.27%	100.00%	900	18
Public Buildings	4	4	100.00%	100.00%	5,605	20,000
Residential	30	29	96.66%	30.00%	161	Unknown
Total	**131**	**79**	**Avg – 60.30%**	**Avg – 77.83%**	**36,526**	**177,537**

The significant number of backup generators in the country can be attributed to frequent power outages throughout the country's recent history. Damage experienced by the electric grid during severe weather events can leave the country without power for days to months. As a result, backup diesel generators have become commonplace within Antigua and Barbuda. The results in Table 3.1 show a range of 65 - 100 percent of the business (hotels, restaurants, private businesses) sector, and public sector having diesel generators. This demonstrates the necessity of owning a backup generator to effectively run a business and workplace in the country. Although the percentage of residential respondents with diesel generators stands at 30 percent, 100 percent of respondents indicated that they would be interested in having a backup generator if they could afford it.

Similarly, of the persons surveyed, 100 percent indicated that they would be interested in owning renewable energy system with battery storage if the systems are affordable. Backup energy is part of Antigua and Barbuda's culture as it is routine to prepare for grid outages caused by weather or other events. Consequently, it is expected that as the cost of sustainable technologies continues to decrease, the dominance of diesel generators will be replaced by alternate backup generation in the form of renewable energy technologies as the people of Antigua and Barbuda continue to adapt to climate change.

GRID DELIVERED ELECTRICITY PROFILE OF ANTIGUA AND BARBUDA:

Grid Power Capacity – Fossil Fuel

The Antigua Public Utilities Authority (APUA), a government-owned and operated company, is the sole distributor of electricity on the islands of Antigua and Barbuda. APUA receives between 80 percent-90 percent of the electricity it distributes from the Antigua Power Company Limited (APCL), a locally owned independent power producer (IRENA 2016). APUA reported that in 2017 Antigua's reached peak electricity demand of s 54MW. They estimate that peak demand will increase to 68MW by 2030. The fossil fuel power plants on the island operate mostly on heavy fuel oil (HFO), which is purchased from the West Indies Oil Company (WOIC).

In Antigua there are three fossil-fuelled power plants, Wadadli, Black Pine and APCL Crabbs which have a total capacity of 107.9MW. The Wadadli plant was commissioned in September 2011 and was closed in September 2020, due to technical challenges. The Wadadli plant is the first of three plants to be decommissioned with the Black Pine slated to be next. Figure 3 shows the gradual decommissioning of the Black Pine plant which started in 2019 and is estimated to be completed by 2027. The APCL Crabbs Plant of

50MW capacity will be the last of the aforementioned plants to be retired. By 2031, APCL will relinquish ownership of the Crabbs plant to APUA. The power capacity of APCL Crabbs Plant is projected to remain unchanged up to the year 2031 from the perspective of the utility company. In July 2020, APUA issued a RFEOI for a natural gas powered 25-30MW plant to succeed the Black Pine power plant and augment firm power generation. The plant is proposed to be commissioned in 2022 (APUA 2020).

Barbuda receives electricity produced from diesel generators owned and operated by APUA. The power plant on the island had a total of 2.15MW capacity which operated at ~60 percent to meet the electricity demand. Prior to the passing of Hurricane Irma's in 2017, the peak electricity demand of the island was 0.5MW, with a mean daytime load of 0.38MW that served a population of 1800[101]. The hurricane had destroyed the majority of the electrical infrastructure leaving several persons without electricity. APUA was able to repair one of their diesel generators 0.6MW and rented an additional generator of 0.535MW to restore electricity on the island as a temporary solution. In 2018, with the restoration of electricity on the island, electricity costs on average 0.37USD/kWh. The population has not returned to post-hurricane numbers which have resulted in the power demand of the island decreasing to an average load of 0.18MW.

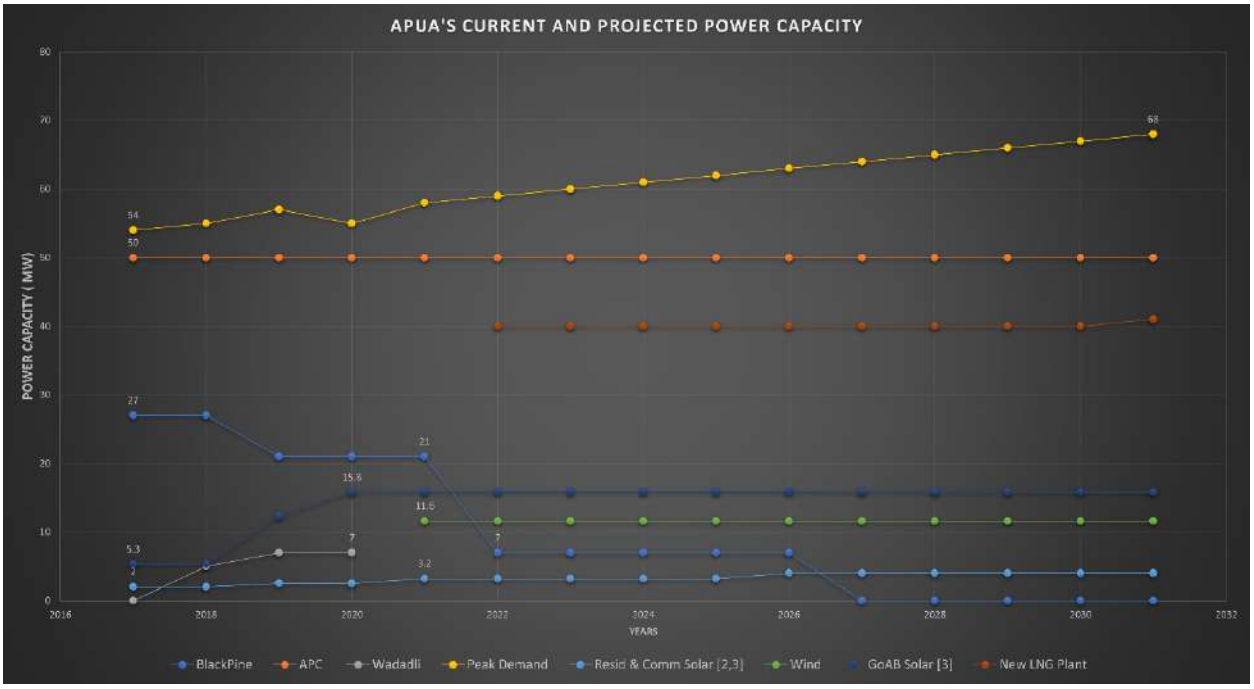
[101] https://reliefweb.int/report/antigua-and-barbuda/uae-partners-build-resilient-green-power-system-hurricane-ravaged-barbuda

The Government of Antigua and Barbuda (GoAB) received funding from the United Arab Emirates (UAE) – through the UAE-Caribbean Renewable Energy Fund, the CARICOM Development Fund (CDF) and the New Zealand Ministry of Foreign affairs and Trade (NZMFAT) to rebuild the electrical grid of Barbuda. An output from the feasibility study conducted in 2019 by Masdar, an Abu Dhabi Future Energy Company, suggested a hybrid electrical grid with a capacity of 0.66MW of diesel generation that compliments a solar farm with battery storage (Green Barbuda 2019).

farms to meet the expected 15.8MW are in the pipeline to be commissioned. The residential/commercial grid-connected solar systems are projected to level off at 3.2MW. A total of 11.6MW of wind energy is expected to be installed by 2021 to further increase renewable energy generation of the islands (APUA 2020).

The passage of Hurricane Irma across Barbuda led to the completed destruction of a 0.1MW solar farm on the island. The renewable energy generation on the island is the pipeline to be rebuilt with assistant from Masdar. In the feasibility study, the Homer Pro Software was

Figure 3.3: APUA's Power Capacity Landscape Breakdown in Antigua Projected to 2031



Source: Adapted from APUA 2020

Grid Capacity - Renewable Energy

APUA's present plans project that solar energy generation in Antigua will peak at 15.8MW. Presently, there are two solar farms on the island, a 3MW farm at the V.C. Bird International Airport (VCBIA) and a 4MW farm in Bethesda. The remaining utility-scale solar

used to model the electrical grid. A total of ~0.72MW of ground-mounted solar system with a 0.86MWh li-ion battery system and two diesel generators of 0.33MW was deemed sufficient to meet the electrical needs of the island (Green Barbuda 2019). The proposed plant is expected to reduce GHG emissions by 690Tones of CO_2 annually, Moreover, the

Government is expected to save 320,000 annually from the reduction in oil purchased since 260,000 liters of diesel oil will no longer be needed.

Annual Electricity Generation

The annual electricity generation for the different fossil-fueled power plants is shown in Figure 3.2. APUA forecasts an increase in annual electricity generation from the 2020 value of 370GWh to 425GWh by 2031. This as an approximate15 percent increase over the next 11 years. The renewable energy contribution is not explicitly shown in the figure. However, in Figure 3.3, renewable energy electricity generation is the difference between the peak demand and the total output from fossil fuel plants.

Transport Sector and Government fleet

The transport sector is heavily dependent on fossil fuel imports, as much as 97.3 percent of the vehicle fleet is run on gasoline and the balance is powered by diesel oil. In 2020, there were a total of 54,891 registered vehicles in the country according to the Antigua and Barbuda Transport Board.

The composition of the vehicle fleet is represented in Table 3.2. Notably, Cars and SUVs make up 90 percent (49,216) of the vehicle fleet in the country.

To further analyze the vehicle fleet in Antigua and Barbuda, the distinct categories of vehicles are broken down by year of manufacture to gain insights into the landscape of the transport sector. Figure 3.4 shows the breakdown for sedan cars and SUVs.

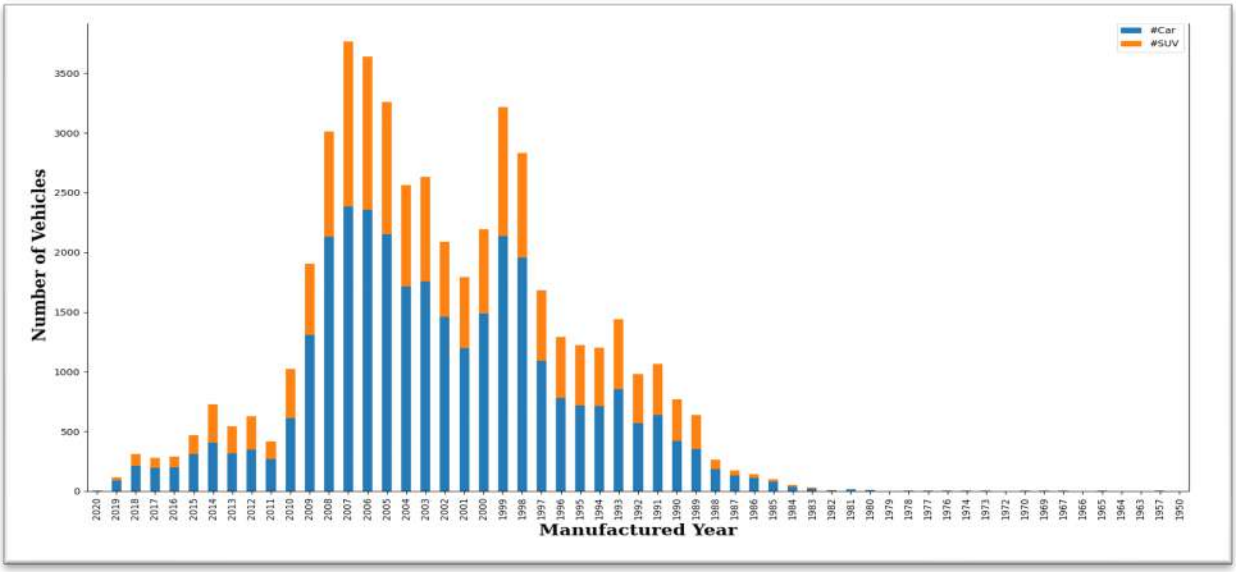
Table 3.2: Summary of the Vehicle in 2020 for Antigua and Barbuda

Motorcycle	Buggies	Buses	Cars	Carts	Hearses	Jeeps	ATVs
694	85	1,094	31,826	19	8	162	124
Pickup Trucks	**Scooters**	**SUV**	**Trucks**	**Vans**	**Wagons**	**Limos**	
772	171	17,390	464	1,441	635	6	
Total Vehicle Fleet **54,891**							

Sedan cars and SUVs make up the largest proportion of the vehicle fleet. There are about 20,000 sedans between 10 and 20 years old which represent 40 percent of the fleet. There are 4,000 (10 percent) sedans presently less than 5 years old and a total of 20 percent of the fleet is between 20 and 30 years old. Finally, there are 200 cars made between 1990 and 1950.

SUVs show a similar age distribution to the sedan's cars with two main distinctions. SUVs have a higher percentage of the fleet less than 10 years old and the oldest being made in 1984. Over 60 percent of the fleet is between 10 and 20 years old and 10 percent is between 21 and 36 years old.

Figure 3.4: Distribution of Cars and SUVs within Antigua and Barbuda by Year of Manufacture

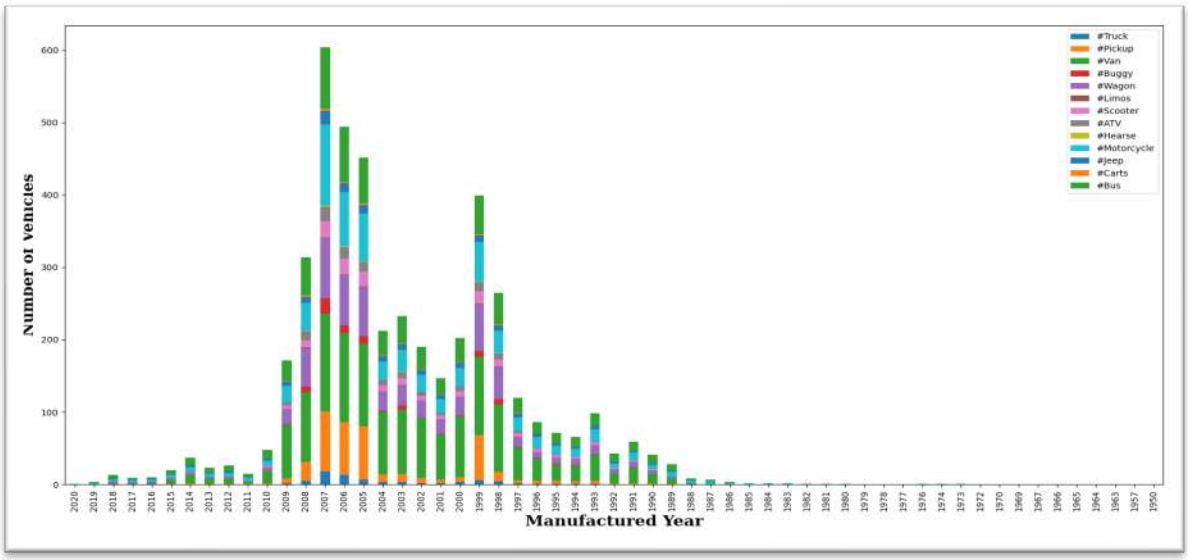


Vehicles that were made after 2010 make up a small percentage of the current vehicle fleet. Vehicles manufactured in the years 2005-2008, constitute a significant portion of the vehicle population. There is a small number of vehicles that were made between the 1950s and 1980s that are still being used in the country.

Lessons learnt from the analysis of the present vehicle fleet:

- A high percentage of vehicles were made more than 12 years ago.
- The abundance of aged vehicles may signal the purchasing power of the population as these vehicles would be less expensive to purchase. Furthermore, it may indicate an active used car market on the island.

Figure 3.5: Distribution of the other vehicles by Year of Manufacture

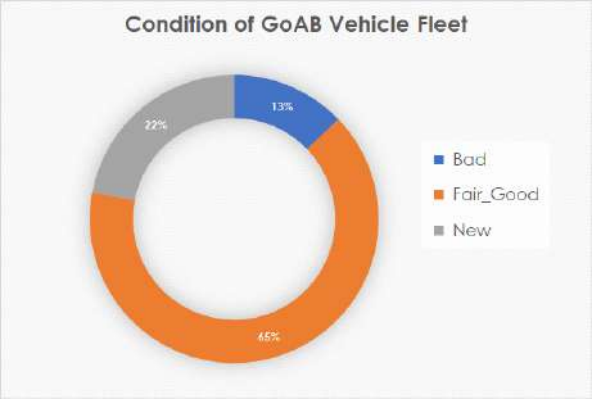


- A small percentage of the fleet is comprised of vehicles made after 2014
- The most abundant manufactured years of vehicles are 2004-2008. Presently, there is no age limitation for imported cars, which can explain why these cars are abundant on the island.
- The number of vehicles made before 1990 indicates that there are persons who have a sentimental attachment to their vehicles.

The Government Vehicle Fleet

A report by the Ministry of Works titled "Management of - Public Vehicles Report - 2018" reported that there were 848 vehicles registered to the GoAB. A total of 803 of 848 were audited. The conditions of these vehicles are represented in the Figure with only 102

Figure 3.6: Breakdown of the Condition of the Government Fleet



Source: Adapted from Ministry of Works 2018

considered to be in a bad condition. Vehicles classified as "new" are 3 years old or less. The report identified that 584 of the vehicles are over 5 years old with 355 being more than 10 years old. The report did not provide a breakdown of the composition of the fleet.

Mitigation Road map -IRENA Summary

A Renewable Energy Roadmap was prepared by IRENA to outline various pathways for increasing the penetration of renewable energy into the electricity sector by 2030, it was completed in March 2021. IRENA considered solar, wind, green hydrogen with a fuel cell and battery. The Homer Pro simulation software was used to model different combinations of selected technologies to arrive at the desired solutions. Five scenarios were selected to be included in the roadmap. The choice of achieving 100 percent renewable energy using solar and wind energy with battery storage, is predicted to be the most expensive pathway to take (Figure 3.7). It indicates that another technology must be explored to achieve complete renewable energy, hence the inclusion of hydrogen. The optimal system scenario which involves keeping the diesel generating plants to aid in firm capacity is the least expensive path at US$388 million, this pathway carries the country to only 89.5 percent renewable energy penetration.

According to IRENA at an additional cost of US$15 million, 100 percent renewable energy could be achieved using hydrogen to replace the diesel plants and reduce the quantity of grid battery storage needed. Under this scenario, the quantity of solar and wind farms is increased compared to the optimal system to facilitate the production of green hydrogen using electrolysers.

The present levelized cost of energy (LCOE) is approximately 0.15 USD/kWh with customers paying 0.37USD/kWh for delivered electricity on the island. The LCOE is forecasted to be reduced under all scenarios except the 100 percent renewable energy with no hydrogen

Figure 3.7: Summary of the Five Scenarios Presented

	SOLAR MW	WIND MW	DIESEL MW	Fuel CELL MW	ANNUAL ELECTRICITY/ GWh	EXCESS ELECTRICITY/ GWh	BATTERY STORAGE MWh	COE USD/kWh	INITIAL CAPITAL COST M USD
89.5% RE Optimal System	199	58	90.8	0	375	117	593	0.105	388
93.1% RE Optimal System + EVs	199	89	90.8	0	489	100	828	0.10	498
100% RE (no hydrogen)	372	111	0	0	375	500	1,398	0.184	783
100% RE (with hydrogen)	202	101	0	40	620	102	164	0.104	403
100% RE (with hydrogen + EVs)	214	117	0	40	722	62	138	0.09	440

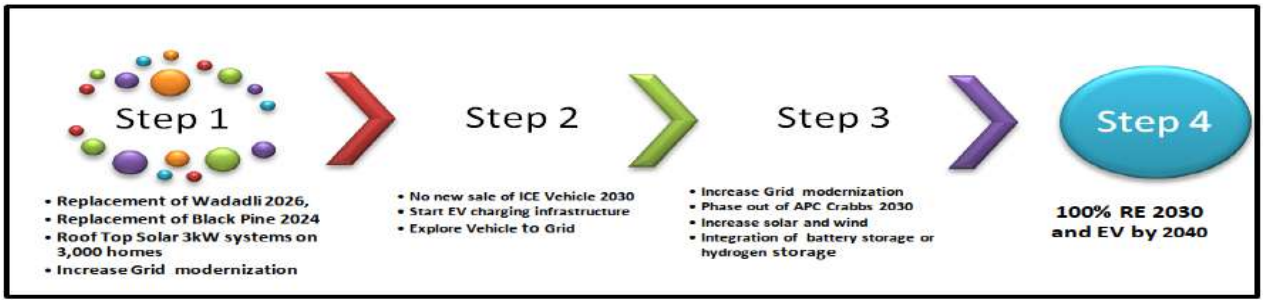
Source: Adapted from IRENA 2020

scenario. The scenarios with electric vehicles (EV) produced lower COE compared to their counterpart scenarios. The lowest LCOE of 0.09USD/kWh was achieved under the scenario that included hydrogen and EV.

Mitigation RoadMap - Climate Analytics

Climate Analytics, a climate science and policy institute, suggests a four-step process of achieving 100 percent renewable energy in the electricity generation sector by 2030 and transitioning to 100 percent electric vehicles in the transport sector by 2040. Data for the electricity produced in Antigua and Barbuda is scarce and incomplete when available; therefore, the pathways to achieving 100 percent renewable energy are derived from the total electricity produced in the year 2019. The main drawback to this approach is that it does not factor in the variation in electricity generation from the different plants which varies daily, monthly, and seasonally. It cannot differentiate between the electricity needs for each month and therefore treats each month as requiring the same amount of electricity. Designing a renewable energy system using only the yearly energy data will lead to the system overproducing in some months while

Figure 3.8: Four-step Process for Achieving Transition the Energy and Transport Sector

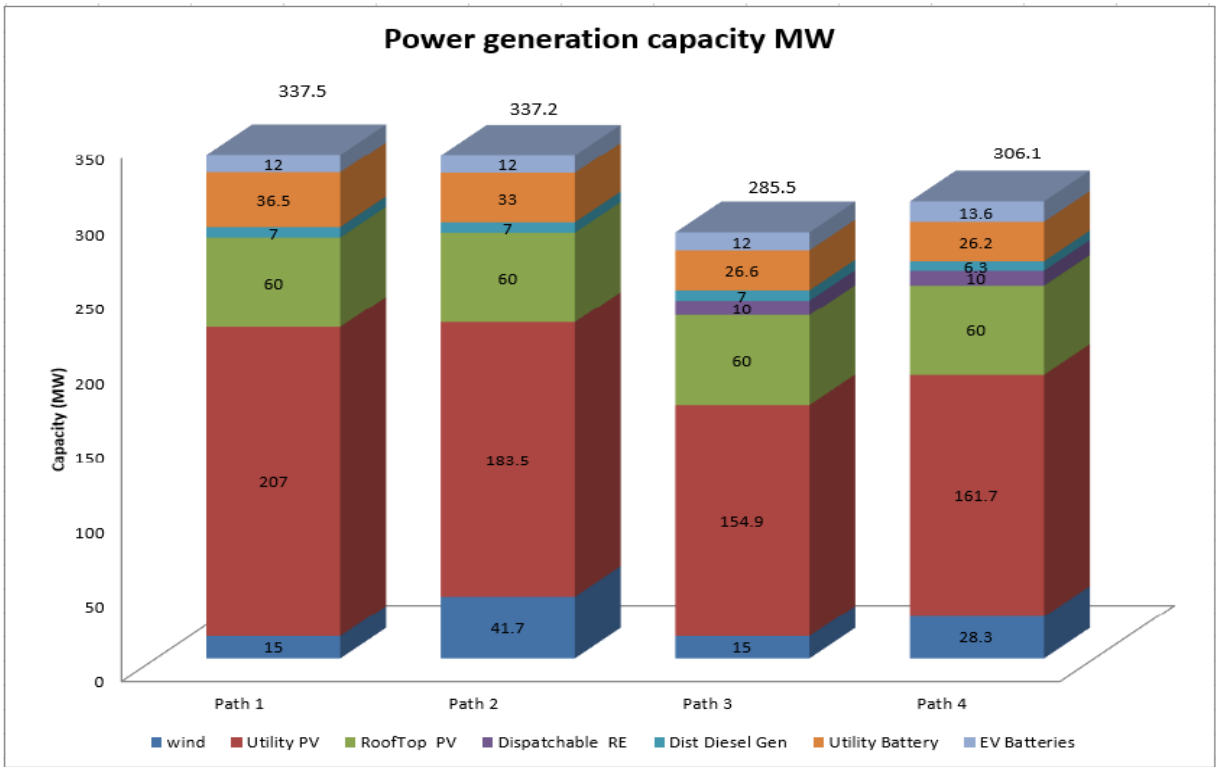


Source: Adapted from Climate Analytics 2020

under-performing in other months. Nevertheless, it is a first approach in designing a system as more detailed studies will be needed to arrive at a final design.

The projected energy generation for the four pathways is displayed in Figure 3.10. The paths generated more than 150GWh of energy in 2030 compared to the 2019 value of

Figure 3.9: Four Pathways: Technologies Options to Increase Renewable Energy by 2030

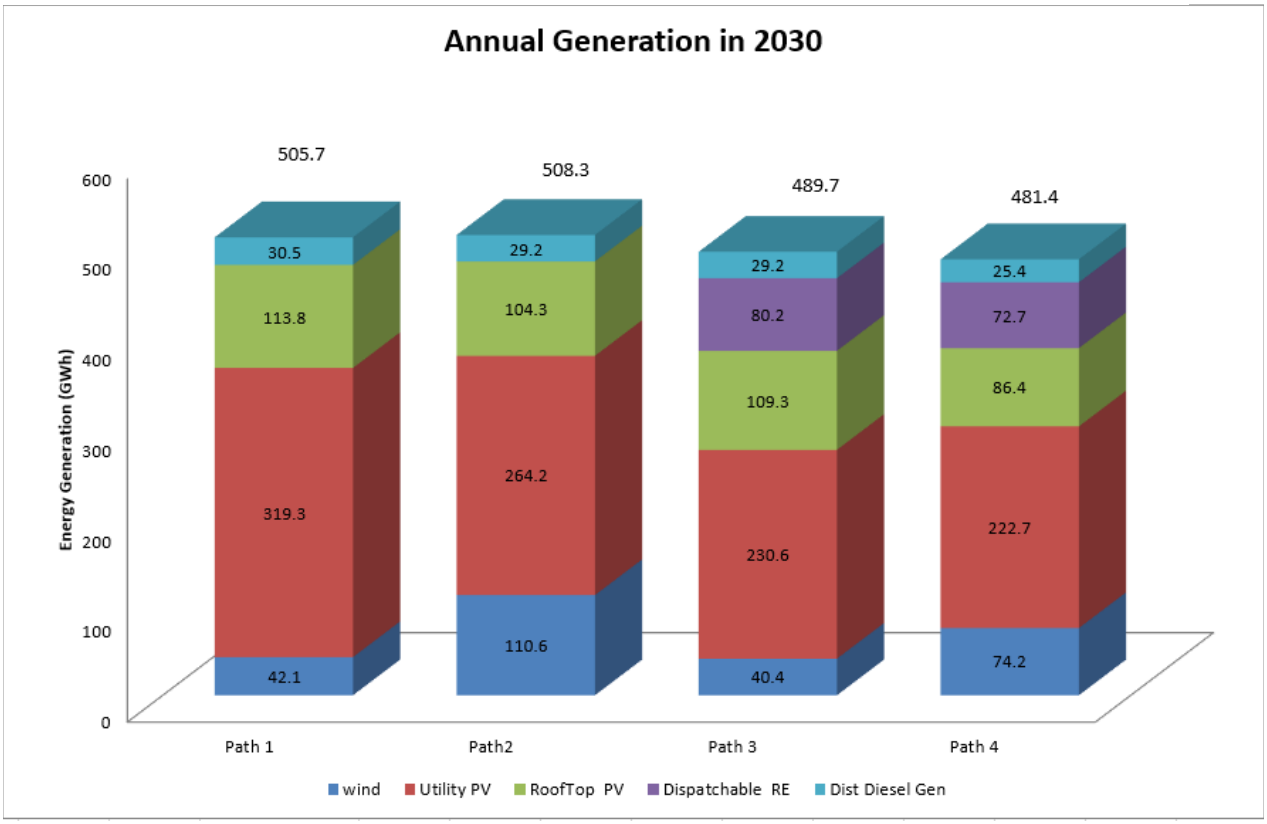


Source: Adapted from Climate Analytics 2020

The four pathways were devised for the energy and transport sector using the LEAP model. The pathways provide information on storage and energy generating systems such as diesel generators and dispatchable energy that will be needed. A dispatchable energy source such as waste to energy (WTE) would supply firm energy to the grid as baseload and reduce the battery storage size. The four pathways consist primarily of solar energy with a constant of 60MW of rooftop solar and a fluctuating quantity of utility solar. The inclusion of the dispatchable source into the energy mix considerably reduces the total utility PV needed for Paths 3 and 4.

3GWh. This surplus energy is sufficient to take into consideration the annual energy growth of the country and the estimated demand of 70GWh for electric vehicles. The use of dispatchable renewable energy and diesel in pathways 3 and 4 is expected to generate 20 percent of the total energy in each pathway. From Figure 5, these sources together have a capacity of 17MW, approximately 5 percent of total capacity. This high production is due to the number of hours they are operated in a year, especially the dispatchable source.

Figure 3.10: A Snapshot of the Annual Energy Generation for the Four Pathways



Source: Adapted from Climate Analytics 2020

Mitigation Focused Gender Analysis

The sectors targeted in Antigua and Barbuda's mitigation program have important implications for the population. Under the current energy system in Antigua, critical services such as health, education, water and emergency services are dependent on fossil fuel sources for energy, which have not only proven unreliable during extreme weather events but are expensive for the average household. For example, due to more intense and increasing drought conditions, electricity costs are increasingly linked to water access, with dependence on reverse osmosis as much as 60 percent.

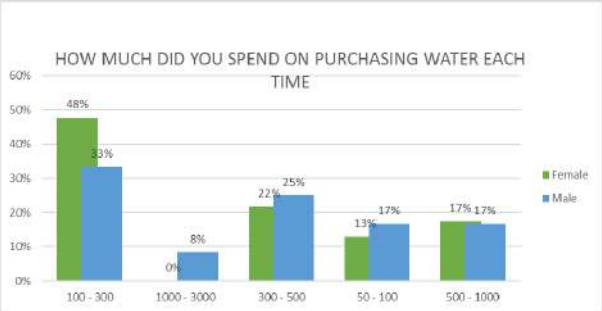
Reverse osmosis desalination plants are dependent on imported fuel and require the water unit of the national utility company (APUA) to spend US$11,000,000.00 per year to ensure that at least 8MW is available for generating water from the four reverse osmosis plants. The cost of this is borne by the Electricity section of APUA[102]. This high cost in electricity resulted in water rationing starting in 2014 for the first time in 40 years, leaving 81 percent of the population whose main water supply is provided through the government[103] without water, and forcing those who were able to purchase water; some parts of the country still experience water rationing. Data

[102] Department of Environment, Environmental and Social Impact Assessment and Management Plan for Variable Renewable Energy Integration to Decentralise Generation on Antigua

[103] 2011 Census of Population and Housing. Report. St. John's, Antigua: Statistics Division (Ministry of Finance and Economy, 2014.

collection done by the DOE found that during the severe drought period of 2013 – 2018, 13 percent of women and 12 percent of men noted that they had to purchase domestic water at least 3 times a month to refill their cistern/tank, paying on average, EC$100 – EC$300 each time.

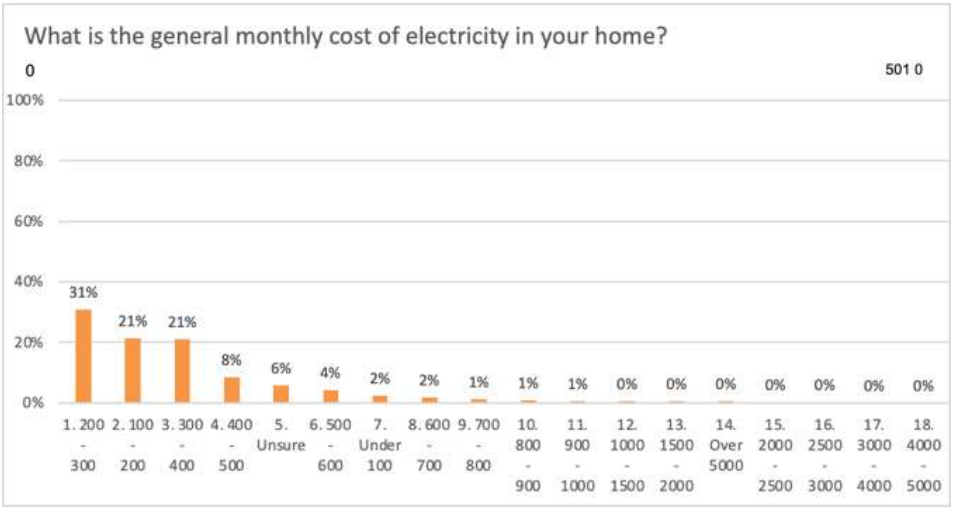
Figure 3.11: Percentage of Persons Purchasing Domestic Water from Private Companies During Severe Drought Periods (2013 - 2018) from National Gender Survey 2020



In rural communities like Wilikies, Urlings and Bethesda, this cost was even higher with women in these communities purchasing domestic water from private companies at least nine times per month and spending between EC$50 – EC$100 and EC$100 – EC$300 each time for water. This cost is in addition to households' monthly water bills which are provided through the APUA company for those connected to the grid.[104] This makes a basic life essential a commodity for the population and has severe implications for lower income households who are unable to purchase water. In agriculture, farmers have decreased losses of over 50 percent during severe drought period due to water scarcity of which farmers note that agriculture is often the last sector to be addressed when providing water.

For health care services, energy consumption for the government is high in this field and adds tremendously to the government's purchase of fuel. In addition, although the main hospital has back-up energy, many of the district clinics are susceptible to power outages all year round. Administrators within these clinics raised concerns about the impact of power outages on their ability to provide quality and efficient health care to patients[105].

Figure 3.12: Monthly Electricity costs for households in Antigua and Barbuda



Source: National Gender Survey 2020

Outside of the cost to critical services, energy for the average household in Antigua and Barbuda is costly, with most households paying on average 7-10 percent of their remuneration on

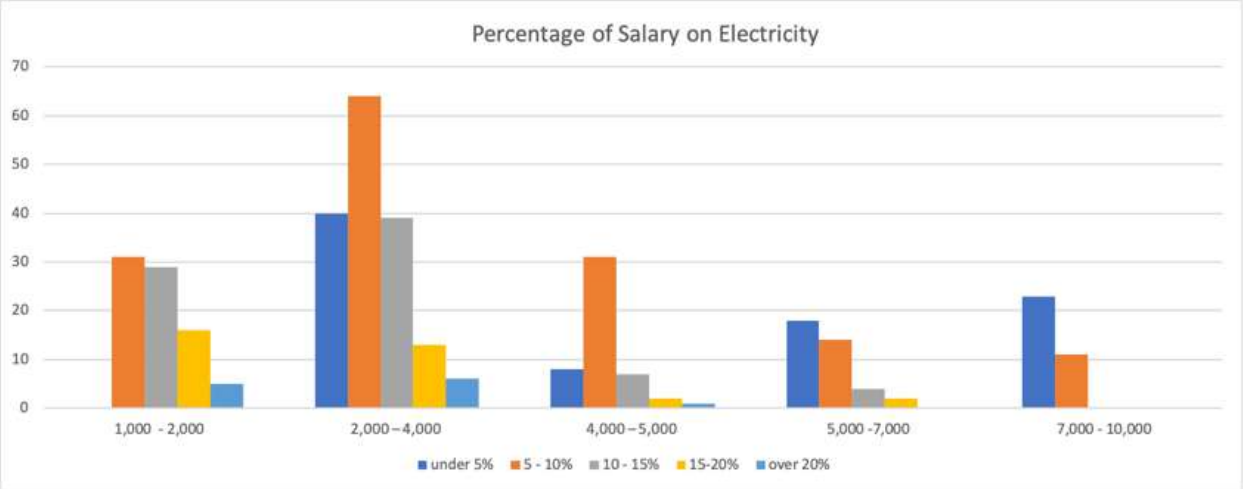
[104] DOE Project Management Unit's National Household Survey on the Economic Impact of Climate Change on Men and Women in Antigua and Barbuda Report

[105] Report on Consultation with schools and clinics by Rashauna Adams-Matthew, Tuesday, 9th January, 2018

electricity alone. This was despite most residents avoiding the use of air conditioning in their home as well as over 95 percent of residents indicating use of energy conservation tips provided by the national utility company[106].

to support their families as documented by the Ministry of Education. As Antigua and Barbuda continues to face the economic fall-out due to COVID-19 and the loss of employment, these conditions will intensify, as women will be placed in even more precarious conditions to

Figure 3.13: Percentage of monthly salary spent on electricity Source: National Gender Survey 2020



Electricity costs in Antigua and Barbuda have socio-economic consequences, particularly for female headed households as it adds to the increase in cost of living. Initial data collection by the DOE has shown the rise of transactional sex within low-income communities. High cost of living is known world-wide as a contributing factor to poverty conditions, which result in women trading sex for money, to afford basic needs such as purchasing food, electricity and water. Transactional sex among adults also exposes children to this activity and they in turn, with even less agency, begin to engage in transactional sex and are exposed to various risks as identified above. Additional social risks associated with the increased cost in living include higher school drop-out rates, particularly for boys from low-income families, pay for required amenities, such as electricity.[107]

The uptake of Renewable Energy is expected to reduce the dependence on imported fuel decreasing the government's expenditure and indirectly curbing the cost generated by the energy consumption of the health sector, education and other critical services. Grid interactive renewable energy installations for the hospital and district clinics allows for the district clinics to act as "access centres" especially after hurricane and alleviate pressure on the general hospital. The DOE's energy project in Agriculture introduces new and innovative RE technology which can increase water provision for farmers and improve food security for Antigua and Barbuda.

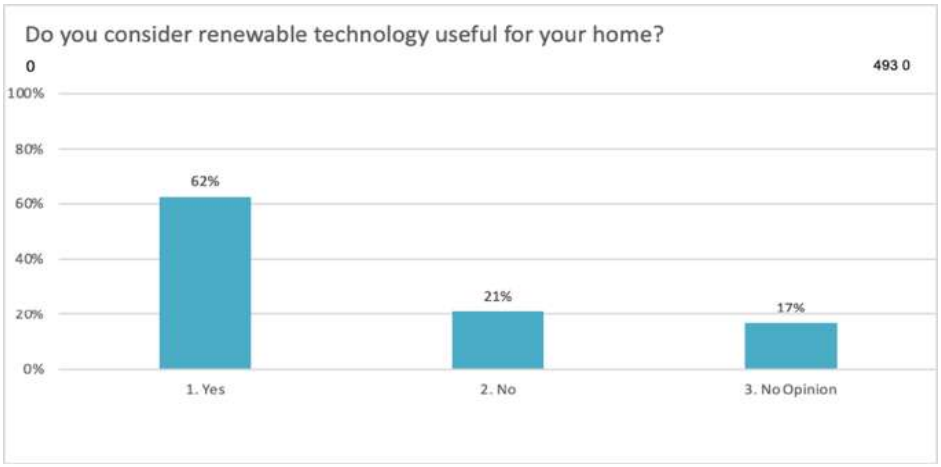
[106] Project Management Unit (Rashauna Adams-Matthew), National Household Survey on the Economic Impact of Climate Change on Men and Women in Antigua and Barbuda Report

[107] Department of Environment, Socio-Economic Impact of Electricity Costs in Antigua and Barbuda

The Department's energy transition plan for the transport sector, starting with public transportation, is expected to raise greater awareness of electric vehicles. This is important for women, who were less likely to support the use of electric vehicles, mostly due to limited knowledge on electric vehicles and its operations, a belief that the Antiguan and Barbudan infrastructure is not equipped for such vehicles and misinformation generally on electric vehicles. As primary users of public transportation, women can be exposed to the operation of electric vehicle through the DOE mitigation initiatives. Moreover, most respondents indicated that they would be encouraged to purchase an electric vehicle if the upfront cost was lower, charging stations were available and if the vehicles required less maintenance than fuel-vehicles. Unlike internal combustion engine (ICE) vehicles, electric vehicles require less maintenance and can be used as energy storage for households. In addition, the Department's climate change program seeks to provide access to financing which would cover the added cost of purchasing an electric vehicle compared to an ICE vehicle through the Revolving Loan Program of the SIRFF. Under the Revolving Loan Program, households, particularly the most vulnerable, are able to access concessional loans of 2 percent in order to purchase these vehicles.

Nationally, despite only two percent of renewable energy, Antiguan and Barbudan households overwhelmingly believe in the usefulness of Renewable Energy Technology with the belief that it would lead to lower electricity bills and was better and more sustainable for the environment (Figure 3.14).

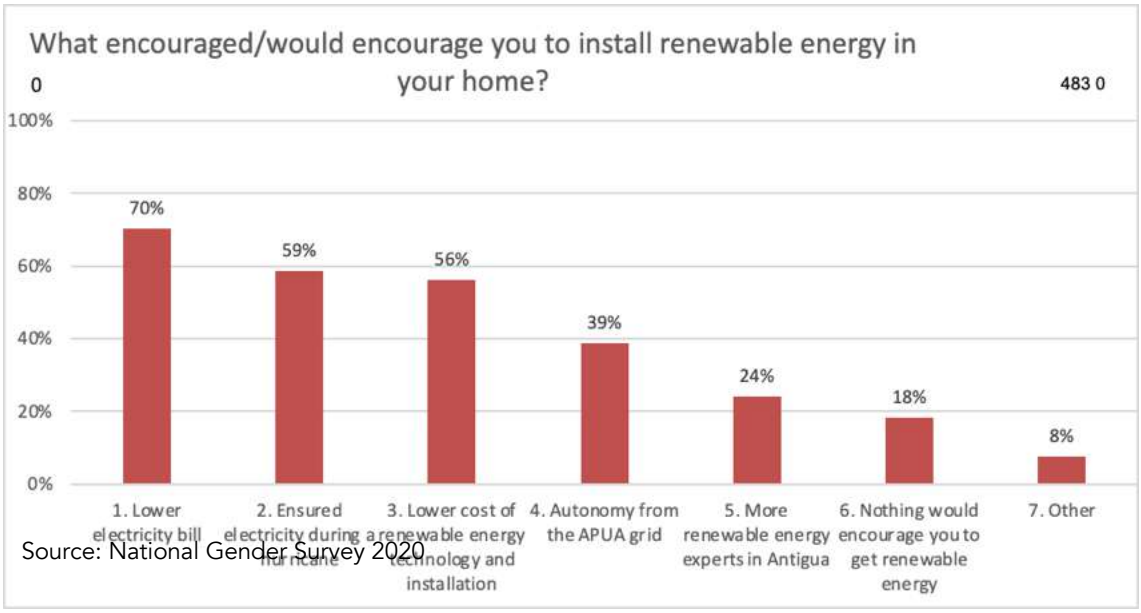
Figure 3.14: Percentage of persons who consider Renewable Energy useful for their home



Source: National Gender Survey 2020

Households are thus likely to support the Department's renewable energy program if it ensured lower electricity costs, access to electricity during hurricane passages and lower cost of purchasing renewable energy technology as well as installing renewable energy technology. The Department's Revolving Loan Program provides the concessional funding for households, particularly vulnerable households, to purchase renewable energy technology and contribute to Antigua and Barbuda greenhouse gas reduction.

Figure 3.155: Rationale for persons to install Renewable Energy in their home



Source: National Gender Survey 2020

Policies, Legislation and Regulations to Support Transition

Table 3.3: Summary of Policies, Legislation & Regulations

Mitigation Thematic Area	Pertinent Policy, Legislation or Regulation
Sustainable Development	Medium Term Development Strategy (2016 to 2020) Environmental Management and Protection Act 2015 Environmental Management and Protection Act 2019 Strategy for the Protection of the Environment and the Sustainable Development of Antigua and Barbuda 2017 to 2018
Energy	Sustainable Energy Action Plan 2013 APUA Net Billing Interconnection Policy 2011 Renewable Energy Act 2015 Building Code (2021 Draft)
Transportation	Environmental Levy Act 2002
Just Transition	University College of Antigua and Barbuda (CUWI) Act 2017
Finance	Sustainable Island Resource Framework Fund (SIRF Fund) Draft Environmental Protection and Management - Regulations Sustainable Island Resources Framework Fund 2017 Draft Environmental Protection and Management Regulations - SIRFF Revolving Fund Program for Adaptation 2017 Banking Act 2015 Securities Act 2020 Antigua and Barbuda Investment Authority Act 2019 Sustainable Procurement Act (In progress)

Mitigation and The Environmental Protection and Management Act (2019)

The Environmental Protection and Management Act (EPMA), passed in 2019, is a landmark piece of legislation for environmental action. The act aligns national law with international commitments to multilateral environmental agreements (MEAs) and the legislation enacts a comprehensive legislative framework for handling environmental matters. The Act identifies GHG as a pollutant and can limit the pollutants generated by various sectors.

The EPMA sets management principles for protected areas and the natural resources therein. The act specifies the need to preserve specific types of flora and fauna and minimize human interference in the natural processes of these ecosystems. It includes forests, foreshore areas, nature reserves, water catchment areas, and wetlands among the types of protected areas, with relevant actions for each. Also, there is an explicit mandate to protect carbon sinks in accordance with internationally accepted principles.

The act also provides protection to key watersheds. It affords protection from natural disasters, environmental degradation as well as livestock and alien species, covering an array of potential risks to these watersheds. The protection of the seven identified watersheds ensures their survivability and continued capacity to act as carbon sinks.

It calls for the establishment of an Environment Registry which will undertake monitoring of all environmental data and information, assisting with reporting requirements under MEAs. It mandates the collection of information on 'the source, quantity, conditions or concentrations relevant to the identification of a pollutant' which will be included in the Environment Registry. Included in the definition of pollutants are greenhouse gases (GHGs), thereby ensuring that the Environment Registry will support GHG inventories through continued data collection. The quantity and source of these gases can be refined for use in mitigation actions, marking a clear baseline for future projects and programs to measure impact levels.

The EPMA also established the Sustainable Island Resources Framework Fund ('SIRF Fund'), a financing mechanism designed to support environmental projects including program and measures for climate change mitigation. The Fund will support environmental projects throughout the Eastern Caribbean, contributing to regional and national climate action. The SIRF is currently being operationalized and is expected to greatly facilitate financial flows toward environmental projects and plans.

Sustainable Energy Action Plan (SEAP) (2013)

The SEAP is a policy roadmap that was created following the approvals of the National Environment Plan (NEP) in 2011. The plan includes milestones and actions that were to be completed from 2013 until 2030 in order to achieve the goals of the NEP. The SEAP includes four strategies drafted to address the five priority areas identified in the NEP. These strategies include:

1. Addressing institutional and regulatory barriers hindering energy efficacy and renewable energy developments.

2. Energy conservation and energy efficiency measures to address high energy intensity and low energy efficiency
3. Renewable energy developments to reduce fossil fuel dependence, high energy costs, and energy import bills
4. Education and awareness to increase technical capacity, increase involvement of the financial sector, increase certified renewable energy installers and auditors.

Each of the above four strategies have specific actions/activities with timelines ranging from 5-15 years

Renewable Energy Act (2015)

The Renewable Energy Act is a legislation drafted to promote the use of renewable energy resources and technologies such as solar PV, wind, biomass, hydropower, geothermal, and wave/tidal. The act established the responsibilities to be carried out by the Minister Responsible for Energy. It also established APUA's net billing policy and energy wheeling policies. Furthermore, the Act established the Renewable Energy Fund, which is meant to utilize money from the Citizenship by Investment Program (CIP) in order to procure, construct, or research renewable energy technologies. Finally, the act mandated that an impact assessment be conducted with the express purpose of determining the feasibility of the use of biomass to generate electricity in Antigua and Barbuda.

APUA Net Billing Interconnection Policy (2011)

The net billing policy was introduced to replace the previous net metering policy that set the feed-in-tariff for household and small business renewable energy production. The net billing policy credits individual producers for each kWh of energy produced and sent to the national grid. This amount credited per kWh is equal to the avoided cost of fuel for energy production, which equates to approximately US$0.17 per kWh. The net billing policy also placed restrictions on the size of individual renewable energy installations. The restrictions are as follows:

1. For systems less than 5kW: all energy produced can be self-consumed. Any excess energy can be sent to the national grid.
2. For systems greater than 5kW: All energy produced must be transmitted to the national grid. All energy used by the consumer must be purchased from the utility at regular market

Antigua and Barbuda Investment Authority Act (2019)

After appropriate consultations with the business community and the financial services sector, the necessary amendments will be passed to create incentives for commercial and residential investments in renewable energy and EE solutions. Among the specific programs to be introduced is a green mortgage facility which will provide concessionary financing for the construction of efficient commercial buildings and residences. Given the front-loaded nature of investments in renewable energy and energy efficiency measures, the Investment Authority will be tasked with identifying appropriate measures to enable consumers (both commercial and residential) to realize a reasonable return on investment.

Securities Act (2020)

This Act aims to provide for the protection of investors in securities in and from within the Currency Union; by regulating the securities market, exchanges and persons engaged in securities business, by regulating the public issue of securities; to reduce systemic risk and to provide for related matters.

Pertaining to mitigation, it allows renewable energy companies to be traded on the stock market. Therefore, this serves to allow and protects companies that put their stocks for trade. It also protects the buyer of stocks as it permits the commission to investigate and inspect the entities.

Banking Act (2015)

This act provides for the Regulation of Banking Business, the Establishment of a single banking space and for incidental and related Matters and the Repeal of the Banking Act 2005. In relation to mitigation, it gives the right to the bank to determine how they perceive renewable energy systems. Banks would then be able to assess the risk of renewable energy systems before providing loans, mortgages, etc. The banks also consider the other funding such as resilience, energy efficiency measures and insurance on the equipment.

Sustainable Procurement Act (In progress)

The Procurement and Contract Administration Act (2011) is currently being updated to improve procurement practices and develop guidelines for emergency procurement that would incorporate aspects of sustainable procurement. This work is currently being done by the Ministry of Finance in collaboration with the World Bank.

Additionally, the Ministry of Finance is working with the Caribbean Development Bank (CDB) with the implementation of the revised act with the inclusion of the sustainable considerations. Also, they are working with EDA in a project to understand the lessons learnt from the implementation of the revised act.

Under the UNEP OECS project, they are currently assessing the following procurement practices to identify how public procurement practices can be strengthened. Specifically, they are assessing:

1. Public infrastructure works: urban and rural roads, highways, airport runways, bridges, tunnels, drainage systems, etc.
2. Public buildings: schools, hospitals, clinics, government offices, etc.
3. Private buildings: residences, commercial premises, etc.

The National Building Code

The revision of the OECS building code was started by the Department of the Environment, Antigua and Barbuda in 2020 under the sustainable Climate Change Fund funded project entitled "Building Climate Resilience through Innovative Financing Mechanisms" and to lead the review of the OECS Building Code 7th edition for adaptation as Antigua and Barbuda's Building code.

Part of the revision was the reference of the CARICOM Regional Energy Efficiency Building Code, which was released by the International Code Council in 2018. It establishes minimum energy efficiency requirements for buildings using prescriptive and performance-related provisions inclusive of building envelope, cooling system, ventilation, pumping, lighting, and the service water-heating systems in buildings. The revision was sent for public consultation in January 2021 and handed over to the cabinet for implementation.

Technical Needs Assessment (TNA)

Antigua and Barbuda was selected along with four other Caribbean countries, forming a group of 23 developing nations from across the world, to participate in Phase III of the Technology Needs Assessment (TNA) project. The project originated within the *Strategic Program on Technology Transfer* approved by the Global Environment Facility (GEF) in 2005. The global aim of the TNA is to assist developing country nations – parties to the United Nations Framework Convention on Climate Change (UNFCCC) – to analyze technology priorities for climate change adaptation and mitigation, determine a portfolio of Environmentally Sound Technologies (ESTs), along with context-specific programs/projects that would facilitate transfer of and access to selected ESTs, and progress towards implementation of Article 4.5 of the UNFCCC. The TNA project is implemented by United Nations Environment (UNEP) and executed through the UDP – a long-standing partnership between UNEP and the Technical University of Denmark (DTU) – based in Copenhagen, Denmark. The project is fully supported by the Government of Antigua and Barbuda, through the Department of the Environment (DOE), within the Ministry of Health, Wellness and the Environment.

The water, building and transport sectors were the three sectors of focused for development via technologies. The technologies then went through the stakeholder consultations and a Multi-Criteria Analysis (MCA) for prioritization. The following are the prioritized technologies for each sector.

Water Sector

1. Solar Pumping Systems
2. Rainwater Harvesting
3. Water Savers
4. Climate-proof Assets
5. Stormwater Reclamation and Reuse

Building Sector

1. Passive House Designs / Site Selection
2. Best Roof Pitch Angle
3. Impact / Energy Efficient Windows & Doors
4. Construction of Energy Efficient Building Infrastructure
5. LED Lighting

Transport Sector

1. Improvement of Road Infrastructure
2. Battery Electric Vehicles
3. Solar Renewable Charging Station
4. Integrated Public Transport
5. Efficiency in the Transport Sector

Mitigation Implementation Strategies in Antigua and Barbuda

After an analysis of the various pathways to reducing GHG, Antigua and Barbuda outlined the following strategy for implementation:

1. Revision of the NDC Targets and pass regulation to support the same;
2. The development of projects and programs to support financing that directly supports communities and families. This includes the accreditation of the DOE to various entities and the development of capacity to access the Loss and Damage fund;
3. Using 2 above can develop a sector coupling approach that will see the rapid adoption of EVs and renewable energy on the grid.

2021 Revised NDC[108]

Antigua and Barbuda communicated its Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) on October 2015. It then complied and ratified the Paris Agreement on 21 September 2016. This action affirmed its commitment to the global goal of holding global average temperature to well below 2°C and pursuing efforts to limit the rise to 1.5°C. By doing so, the Government of Antigua and Barbuda (GOAB) seeks to ensure that it reduces national GHG emissions and implement measures to adapt to climate change in line with development priorities. All Parties to the Paris Agreement are to submit updated or new NDCs starting from 2020 up to 2030 and submit new NDCs every five years that are more ambitious overtime.

The country submitted its updated NDCs in September 2021. For this planned update, Antigua and Barbuda increased its ambition to cut emissions and scale up renewable energy. Central to its push towards a cleaner, more resilient future is the decarbonization of its energy sector, which has the largest share of national emissions.[109] This process will involve reducing its reliance on fossil fuels for energy production and transport. To drive the transformation in its energy system, its NDC mitigation targets will have impacts on the backup energy, grid-tied energy, transportation, agriculture, construction, infrastructure, and information technology sectors. However, increases in adaptation and mitigation ambitions are conditional on attracting and accessing significant financial support from external sources. Table 3.4 shows the 2021 NDC Targets for Antigua and Barbuda.

[108] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Antigua%20and%20Barbuda%20First/ATG%20-%20UNFCCC%20NDC%20-%202021-09-02%20-%20Final.pdf

[109] Department of Environment, Ministry of Health, Wellness and the Environment. *Antigua and Barbuda First Biennial Update Report, 2020.*

Table 3.4: Approved NDC Targets 2021

Thematic Area	Target and Actions	Completion Date	Year Communicated	Conditionality
	NDC Targets			
Mitigation	**1.** 86% renewable energy generation from local resources in the electricity sector	2030	2021	Conditional
	2. 100% all **new** vehicle sales to be electric vehicles	2030	2021	Conditional
	3. Explore potential for emissions reductions in the waste sector	2025	2021	Conditional
	4. Explore potential for emissions reductions in the Agriculture, Forestry and Other Land Use (AFOLU) sector	2030	2021	Conditional
	Indicative actions supporting implementation of mitigation targets			
	1. Energy Sector			
	a) Enhance the established enabling legal, policy and institutional environment for a low carbon emission development pathway to achieve poverty reduction and sustainable development	None	2015	Unconditional
	b) Establish efficiency standards for the importation of all appliances	2020	2015	Conditional
	c) Dedicated technical and other support aimed at derisking investments in greenhouse gas reduction by MSMEs in Antigua and Barbuda	2030	2021	Conditional
	d) A legal and technical framework is established as an enabling environment to support the raising of necessary resources for the low greenhouse gas emissions, climate resilient transition from international support providers, private sector (community, national, and international levels), and social investors	2024	2021	Conditional
	2. Electricity			
	a) 100 MW of renewable energy generation capacity available to the grid	2030	2015 (*Updated in 2021*)	Conditional
	b) 50 MW of renewable energy generation capacity owned by farmers who can sell electricity to off-takers	2030		
	c) 100 MW of renewable energy generation capacity owned by social investment entities for (*for e.g., Social Security Board, Medical Benefit Scheme, non-governmental organizations, faith-based organizations, community-based organization, taxi associations, bus associations, and other businesses registered as social investors*)	2030		

Thematic Area	Target and Actions	Completion Date	Year Communicated	Conditionality
	d) 20 MW of wind-powered energy generation	2030		
	e) 100% renewable energy generation for all government operations	2030		
	f) 100% of fixtures and appliances in government buildings will be energy efficient	2030		
	g) Elimination of the fuel surcharge tax on electricity bills	2030		
	h) Finalize the technical studies with the intention to construct and operationalize a waste to energy (WTE) plant	2025	2015	Conditional
	3. Transport			
	a) Change fiscal policies on fossil fuel by 2025 to enable the transition to 100% renewable energy generation in the transportation sector	2025	2021	Conditional
	b) Ban on the importation of new internal combustion engine vehicles (with an indicative start year of 2025)	2030		
	c) 100% of government vehicles will be electric vehicles	2035		
	d) Establish efficiency standards for the importation of all vehicles	2020	2015	Conditional
	4. Waste			
	a) Circular economy policy and regulations agreed on	2025	2021	Conditional
	5. Agriculture, Forestry and Other Land Use			
	a) All remaining wetlands, watershed areas, and seagrass bed areas with carbon sequestration potential are protected as carbon sinks	2030	2015 (*Updated in 2021*)	Conditional
Adaptation[110]	6. Building Code updated and passed into law in line with a climate resilient development pathway including, *inter alia*, a requirement that all **new** homes built after 2025 have back-up renewable energy generation and storage systems	2025	2015 (*Updated in 2021*)	Conditional
	7. 100% of the water supply infrastructure powered by their own grid-interactive renewable energy sources	2030	2015 (*Updated in 2021*)	Conditional
	8. 100% education, health, food security, and emergency shelter facilities powered	2030	2015 (*Updated in 2021*)	Conditional

[110] Any mitigation co-benefits arising from the adaptation actions are not additional to the mitigation targets.

Thematic Area	Target and Actions	Completion Date	Year Communicated	Conditionality
	by their own grid-interactive renewable energy sources			
	9. 100% of community and sports infrastructure and assets are climate resilient (to withstand at a minimum Category 4 tropical cyclones) and have adequate water harvesting and storage system	2030	2021	Conditional
	10. 30,000 homes or 50% of pre-2020 homes to have back-up renewable energy systems for at least 4–6 hours of energy	2030	2021	Conditional
	11. All waterways are protected to reduce the risks of flooding and health impacts	2030	2015	Conditional
Targets to support social inclusion, gender and reduce transitional risks				
Just Transition	12. 100% of the affected parts of the national workforce are trained to use new mitigation technologies for a low greenhouse gas emissions transition	2030	2021	Conditional
	13. 50% increase in the number of micro, small and medium enterprises (MSMEs) that provide energy services aligned with the objectives of the Paris Agreement (through the Sustainable Island Resources Framework Fund [SIRF Fund] and using the Entrepreneurial Development Program [EDP] Fund)	2030	2021	Conditional
	14. Develop a gender-responsive approach to the just transition of men in the energy and construction sectors (*Baseline: currently approximately 95% men in these sectors*)			
Gender-Responsive	15. Gender-responsive green business development program particularly focused on (1) providing support to SMEs to access to green technologies and climate-related investment; (2) providing support to green entrepreneurs via the EDP Fund and other means, (3) providing support to businesses in their transition towards a low-carbon development	2025	2021	Conditional
	16. Farmers and their families are provided with support needed to recover from drought and hurricanes in order to prevent the accumulation of unsustainable debt and its corresponding increased risks, while supporting food security, taking into account the differential needs of male and female farmers (e.g., loan default, foreclosure, etc.)	2025	2021	Conditional

Thematic Area	Target and Actions	Completion Date	Year Communicated	Conditionality
	17. 50% reduction in the average annual preparation costs for hurricanes on single-parent households (*Baseline average preparation costs hurricane: US$2,000 per year or 20% of annual median income*)	2030	2021	Conditional
	18. 100% of community businesses and organizations that support women in their post-extreme weather event recovery are identified and provided with support for their efforts to facilitate women's ability to resume work/livelihoods (and potentially return to their homes/communities) within seven (7) days after such an event	2030	2021	Conditional
	19. 100% of female-headed households have all barriers removed to access back-up renewable energy generation and storage systems (i.e., 20,000 homes)	2030	2021	Conditional
	20. 20% increase in the number of women-led businesses implementing renewable energy and adaptation interventions	2030	2021	Conditional
Children and Youth	21. All students from primary to tertiary level have access to relevant climate change education	2027	2021	Unconditional
	22. 25% increase in access to financing for businesses related to the transition to a low carbon, high resilient economy	2030	2021	Unconditional
	23. Provide apprenticeship program for 100% of all students at secondary and tertiary institutions	2030	2021	Conditional
Loss and Damage Response	24. Farmers, fishers, and residential and business owners have access to comprehensive and tailored national programs that allow them to affordably manage and transfer risks resulting from increasing climate variability	2030	2015 (*Updated in 2021*)	Conditional
Finance	25. A legal and technical framework via regulations is agreed as an enabling environment to support the national alignment of all of its finance flows with a low greenhouse gas emission, climate resilient development pathway (*i.e. achieving Article 2(1)(c) of the Paris Agreement*)	2030	2021	Conditional
	26. Debt-for-climate swaps initiated with willing creditors with the objective to support implementation of NDC	2025	2021	Conditional
	27. US$120 million in finance from external support providers for adaptation in the private sector (for e.g., via back-up	2030	2021	Conditional

Thematic Area	Target and Actions	Completion Date	Year Communicated	Conditionality
	renewable energy system [111], climate-resilient homes and businesses, and cooling) is raised			
Regional Engagement	28. Engage on the potential operationalization of non-market approaches for climate action (e.g., bulk procurement of climate technology) with the Organization of Eastern Caribbean States (OECS) Member States in line with Article (6)(8) of the *Paris Agreement*	2025	2021	Conditional
	29. Promote the use of a sustainable procurement policy within the OECS Commission and its Member States	2025	2021	Conditional
	30. The University of West Indies (UWI) Five Island Campus commences its leadership role in the operationalization of the just transition of the workforce through initiatives such as the development of new training and entrepreneurship program to encourage local businesses and investments to engage in low greenhouse gas emissions, climate resilient development	2025	2021	
	31. Engage with the Eastern Caribbean Central Bank (ECCB) and the Eastern Caribbean Securities Exchange (ECSE) to build capacity and broaden the financial instruments available to local investors via local banks in anticipation of low greenhouse gas emission, climate resilient transition as well as the implementation of Article (2)(1)(c) of the *Paris Agreement*	2028	2021	Conditional
	32. Engage on the potential adoption of OECS regional agreements on the conservation and enhancement of sinks and reservoirs of greenhouses gases for the results-based payments (*Note: Payments could be collected at the regional level and channeled to community-based climate resilience programs*)	2030	2021	Conditional
	33. Operationalization of the SIRF Fund to act as an interim regional funding mechanism for the OECS through the financing of high-risk climate action projects, including ones focused on communities and lower-income persons who are at a	2030	2021	Conditional

[111] Any mitigation co-benefits arising from this action will not be additional to the mitigation targets.

Thematic Area	Target and Actions	Completion Date	Year Communicated	Conditionality
	high risk of being affected by the negative climate change impacts as well as the just transition of the workforce			
	34. Engage on the potential adoption of OECS regional agreements, frameworks and policies on forced displacement and human mobility caused by climate change within the OECS region.	2030	2021	Conditional

Development and Implementation of Projects and Programs

The DOE has been an accredited entity to the Adaptation Fund and the Green Climate Fund and have access significant resources for Adaptation and Mitigation. Each project is designed with the sector coupling approach built in and with outputs that provide resources directly to communities and households in the form of grants and loans respectively. Over two thirds of the projects are designed to reach out directly to persons who will be affected by the implementation of various policies and measures.

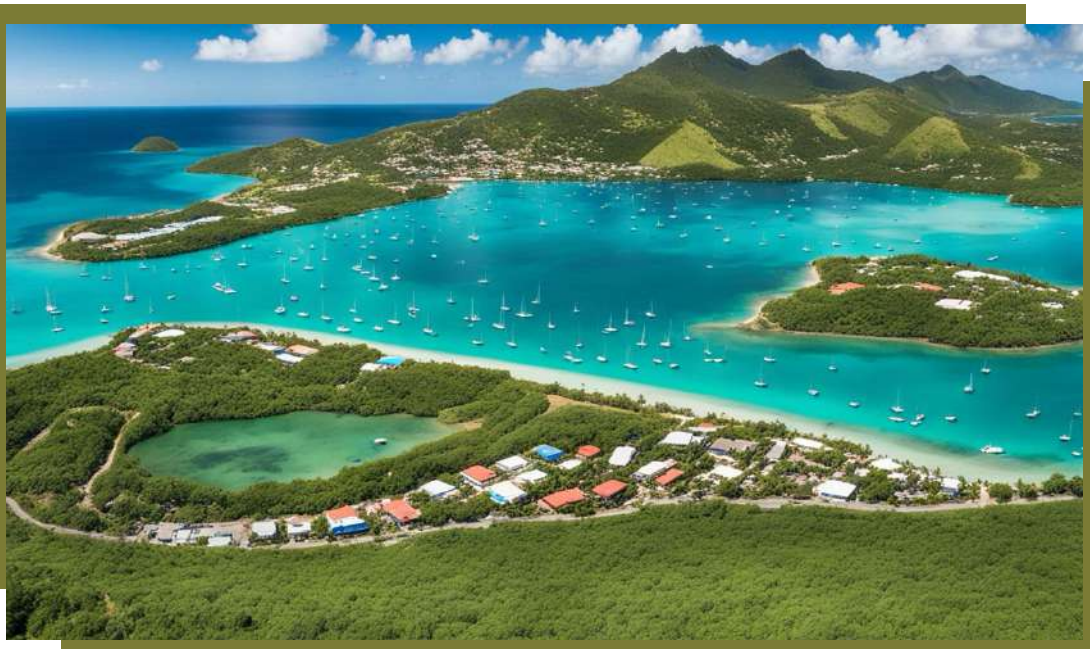
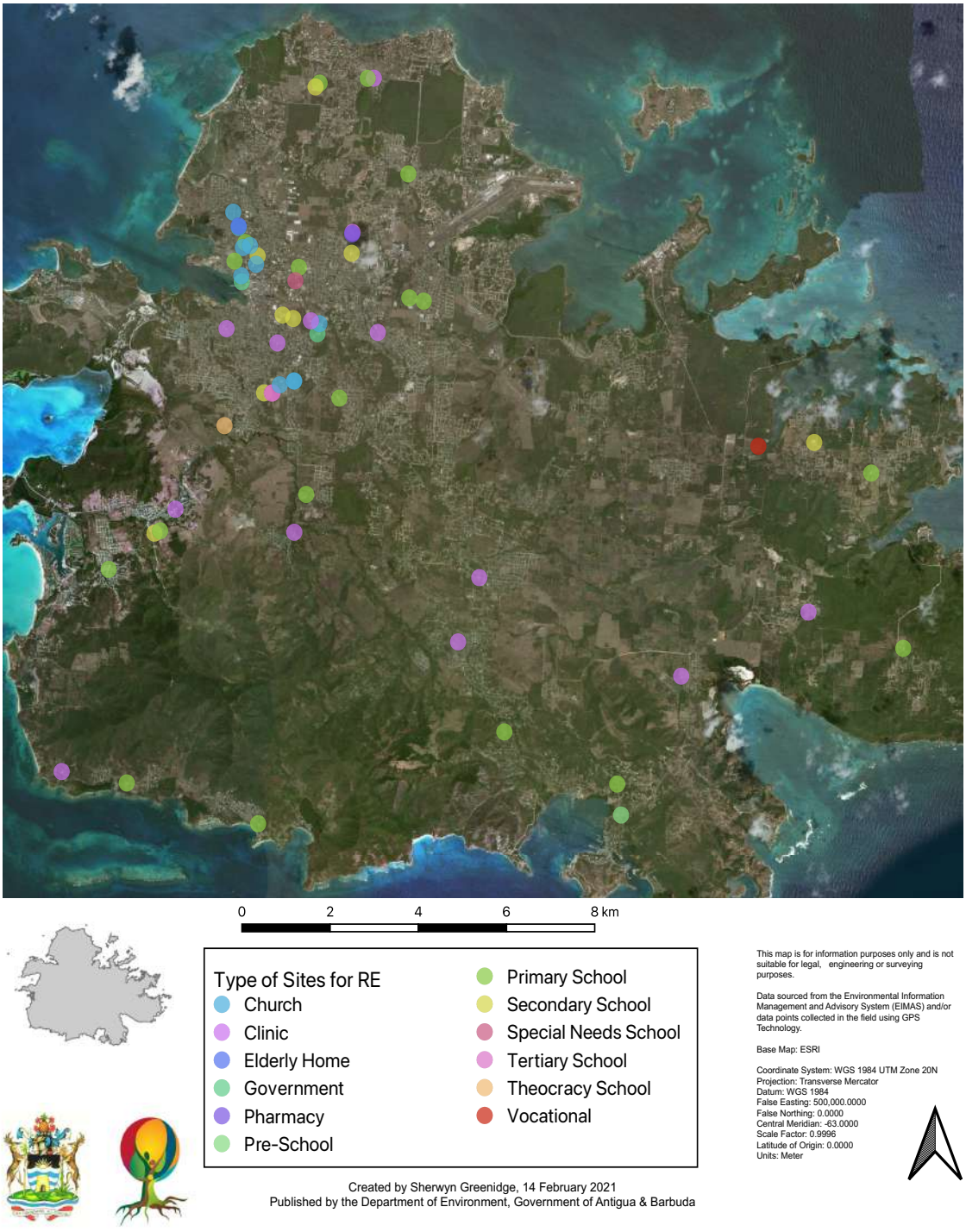


Figure 3.16: Map of Renewable Energy Projects undertaken by the GoAB

#DOE/ATG/192



Overview of Current Mitigation and Adaptation Projects and Programs

Antigua and Barbuda have committed to reducing its GHG emissions as outlined in its 2015 NDC and revised 2021 NDC. The following tables outline the projects that have been completed and implemented since the Third National Communication.

Table 3.3: Mitigation and Adaptation Projects Completed by 2020

Project	Start Date & Implementation Completion Date	Summary	Priority	Renewable Energy Capacity (kW)	Approximate tCO_2e avoided annually [112]
Energy for Sustainable Development in the Caribbean	2013 – 2020	The Energy for Sustainable Development in the Caribbean (ESD) is aimed at reducing the growth of energy demand in five Caribbean countries through increasing the efficiency of energy use in buildings, increased use of energy conservation and promoting the increased use of renewable energy resources.	Mitigation	9	82.26
Electric School Bus Pilot Project	2017 – 2020	This pilot project will install two electric charging stations and purchase two electric school buses to collect data. Technical and financial feasibility studies will be conducted and a Small/Medium size GCF project will be developed and submitted for funding.	Mitigation	0	Not yet quantified
GISS: Grid Interactive Solar PV Systems for Schools & Clinics	2017 – 2020	The goal of this project is to assist schools to become fully operational following major climactic events such as hurricanes and droughts. This is being done through the provision of clean technology solutions, in the form of grid-interactive solar PV systems. Schools apply for the grants, made available through the funding provided by the	Cross-Cutting: Adaptation & Mitigation	133	134.4

[112] Grid Emissions Factor for Antigua = 0.6154 tCO_2e/MWh; Grid Emissions Factor for Barbuda = 0.9616 tCO_2e/MWh

Project	Start Date & Implementation Completion Date	Summary	Priority	Renewable Energy Capacity (kW)	Approximate tCO_2e avoided annually [112]
		Ministry of Environment, Land and Sea of Italy.			
10 MW Solar Project	2015 – 2019	To provide Antigua and Barbuda with 10 MW of renewable energy. This has been realized in the 3 MW Airport and 4 MW Bethesda installations. Approximately 2 MW of renewable energy has come from the private sector.	Mitigation	9,000	9,097.15
Energy audit of public buildings	2019 – 2020	To assess and reduce the energy consumption from 3 facilities - the airport, the government complex and the hospital. The project will involve an assessment of the energy usage as well as engage on a program of behavioral change to address any energy wastage.	Mitigation	0	0

Table 3.4: Ongoing Mitigation and Adaptation Projects

Project	Start Date & Implementation Completion Date	Summary	Priority	Planned Renewable Energy Capacity (kW)	Approximate tCO_2e avoided annually
GEF SCCF: Building climate resilience through innovative financing mechanisms for climate change adaptation	2015 - 2021	To build national and sub-national capacity for medium- and long-term adaptation planning, accessing innovative financing mechanisms and implementing cost-effective adaptation interventions focused on ecosystems for communities and	Cross-Cutting: Adaptation & Mitigation	400	404.32

Project	Start Date & Implementation Completion Date	Summary	Priority	Planned Renewable Energy Capacity (kW)	Approximate tCO_2e avoided annually
		sectors vulnerable to climate change in Antigua and Barbuda.			
Sustainability Energy Facility / Caribbean Development Bank (SEF/CDB) project	2017 –2021	Reduce the dependency on fossil fuels by promoting the implementation of Energy Efficiency (EE) measures and Renewable Energy (RE) pilot demonstration projects and solutions, including through promotion of Smart Grid solutions, as a way to reduce energy consumption and costs.	Mitigation	142	143.76
SPPARE	2015 - 2021	To establish 1,039 ha of land as national park, contributing towards mitigation targets, and to improve management effectiveness of this new protected area. To procure and install 4.125 MW of wind turbines To develop a national wildfire prevention strategy to protect the forest ecosystems and reduce nationwide fires by 20%. Additionally, to plant 20,000 trees, in order to restore degraded land and increase CO_2 sequestration. Overall aim is to successfully	Cross-Cutting: Adaptation & Mitigation	4,125	6,221.69[113]

[113] Assuming an average wind speed of 6.5m/s

Project	Start Date & Implementation Completion Date	Summary	Priority	Planned Renewable Energy Capacity (kW)	Approximate tCO_2e avoided annually
		rehabilitate the watershed.			
Green Barbuda	2019 – 2021	To install a modular hybrid power plant that will consist of 720 kW of solar capacity, 860 kW battery storage, and 660 kW diesel engine capacity.	Cross-Cutting: Adaptation & Mitigation	720	727.77
GEF 7 Antigua and Barbuda Sustainable Low-emission Island Mobility (SLIM) project	2021 - 2025	Promotion of low emission public and private transportation systems in Antigua and Barbuda that are resilient to the projected impacts of climate change.	Cross-Cutting: Adaptation & Mitigation	150	151.62
Resilience to hurricanes, floods and droughts in the building sector in Antigua and Barbuda (GCF Build)	2021 – 2024	To increase the resilience of the population in Antigua and Barbuda to extreme climate events, the proposed project will implement climate-resilient technologies and interventions in public and community buildings and will strengthen institutional, technical and financial capacity within the GoAB to enable climate-resilient building development in the long term.	Cross-Cutting: Adaptation & Mitigation	1,500	1,516.19
AF: An integrated approach to physical adaptation and community resilience in	2017 -2021	The project will implement concrete adaptation interventions in Antigua's northwest watershed. The project goal is to reduce vulnerability of the	Cross-Cutting: Adaptation & Mitigation	900	909.72

Project	Start Date & Implementation Completion Date	Summary	Priority	Planned Renewable Energy Capacity (kW)	Approximate tCO_2e avoided annually
Antigua and Barbuda's northwest McKinnon's watershed		community, by increasing the ability of the watershed to handle extreme rainfall, while increasing the resilience of the built environment simultaneously to cope with the multiple stressors of climate change.			
The Path to 2020 – Antigua and Barbuda	2019 - 2023	To actualise protection and sustainable use of biodiversity and protected areas, under the umbrella of the newly passed Environmental Protection and Management Act (EPMA) of 2015. It aims to improve management of landscapes and seascapes to enhance protection and sustainable use of globally significant biodiversity in protected areas and surrounding communities.	Cross-Cutting: Adaptation & Mitigation	TBD	TBD
AF: Innovative Technologies for Improved Water Availability to Increase Food Security in Antigua and Barbuda		This project aims to improve food security in Antigua and Barbuda by facilitating the availability and use of ground or surface water for agricultural purposes via innovative technologies. The proposed technologies for demonstration purposes run on self-generating renewable power, making them	Cross-Cutting: Adaptation & Mitigation	16	16.17

Project	Start Date & Implementation Completion Date	Summary	Priority	Planned Renewable Energy Capacity (kW)	Approximate tCO_2e avoided annually
		resilient to disruptions from grid instabilities or extreme climate events, and are aligned with the country's Nationally Determined Contribution (NDC) target of transitioning to 100% renewable energy by 2030.			
GCF: Enhancing Direct Access (EDA)		Strengthening the resilience of three Caribbean islands to climate change-related threats by improving the hurricane resilience of community buildings, homes, and businesses, and through flood prevention measures.	Cross-Cutting: Adaptation & Mitigation	650	657
IRENA/ADFD Phase 2	2021- 2025	The project will install renewable energy technologies and implement energy efficiency measures on critical public infrastructure such as the Port Authority, V.C. Bird International Airport and the University of the West Indies, in addition to procuring solar kits to be distributed through the SIRF fund.	Cross-Cutting: Adaptation & Mitigation	1,800[114]	1829.43

[114] This figure does not include the connection of the VCBIA to the existing 3 MW solar array at this location as it has been accounted for in the 10 MW solar project.

Summary Renewable Energy Generation (APUA information)

Table 3.7: Antigua

Description	Installed (MW)	To be installed (MW)[115]	Annual Output 2019 (MWh)	tCO_2e avoided in 2019[116]
Solar Residential & Commercial	2	5.878	295	181.543
Solar (Utility Scale)	7	TBD	9,000	5,538.6
Wind (Utility Scale)	0	4.125	0	0
Total	9	10.003	1,195	5,720.143

Table 3.8: Barbuda

Description	Installed (MW)	To be installed (MW)	Annual Output 2019 (MWh)	tCO_2e avoided in 2019
Solar Residential & Commercial	0	0.00	0.00	0.00
Solar (Utility Scale)	0	0.75	0.00	0.00
Wind (Utility Scale)	0	0.00	0.00	0.00
Total	0	0.75	0.00	0.00

Implementation Strategies for Renewable Energy – Sector coupling Approach

In Antigua and Barbuda, adaptation and mitigation are implemented using the sector coupling approach. As the country seeks to adapt to the changing climate by building resilience, measures to mitigate climate change are also incorporated. The implementation of grid-interactive renewable energy solutions throughout various essential sectors seeks builds their resilience as their recovery time is not hindered by the repair and recovery of the grid. The renewable energy implemented in target sectors within Antigua and Barbuda are done as both adaptation and mitigation measures. The strategies implemented throughout essential sectors, which are guided by the 2015 NDC commitments are outlined in Table 3.9.

Table 3.9: Implementation Strategies for NDC Commitments

Sector	Progress
Water i.e., Seawater Desalination	• IRENA/ADFD Phase 1: 4.125 MW wind turbines will be connected to the largest reverse osmosis (RO) desalination plant in Antigua. The turbines are approximated to provide at least 50% of the energy demand of the plant. • IRENA/ADFD Phase 2: A solar PV farm will be installed and connected to the aforementioned desalination plant. This

[115] The quantity outlined in this column considers government renewable energy initiatives and does not account for private sector initiatives

[116] Grid Emissions Factor for Antigua = 0.6154 tCO_2e/MWh; Grid Emissions Factor for Barbuda = 0.9616 tCO_2e/MWh

Sector	Progress
	installation is expected to increase the renewable energy electricity share at the plant up to 80%. • AF Innovative Technologies for Improved Water Availability to Increase Food Security in Antigua and Barbuda: Solar powered, off-grid RO units and solar powered water pumps will be demonstrated and tested inland at agricultural sites. The data generated by this project will inform potential further deployment of renewable energy technologies in the water and agricultural sectors.
Health	• 75% (16 of 21) clinics Health Clinics have been targeted for renewable energy interventions under the SPPARE, GCF Build, SEF projects. The balance of clinics will be transitioned to renewable energy generation upon completion of ongoing projects and once additional funding is secured. • IRENA/ADFD Phase 1: The design for a grid-interactive solar array for the Mount Saint John's Medical Centre (MSJMC) has been completed. This grid-interactive array is expected to cover the majority of the electricity demand at the facility. • Energy audit of public buildings: Energy efficiency recommendations from this study will be implemented at the Mount Saint John's Medical Centre (MSJMC) under the IRENA/ADFD Phase 2 project.
Emergency Services	• Under the SCCF project the Sustainable Island Resource Framework (SIRF) Fund was established and operationalized in 2019. Under this fund a financing window was created that allowed for emergency responders to apply for affordable financing to climate-proof their homes. Renewable energy technologies fall under climate-proofing measures and it is anticipated that the majority of applicants will access renewable energy technologies. • AF Mckinnon's project & EDA project target the 9 churches in the Mckinnon's and Cashew Hill communities for climate proofing upgrades to enable the churches to serve emergency shelters. Grid-interactive solar PV systems are included as part of these upgrades. • IRENA/ADFD Phase 2: Critical public infrastructure such as the Port Authority, V.C. Bird International Airport, have been targeted for renewable energy interventions under ongoing projects. The port and airport are essential gateways for goods and services for Antigua and Barbuda. The renewable energy installations seek to build resilience by reducing their recovery time post disaster.
Education	• 45 schools have been targeted under ongoing and planned projects. Of the 45 schools, 28 are targeted under the GISS, GCF

Sector	Progress
	Build, SEF projects and 15 schools will be targeted under projects that are in development.
Transport	• 2 electric buses were introduced to the school bus fleet under the Electric School Bus Project. • The SLIM project scales up this electric vehicle initiative and will develop the enabling framework required to encourage the uptake of electric mobility, procure 2 electric taxis, 2 electric buses, 2 solar powered charging stations (150 kW), and provide affordable, concessional financing for taxi drivers to purchase electric taxis.
Electric Grid	• 10 MW Solar Project: completed with 3 MW & 4 MW installations at the VC Bird International Airport & Bethesda respectively. • The Green Barbuda Project: This project will be replacing the generation in Barbuda that was irreparably damaged in the 2017 hurricane season. This project will install a hybrid solar, diesel and battery project with 720 kW of solar capacity, 860 kW battery storage, and 660 kW diesel engine capacity.

Sector Coupling of the Energy and Transport Sector

Antigua and Barbuda is highly vulnerable to the impacts of climate change, requiring the country to be proactive in its strategies to increase resilience. The transport, backup energy and electricity sectors in Antigua and Barbuda are connected by their primary energy source, fossil fuel, which must be imported by WIOC, as the country has no known fossil fuel reserves. These sectors therefore vulnerable to international oil market prices which limits the country's ability to truly achieve a resilient economy.

The country has two natural resources that can be used to build resilience in the aforementioned sectors which are its abundant sun and wind resources. By harnessing these resources by using renewable energy technologies, Antigua and Barbuda can shift the linkage between the sectors from fossil fuel to an electricity coupled sector.

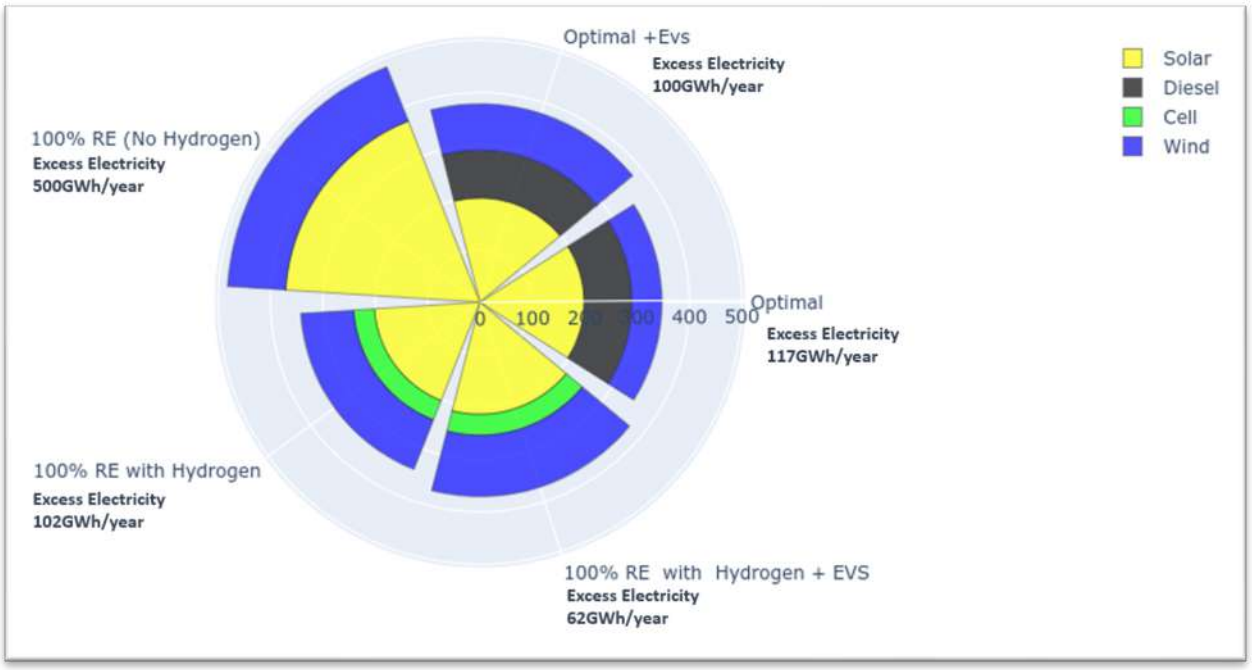
An electricity coupled sector approach gives the GoAB several possibilities as the country seeks to meet its NDCs. Initially proposed targets for the revision of the NDC increased the renewable energy share in the electricity sector to 100 percent by 2030, and the transition of the transportation sector to 100 percent electric vehicle by 2040. Careful planning and campaigning can be used to exploit the synergies among these sectors to create a more robust system in the country.

Several scenarios were presented in the IRENA roadmap for the transition to a higher percentage of renewable energy in the energy generation sector and an electric vehicle fleet. Four of the scenarios are represented in Figure 3.17, which shows the breakdown of the energy production, quantity of solar and wind

energy needed and battery storage for the given scenarios. It is seen that irrespective of the scenarios, there is excess energy being produced. The other important apparent trend is that the introduction of hydrogen significantly reduced the need for battery storage but does not eliminate it from the electricity sector.

The addition of electric vehicles to the optimal system required 30MW of wind power to be added which resulted in an excess of 100GWh of electricity annually. Extrapolating the estimating the electricity needed for the electric vehicles by taking the difference of the optimal and the optimal plus EV showed that 114GWh/year was used by the software. Therefore, the electricity to power the EVs is less than the 117 GWh/year excess energy that is generated under optimal conditions. Instead of increasing the generating capacity for wind and battery storage, deploying smart charging solutions could utilize the excess energy to recover the cost of the system and reduce the payback time for loans. A similar observation can be found under the scenario that employs hydrogen to achieve 100 percent renewable energy that produced 102GWh/year of excess energy which is the same quantity of energy that is needed when EVs are added to hydrogen scenario.

Figure 3.17: Graphical representation of the excess electricity for the 5 scenarios in IRENA's roadmap

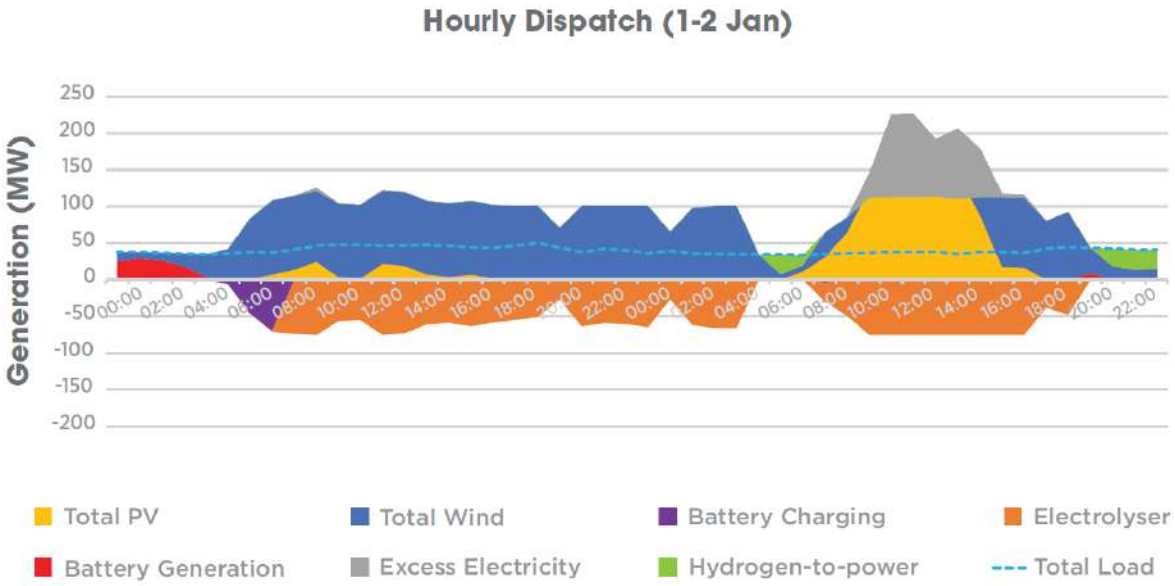


IRENA created a load profile for the scenario that represented achieving 100 percent renewable energy production with the use of green hydrogen as a firm capacity (Figure 3.18). In this scenario, the quantity of wind turbines and solar modules are increased to produce the hydrogen using the electrolyser resulting in an increased total load of approximately 100-110MW. On the 1st of January, a cloudy day, between 6AM and 8AM, the battery system was charging using the surplus energy produced by the wind

farms. For the rest of the day, no excess energy was available as the electrolyser would be working to absorb this energy. When no hydrogen is produced, the total load return to less than 50MW which is the present baseload. On January the 2nd, a sunny day, the electrolyser was constantly on between 10AM and 6PM. During this period, the total load was not sufficient to use all the electricity that was produced, resulting in curtailment of the excess electricity. Sector coupling of the electricity and the transport sector could be achieved using the same principle of how the electrolyser used the excess electricity to produce hydrogen. The excess energy can be used to charge electric cars without the need for new electricity generating capacity.

For explanatory purposes, Figure 3.19, depicts two extremes for how the grid could respond to a cloudy day (1st January), and a sunny and windy day (2nd January). On 2nd January, the excess energy produced from wind energy between 6AM and 2PM is used to charge the grid battery storage. However, excess energy is produced between 4PM and 4AM of the next day that will be curtailed Assuming an average power of 5MW during this period, a total of 60MWh of energy could be curtailed.

Figure 3.18: Hourly Dispatch - 100% renewable energy with Hydrogen (IRENA Roadmap)



Conducting a similar analysis for 2nd of January reveals that by 10AM, energy curtailment will begin and continue until 6PM. A total of 199MW of solar PV are installed, therefore during the period of 10AM and 4PM, an average of 100MW of solar will be curtailed that would produce 600MWh of energy. Wind energy production will not be calculated due to its uncertainty in this quantity being repeatable at all the sites across the island throughout the year.

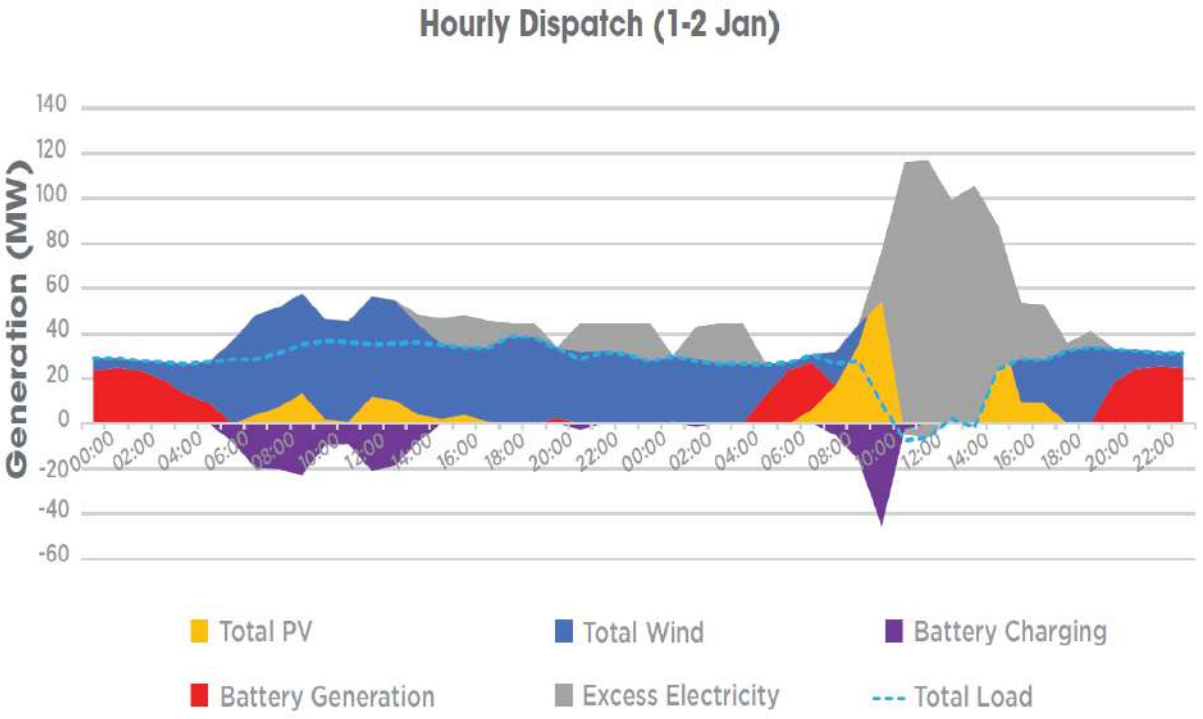
It is estimated that a total of 60MWh excess energy could be produced during the night on cloudy days from the wind farms. A car and an SUV would use approximately 4.1kWh and 5kWh respectively, to travel 25km per day. Assuming persons plug in their car to charge each night when they arrive at home, a total of 14,634 cars or 12,000 SUVs could be charged with this excess energy. This type of charging would require persons plugging in their vehicle in a smart socket that would allow the

utility company to distribute the power to the cars. Without this smart plug technology, the simultaneous charging of vehicles will cause the grid to collapse. Another, scenario for the usage of this energy is for the charging of public transportation fleet (large buses and minibuses). At the end of each day, large buses will require 200kWh while minibuses would require 60kWh of energy to be replenished before the next day. Therefore, the 60MWh of energy could recharge 300 large buses or 1,000 minibuses. One limitation of this scenario is that these vehicles require special level 2 (minibus) and level 3 (large bus) charging infrastructure that will not be available at homes. Another limitation is that the calculation assumes each vehicle will have its own charging station which will not be the case due to cost and space limitation for charging infrastructure.

Charging on Sunny Days

The quantity of excess energy produced from solar farms during the day when it is sunny is 10 times more than estimated for excess energy produced during the night from wind energy. The total number of cars and SUV that could be charged would be 20 times that said above give that the vehicle would have only driven half the distance. This approach is not practical given that it assumes level 2 (3.6 kW) charging for these vehicles and that each vehicle has its charging station. Therefore, this analysis will be done from the vantage point of calculating the number of charging station that could be used on sunny days simultaneously. A total of 100MW (100,000 kW) of solar will be used to decide the number of charging station that could be operated. Using a Level 2 charger that needs 7.2kW, a total of 13,888 stations could be used simultaneously.

Figure 3.19: Charging Scenario on a Cloudy day using IRENA's Optimal System Scenario



Cars and SUVs are assumed to be parked at workplaces for the above situation. Considering public transportation and how they could benefit from the available excess energy, using a rail charging station for a large bus that requires 150kW[117], a total of 660 stations could be available for charging bus along their route.

Charging infrastructure for the Government Fleet

The GoAB intends to lead the electric vehicle transition by converting its fleet by 2035. This section will discuss a scenario for the charging infrastructure needed to meet the energy needs of the fleet at their respective workplaces. The following assumptions were made to calculate the charging infrastructure:

1. Charging takes place Monday to Friday between 10AM and 4PM.
2. All chargers were powered by solar panels with a small battery installed.
3. Each car charged once per week during this period.
4. A Level 2 (10kW) Charger could charge 2 cars per day.
5. A Level 1 (2kW) Charger can only charge 1 vehicle per day.
6. Where the number of vehicles was less than 30, a package of two Level 2 Chargers and two Level 1 sockets were utilized.
7. Level 3 (50kW) Chargers were given to ministries that have large and active vehicle fleet.

A total of 1.14MW of solar power is estimated to cover the charging needs of the 794 cars of the government fleet. This would power a total of 68 Level 2 Chargers, 55 Level 1 Chargers

Table 3.10 Charging Infrastructure Scenario for the Government Fleet

Ministry	Total Vehicle	level 1	level 2	level 3	Total (kW)
Ombudsman	1		1		10
Housing, Land and Urban Renewal	10	2	2		24
Government House	13	2	2		24
Sports, Culture National Festivals and the Arts	14	2	2		24
Tourism and Economic Development	15	2	2		24
Social Transformation and Human Resource	17	2	2		24
Education, Science and Technology	23	2	2		24
Barbuda	23	2	2		24
Foreign Affairs, Internagtional Trade and Immigration	24	2	2		24
Broadcasting, Telecomminucation and Information	25	2	2		24
O.N.D.C.P	26	2	2		24
Legal Affairs, Public Safety and Labour	37	3	3		36
Agricturlture, Lands, Fisheries and Barbuda Affairs	45	3	4		46
Defense Force	61	5	5	1	110
Finance and Corporate Governance	62	5	5		60
Public Utilies,Civil Aviation and Transportation	77	5	6	1	120
Health, wellness and Environment	79	5	6		70
Police	92	4	8	1	138
Works	150	5	10	4	310
Grand Total	**794**	**55**	**68**	**7**	**1140**

[117] https://www.oppcharge.org/

and 7 Level 3 Chargers. Workers that need more charging could charge on the weekend. In an effort to promote electric vehicle adaptation, the government could make its charging infrastructure accessible to the public on the weekend.

Policy Development to Support Sector Coupling

The coupling of the energy and transport sectors must be guided by an enabling policy framework which will provide the guidelines for private businesses, consumers and government agencies involved. The legislative and policy instruments of the government will need to accomplish two tasks. The first is the gradual transformation of the vehicle fleet from ICE-powered vehicles to EVs. This step will include a range of political and economic activities which are captured under the title 'EV Adoption'. The second task is the 'coupling' of the electricity and transport sectors to maximize the efficiency of the electricity generation activities. This coupling will require a pioneering set of policies and mechanisms to encourage appropriate behavior by the driving populace.

EV Adoption

The transition of the vehicle fleet in Antigua and Barbuda will require the active participation of the public and private sectors, engaging stakeholders involved in the import, processing, and sale of vehicles across the country. The current import market is dominated by foreign used vehicles, with a few local businesses selling new cars. The historical growth rate of the fleet is approximately 1,000 vehicles per year (LOGIOS, 2018). The aim for EV adoption then should be that these additions to the fleet are EVs and that they should gradually replace the existing ICE vehicles in tandem with the decarbonization of the electrical grid.

To encourage this uptake, a cohesive policy framework must be developed as a co-condition for market formation (Broadbent et al, 2017). The policy is necessary to facilitate the consumer use of EVs, including the development of infrastructure and public education campaigns to alleviate misconceptions about the technology. These measures should assist in the diffusion of EVs into the local car market while addressing possible market failures including limited information, negative externalities and varying standards for technical components.

Financial Incentives

The top 11 countries with high EV adoption have utilised some form of a monetary incentive to enhance EV penetration (Song & Potoglou, 2020). Most have offered reductions or exemptions on taxes for EV owners. Research in the European market suggests that EVs only become popular when comparably priced to ICE vehicles (Lévay, Drossinos, & Thiel, 2017). In Antigua and Barbuda, research by LOGIOS (2019) found that car dealerships agreed with the need for subsidies on EVs if they are to penetrate the local market. Financial incentives will make sense when the negative externalities from the ICE run fleet are accounted for and integrated into economic considerations of the current transport sector.

Incentives for adoption can come at different stages of purchase. Subsidies on the purchase price for EVs are the most direct means to lower costs and achieve price parity with traditional ICE vehicles. The UK for instance, has a Plug-In car grant, which subsidizes the purchase of EVs by up to £3,000 (US$4103/ EC$11,087). Subsidies have been shown to be

most impactful for stimulating the EV market in its infancy, with limited effectiveness over the long term (Harrison & Thiel, 2016).

In addition to subsidies, tax and registration discounts and exemptions have been instituted. These reductions in additional costs, such as the registration cost for the vehicle, form an integral part of many countries' EV policy framework. Tax exemptions from the national sales tax (15 percent) and the environmental levy (EC$1000 for new vehicles; EC$4000 on vehicles >1 year old) on EVs are possible avenues for offering subsidies (Antigua & Barbuda Customs & Excise Division). A more demanding approach is the use of a bonus-penalty system that offers bonuses to EV users while increasing taxes on ICE vehicles. Developing the current environmental levy to reflect a more progressive system which penalizes older, ICE vehicles while offering more generous exemptions for newer, electric vehicles.

Non-monetary Incentives

To further encourage uptake of EVs, other incentives may be offered to users. These include parking benefits and preferential travel (Song & Potoglou, 2020). Parking lots with charging stations are a joint opportunity to offer non-financial incentives while enhancing public charging infrastructure.

Regulations

There are multiple regulatory opportunities to encourage EV adoption. A policy for public procurement of EVs for the government fleet, as suggested in the earlier analysis, has been undertaken in the EU for its participating countries (Song & Potoglou, 2020). Government procurement serves multiple purposes: increasing the second-hand market after a few years while facilitating information diffusion through the employees that use them. Government fleet infrastructure sets the groundwork for further profusion of charging stations.

Regulations on imported vehicles are another opportunity to encourage EV purchases. The implementation of emissions standards on imported vehicles can greatly reduce the influx of old ICE vehicles into the market.

Charging Infrastructure – Sectors coupling with NGOs and Community Support

Consumers are reluctant to purchase EVs without adequate and widespread charging infrastructure. Most of the studies and consultants used for this report were from large, developed countries who identified charging infrastructure as a limiting factor. Most EV owners in Antigua and Barbuda however can adequately charge their EVs at home. Consequently, the build-out of charging infrastructure without taking this into consideration may be a risky investment. The Country is therefore using grants to build charging stations in churches, community centers and other small businesses that will not depend on the infrastructure for their 'bread and butter'. This can bring in additional income and person will presumably be happy to support these entities that they have a community and an emotional attachment.

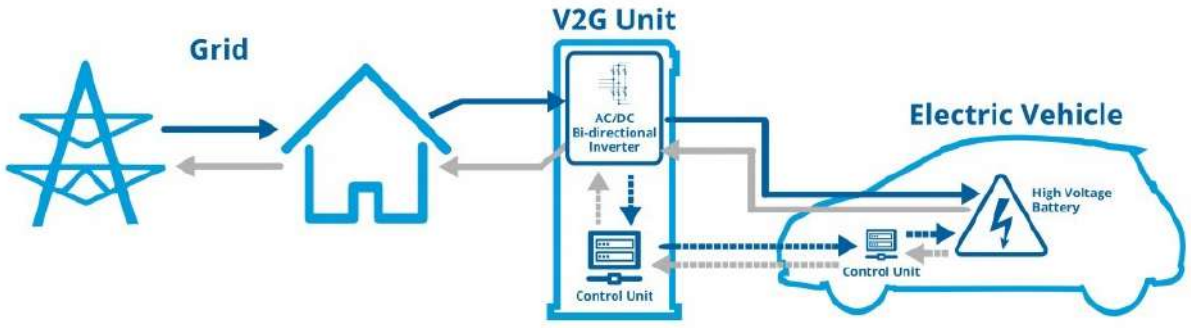
Charging infrastructure is however necessary in the public transportation sector but this is being built out at the National Stadium and other areas including home charging. At this point the Goal is to limit most charging stations to Level 2 only and have minimal fast charging stations.

Vehicle-to-Grid (V2G) Approaches

Under a sector coupled regime, the use of Vehicle-to-grid (V2G) service can enhance the profitability of EVs. The V2G concept, according to Wagner, 2014 "aims to optimize the way we transport, use and produce electricity by turning electric cars into 'virtual power plants." Electric cars would both store and dispatch energy stored in vehicle batteries connected a network. This would supply the grid when demand is high and draw from it for charging when demand is low. Additionally, the EVs can support Vehicle-to-home (V2H) functionality, where the vehicle batteries can serve as energy sources for households.

A viable V2G system needs buy-in from both grid operators and vehicle owners. Owners require adequate compensation for allowing their vehicles to be used for grid services, as well as a suitable level of availability for personal use. Grid operators must derive sufficient benefits from the integration of the EVs to overcome the additional costs of monitoring and controlling the interactions of EVs and the grid, as well as administrative costs and payments to owners (Steward 2017).

Figure 3.20: Representation of V2G system



Source: Cenex - https://www.cleantech.com/ev-charging-software-and-grid-services/

In a proposed sector-coupled approach to a renewable transition in the energy sector, the V2G process offers many benefits. Renewable energy sources raise issues with supply consistency due to the variable generating capacity at a given time. Variables such as cloud cover and changing wind speeds can impact the generation levels of renewable energy systems reliant on these inputs (Weiller & Sioshansi, 2014). The variability and uncertainty associated with renewable power sources create challenges for the grid operators in ensuring that electricity supply and demand are matched. The V2G system provides backup power and can stabilize intermittent renewable energy sources (Guille & Gross, 2009). V2G integrated vehicles can provide three services: bulk storage, operating reserves and frequency regulation.

Under a renewable energy regime, bulk storage in the aggregated fleet can offer a cheaper alternative to storage systems such as utility-scale batteries. In this case, the EVs are used as a distributed energy storage system. The vehicles will store excess electricity for release back into the grid when demand peaks (Mullan et al, 2012).

V2G systems also capitalize on the potential for bi-directional charging. This refers to the option to have energy move from the vehicle's battery to the home system or grid. In this capacity, EVs can function as effective backup energy systems for households. They can be used in tandem with a renewable energy-based grid to regulate variations in energy supply. This process will rely on V2G communication to the vehicles to take in or release energy in response to energy production (from renewables) and demand (from the grid).

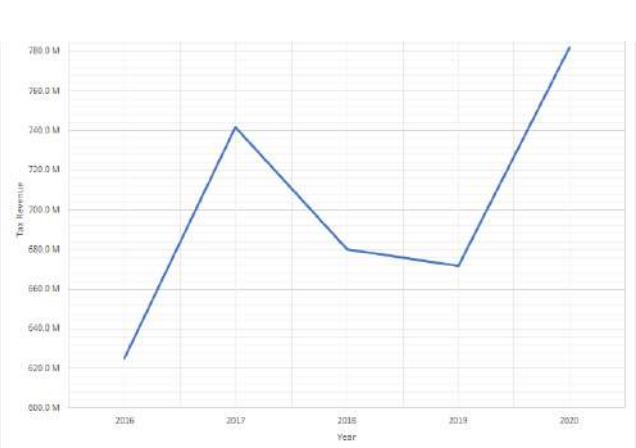
CONSTRAINTS AND GAPS TO IMPLEMENTING MITIGATION ACTIONS:

Financial Barriers

Antigua and Barbuda's efforts toward mitigation are hindered by a lack of available finance for large scale projects in the major GHG emitting sectors. The country has a limited tax base, amounting to EC$782.4 million in 2020[118], with a projected budget deficit of EC$96 million. Its economy is the largest in the Eastern Caribbean Currency Union, with the tax to GDP ratio being the lowest at 16 percent. Results from the total budget from 2014 to 2017 show that an annual average of 3 percent (which is EC$29.1 million) is used in climate-related public funding[119]. Of this, most of the spending was aimed at adaptation actions.

The COVID-19 pandemic has come as a massive external shock to the local economy. The pandemic has reduced visitors' arrivals to the country[120], impacting the tourism industry, which is the country's main revenue generating sector. The pandemic has caused the loss of approximately US$910 Billion to US$1.2 Trillion in international visitors' spending globally[121], the impact of which is still being felt by Antigua and Barbuda. The long-term effects on the local economy remain to be seen and will be contingent on demand for tourism and the condition of source markets in coming years. Considering these effects, financial constraints on mitigation activities will likely be exacerbated by more cautious public sector spending.

Figure 3.21: Annual Tax revenue



Source: 2020 Budget statement, Antigua and Barbuda

Despite these limitations, the government has been able to access international finance to facilitate mitigation projects. Bilateral funding arrangements have complemented these flows and allowed for pilot projects that tackle adaptation and mitigation needs. The accreditation of the DOE to the Adaptation Fund (AF) and Green Climate Fund (GCF)

[118] https://ab.gov.ag/pdf/budget/2020_Antigua_Estimates.pdf
[119] http://unfccc.int/documents/231984
[120] Statistics Division Data, 2020
[121] https://www.unwto.org/tourism-and-covid-19-unprecedented-economic-impacts

allows the country simplified access to these multilateral funds and will open the door for larger financial flows to accommodate more substantive mitigation actions.

The private sector has not been able to drive technological change to facilitate mitigation efforts. This is in part because of the expenses associated with shipping to the island, and the small market size for supply chain interaction. There are also high financial risks associated with the introduction of new technologies. Multiple regional reports have portrayed Antigua and Barbuda as one of the most disaster-prone locations in the OECS subregion[6], with the island being subjected to tropical storms, hurricanes, seismic tremors, and incessant dry spells.

Market Barriers

Almost all fossil fuel needed for electricity generation and transportation are still imported by Antigua and Barbuda [122]. Petroleum product imports consist of heavy fuel oil (HFO) for the power sector, gasoline, and diesel for the transport sector, liquified petroleum gas for cooking, and kerosene for aviation.

The market size for renewable energy in the country is small [123] compared to developed countries, as is typical for the Caribbean islands. Therefore, both energy demand and energy investment are considerably lower than in first world countries. The absence of renewable energy investment in most Caribbean Islands is caused by a lack of economies of scale and scope for renewable energy projects[124], which is indicative of the case of Antigua and Barbuda. Additionally, renewable energy requires substantial land space to install equipment. Antigua and Barbuda are small islands, having a total area of 420 km^2 therefore, land availability for renewable installations is limited [125]. Restrictions or limitations on land space are hindering the placement of wind turbines in facilities such as V.C. Bird International Airport, where wind turbines would obstruct civil aviation operations.

Further, the high cost of renewable energy technologies affects Antigua and Barbuda in decarbonizing its energy system. The capacity of renewable energy to contend effectively against other fossil fuel sales is low. The solar PV installation under the ESD project, projected a complete system cost of 3 single phases 7 kw SMA inverter with 3 MPPT,7 Testa Powerwall II with gateway and installation (13.5 kWh per unit), 84 Sunpower E20 DC Panel, Installation, of a total EC$338,572.37 compared to international cost of the same system to be EC$27,6247.18. The price exemplifies the patten for solar PV. According to IRENA, installing solar PV costs are notably higher than international averages, at EC$11 – EC$13 per watt, almost twice the highest cost elsewhere [126]. Therefore, the cost of technologies within Antigua significantly exceeds international cost.

[122] https://unfccc.int/sites/default/files/resource/Antigua%20and%20Barbuda%20%20UNFCCC%20Biennial%20Update%20Report%201%20-%20Final.pdf

[123] https://repositorio.cepal.org/handle/11362/40458

[124] https://www.cepal.org/en/publications/40458-barriers-identification-and-implementation-energy-efficiency-mechanisms-and

[125] https://www.researchgate.net/publication/282804308_Barriers_and_solutions_to_implementing_renewable_energies_on_Caribbean_islands_in_respect_of_technical_economic_political_and_social_conditions/link/561cc02a08aea80367256554/download or Blechinger, P. (2015). *Barriers and solutions to implementing renewable energies on Caribbean islands in respect of technical, economic, political, and social conditions.* Berlin: Reiner Lemoine Institute.

[126] IRENA Power Generation Costs 2019.

Technical Barriers

According to Blechinger (2015), technical barriers to renewable energy development are natural conditions such as a hurricane, lack of trained personnel, and availability of technologies such as large-scale wind turbines and PV solar panels and climate resilience technologies.

Antigua and Barbuda is faced with limited availability of technical know-how and skilled professionals required for the installation and use of new technologies. The small market size does not incentivize gaining skills in alternate technologies that are not used locally. Integration of new technologies for mitigation will require a simultaneous skills training initiative to ensure that the local market can adequately manage the maintenance and installation of these items.

The revised NDCs include a Just Transition of the workforce, which will complement the transition of the energy and transport sectors. In 2020, Antigua and Barbuda launched a Teacher Resource Guideline book that focuses on climate change issues for schools and the Government of Antigua and Barbuda. Further, a certified training program at the University of the West Indies, Five Islands Campus is scheduled to commence in 2021 along with, component 2, of the GCF built project, which intends to showcase capacity building and awareness-raising for the public and private sectors.

Barriers Related to Data and Information in Antigua and Barbuda

Data constraints inhibit climate actions in Antigua and Barbuda. The development and maintenance of a comprehensive data management system for tracking climate actions require extensive technical and financial resources which continues to be a challenge for the country. Various ministries and governmental agencies are tasked with regular data and information collection, however, there are gaps in consistency and sharing of this data[127]. Limited data collection activities in the past have created gaps in the existing data and information related to climate action while hampering the ability to contrast current and future values to historical figures. Compounding this issue is the delay in public sector digitization efforts, leaving large sets of data inaccessible for modern assessments. These data gaps limit the accuracy and scope of research on both current and potential mitigation projects and activities.

Data collection faces challenges related to the absence of a culture of data and information sharing. Stakeholders are often apprehensive about sharing their data due to concerns about confidentiality and an unfamiliarity with external sharing of organizational data. These challenges are expected to persist for some time until social and institutional practices address data and information needs. There have, however, been major efforts toward enhancing the data environment in Antigua and Barbuda since the Third National Communication (TNC).

Data collection is being improved through the creation of a domestic measuring, reporting, and verification (MRV) system which is being developed as a component of the Capacity Building for Improved Transparency (CBIT) project. MRV data collection aims to focus on GHG emissions, such as financial flow, and

[127] Biennial Update Report, 2020.

mitigation actions and policies. This framework incorporates the techniques used to track climate action activities. This project intends to operationalize the environment registry detailed in the EPMA (2019) legislation which will record all sources of pollution, including greenhouse gas emissions. The GEF-funded Monitoring and Assessment of Multilateral Environmental Agreements (MEA) implementation and environmental trends project will capture the relevant data to uphold the current legal commitments made by the country in international negotiations. These two data specific projects will create an enabling environment for more accurate and consistent tracking of data produced by all relevant mitigation projects in Antigua and Barbuda.

MRV data collection can be limited by significant financial, human constraints and limited network connectivity. As stated by the Biennial Update Report (BUR), as a SIDS, Antigua and Barbuda has a challenge in providing data due to inadequate human resources, and a lack of technical skills and infrastructure for the processing of data collection and management. Network connectivity can be another limitation where storing backup information and retrieval of data may be slow and unstable. Antigua and Barbuda currently has four network providers, however, a higher bandwidth that provides a faster and smoother flow of information is needed.

Policy Barriers

Institutional Capacity

The current legislative framework offers a foundation for enabling climate action in the EPMA (2019). However, there is still a need for legislation that encourages technological innovation and adaptation particularly regarding green technology (MTDS, 2015). Additionally, the lack of a comprehensive climate change framework limits the potential for integrated climate action and highlights institutional fragmentation. The strategies required for the development of a green economy, which mitigates the GHG emissions, demand more far-reaching and proactive legislation.

Enabling Framework

Clear and concise strategies must be developed in the transition to renewable energy. Policies need to be strategic if they are to accomplish the long-term outcomes outlined in prior publications. Therefore, the enforcement of these strategies should integrate short-term objectives with long-term, sustainable goals, with room for amendments if necessary. An area that currently lacks an enabling framework is the transport sector, where there has been no strategies and policies implemented to facilitate the conversion from internal combustion engine (ICE) vehicles to electric vehicles. The goal envisioned is a full conversion to EVs by 2040, however, with the absence of a clear framework, this might be jeopardized.

Policy targets

Policy implementation should have clear objectives and purpose in relation to the transitional goals of the Government of Antigua and Barbuda. In the past, policy positions taken have not been viable and lacked definite implementation plans. Therefore, for future policies to have an impact on the Sustainable Development Goals, the targets must be accurately defined, whether

short term or long term and be realistic for the suggested time period. A clear position enables clear communication and public education, which is essential for a buy-in of the general public to transition plans.

Investment and funding availability/access

Antigua and Barbuda does not possess the financial resources required for the complete decarbonization of its economy, and so it regularly seeks external finance for climate change activities. The country has accessed funding from a range of multilateral funds including GCF, AF, SCCF and GEF. As of 2020, there are at least 25 mitigation action related projects taking place in Antigua and Barbuda, which have been funded through finance from government ministries, state owned enterprises, regional bodies, bilateral agreements and multilateral funds. For the period 2014-2017, 10 percent of all international public finance was for mitigation activities, with a further 25 percent covered cross-cutting initiatives[128].

In addition to the extensive efforts to obtain financial assistance for multiple projects, the government has developed a complementary funding instrument to disburse finance to address climate change. The EPMA (2019) called for the establishment of the Sustainable Island Resources Framework Fund (SIRF) which will serve as a financing mechanism for regional environmental projects and the implementation of Multilateral Environmental Agreements. The fund will support measures for mitigation and adaptation, with a clear intent to support vulnerable populations. Activities such as collection of applications pertaining to the SIRFF started in 2017, however, most of the work was done in 2020 and the SIRFF will service future mitigation and adaptation actions. The two projects that contributed to the SIRF fund in 2020 were the Adaptation Fund (AF) and Special Climate Change Fund (SCCF) projects.

Despite the notable work done to improve access to finance, there remain obstacles to funding. Antigua and Barbuda is classified as a high-income country[129], which greatly reduces the funding options available from international lenders. This has also limited the availability of concessional finance[130], which is necessary to ensure that debt levels remain sustainable in the medium term. Attempting to access loans at non-concessional interest rates will pose a challenge for the government which must balance variable and volatile flows from the tourism sector to maintain revenue streams. Concessional finance will be necessary for utility-scale mitigation projects that can substantially reduce GHG emissions.

Applicability/compatibility of available renewable energy technologies in Antigua and Barbuda

Caribbean islands have great potential to capitalize on renewable resources, especially solar and wind. In the majority of the islands that potential remains largely untapped, mostly due to investments in fossil fuels, which in turn leads to undeveloped advanced

[128] Watson C, Robertson M, Ramdin A and Bailey C. 2020. Assessment and Overview of Climate Finance Flows: Antigua and Barbuda 2014–2017

[129] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-grou

[130] Quak. 2019. How losing access to concessional finance affects Small Island Developing States (SIDS).

renewable technologies. According to Irena (2016), available resources in Antigua and Barbuda include solar energy, wind energy, biomass, and ocean energy. Antigua and Barbuda's water security is heavily dependent on water desalination, according to Irena, over 60 percent of the public water supply is desalinated from seawater. The climate change technologies that are being considered in Antigua and Barbuda are as follows:

1. Air to atmospheric water generator - One application of climate change technology is to lessen the dependence on bottled water. This technology utilizes air to atmospheric water generators on a residential and commercial scale by extracting vapor from humid, ambient air and converting it to water. Barriers associated with this technology are reliability, performance, and lack of knowledge by the public.

2. Another available renewable energy technology is the solar water pump which is used mainly by farmers for crops and livestock, it substitutes grid electric and diesel-run water pumps by using power generated by solar photovoltaic panels. The only gap for this technology would be the financial constraint where government funding and subsidies would be necessary to overcome this gap.

3. Another available technology that should be considered for the islands is small scale wind turbines for residential uses, where the available wind regime for sections of the island has a maximum wind speed of 6 m/s above 10 meters. The only barriers to this technology are a high capital investment for wind turbines, which is due to the complexities of the design. Wind turbines have a historical presence in Antigua where windmills were used to generate electricity, pumping water, and grind grain. Antigua and Barbuda's Ministry of Finance secured international funds to construct a 4.125MW wind farm that will partially power the country's largest reverse osmosis plant and the Sir Vivian Richards stadium. For the Caribbean region, offshore wind turbine systems are achievable as seen where Barbados has budding possibility for fixed offshore turbine in shallow water near the coast (Sweyn et al 2016). However, there are a few gaps due to the lack of maturity of the technology and finances in the Caribbean.

CONCLUSION

The country considered about 30 mitigation actions, out of these mitigation actions, 14 were not modelled due to lack of precision or data to properly represent the scenarios. In addition to these actions, there are other areas suitable for modelling mitigation actions. Some of these areas for consideration in the future are:

- Transitioning to more efficient water heating
- Improvements in transmission and distribution losses
- Improvement in the energy efficiency of electricity generators
- Transitioning to more efficient ovens
- Improvements in the domestic aviation sector
- Improvements in the industrial sector

An important component of demand projections in the models is energy intensity.

Though these values were estimated using energy balance data and related assumptions, it is reasonable to say that the model can be enhanced from "bottom-up" estimations of energy intensities. For this, further studies need to be conducted in Antigua and Barbuda on different demand technologies such as cooking, water heating, cooling, refrigeration, etc. to better establish energy intensities. This study would not only benefit mitigation assessments and modelling but can also give a good indication of areas where the country lies in these areas compared to other similar states.

By building the model for Antigua and Barbuda within LEAP and GACMO, the model is readily available for future updated mitigation assessments. In addition, in-country experts were trained on using LEAP and GACMO to ensure that the government retains the capacity to use the models as this was the purpose of the project.

CHAPTER 4

VULNERABILITY AND ADAPTATION ASSESSMENT

Context

This chapter provides information for Antigua and Barbuda, consistent with the requirements for reporting by non-Annex 1 Parties to the UNFCCC, as recorded in paragraphs 32-36 of FCCC/CP/2002/7/Add.2. Specifically, this chapter covers:

i. information on the scope of Antigua and Barbuda's vulnerability and adaptation of vulnerable areas/sectors;

ii. description of approaches, methodologies and tools used, including scenarios for the assessment of impacts and vulnerability and adaptation to climate change, as well as the uncertainties inherent in these methodologies;

iii. key findings and direct effects arising from climate change for Antigua and Barbuda;

iv. strategies and measures for adapting to climate change in key areas; and

v. Antigua and Barbuda's policy frameworks for developing and implementing adaptation strategies and measures.

According to the UNFCCC, Adaptation refers to *"adjustments in ecological, social, or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damage or to benefit from opportunities associated with climate change. In simple terms, countries and communities need to develop adaptation solutions and implement action to respond to the impacts of climate change that are already happening, as well as prepare for future impacts."* This chapter provides information for Antigua and Barbuda, consistent with the requirements for reporting by non-Annex 1 Parties to the UNFCCC, as recorded in paragraphs 32-36 of FCCC/CP/2002/7/Add.2.

Background

The most recent international scientific information reported by the Inter-governmental Panel on Climate Change (IPCC) from Working Group One (WGI) on its Sixth Assessment Report (AR6), has amplified the messaging of unprecedented increasing changes, across all regions due to climate. There has been a call for aggressive large-scale emission reductions, within the next decade, to secure warming limits of close to 1.5°C[131]. Increasing heat waves, longer warm seasons, intensified water cycles, continued sea-level rise, marine heatwaves, ocean

[131] Ibid

acidification, and increased heat in urban spaces are all predicted[132].

Efforts to address risks to climate hazards, to which Small Island Developing States (SIDS) are particularly exposed, are therefore critical to their very existence. The IPCC's special report on global warming of 1.5°C, recommends an approach to adaptation for SIDS that involves all actors from the international to the community level. It further recommends addressing barriers such as social values, attitudes, and institutional constraints which can significantly impact adaptation actions.

The vulnerability faced by SIDS due to climate change has been further exacerbated with the onset of the COVID-19 pandemic. In November 2020, at the height of the COVID-19 pandemic, an extreme rainfall event impacted the island of Antigua and Barbuda, resulting in flash flooding and erosion of most of the road network. The infrastructural damage totaled EC$168 Million. This event, although not attributed to climate change and demonstrated how multiple hazards could further compound the vulnerability of SIDS. This added layer of complexity, of the convergence of COVID-19, resulted in significant challenges in resource allocation; impacts on national services such as healthcare, education, insurance, national pension and social security fund, and communication; and adverse impacts on the scarce human resources were forced to operate in a multiple hazard context[133]. It also further deepens gender and other social disparities[134].

Antigua and Barbuda Climate Trends and Projections

The OECS Climate Trends and Projections Report also focused on local level trends and impacts. For Antigua and Barbuda, the specific results are presented below.

Heat Trends - Antigua and Barbuda

For Antigua and Barbuda, a Leeward Island, the heat climatology and recent trend as represented by hot days, recorded a threshold temperature of 3.16^{0}C [135] . The threshold temperature for a heat wave can be generally defined as the epidemiological threshold at which the effects of heat begin to provoke excess mortality attributable to heat[238]. Peak season for Antigua and Barbuda is August-September with heat watches now occurring as early as June.

The annual average hot days prior to 1994 is 20 and from 1996 is 31. It should be noted that for Antigua and Barbuda, there is reduced confidence in the number of hot days owing to inhomogeneity in the daytime temperature record. Variability prior to 1994 was recorded between 0-50 and from 1995 between 10-75. The observed trend per decade is +2[136].

[132] Ibid
[133] Ibid
[134] ACP-EU Natural Disaster Risk Reduction Program - Global Facility for Disaster Reduction and Recovery (GFDRR) - The World Bank, 2017. Hurricane Irma and Maria Recovery Needs Assessment for Antigua and Barbuda. https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda
[135] University of the West Indies- Cave Hill Campus. 2010. The impact of climate change on Caribbean tourism demand. Winston Moore
[136] Department of Environment. 2021. State of the Environment Report 2021. Environmental Solutions Limited

Extreme Rainfall - Antigua and Barbuda

For Antigua and Barbuda, the threshold 3-day rainfall for wet spells, and climatology and seasonality of flash flood potential, have been recorded at 84mm. The annual frequency of flash flooding is 1.9, with April-May recording a frequency of 0.5 and August to November recording 1.2.

Drought - Antigua and Barbuda

Drought impact potential was measured historical percentage of time spent in impactful drought per decade. Between 1999–2008 and 2009–2018, the impact potential of the short-term drought was 30.0 percent and 32.8 percent respectively, during the dry season. On the other hand, 1969-1978 and 1979–1998 recorded 23.3 percent and 15.0 percent respectively during the dry season for short-term drought. During the wet season, 1999–2008 and 2009–2018 the impact potential of short-term drought was 13.3 percent and 1.9 percent respectively. For 1969–1978 and 1979–1998, during the wet seasons, 10.0 percent and 3.3 percent were recorded respectively, for short-term drought.

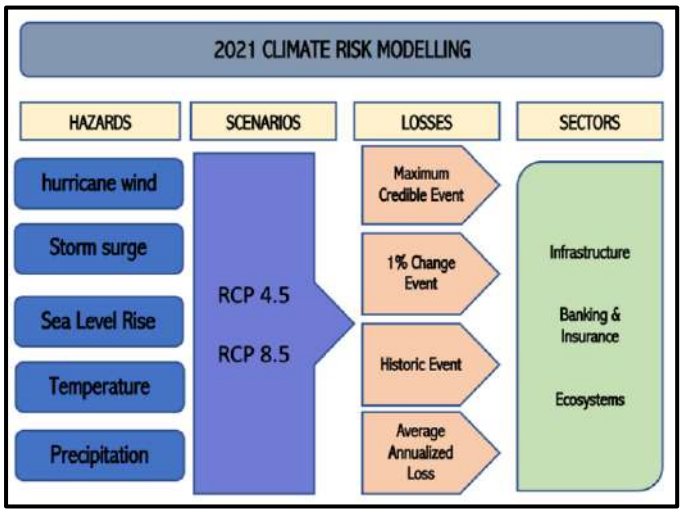


Figure 4.1: Scope of Climate risk modelling adapted from Risk Modelling Project Summary Report 2020.

For long-term drought, the impact potential during 1969–1978 and 1979–1998 was 28.0 percent and 16.7 percent respectively, during the dry season. For the period 1999–2008 and 2009–2018 the impact potential of long-term drought was 38.3 percent and 20.8 percent respectively during the dry season. For long-term drought, the impact potential during 1969–1978 and 1979- 1998 was 11.7 percent and 8.3 percent respectively during the dry season. For the period 1999-2008 and 2009-2018 the impact potential of long-term drought was 18.3 percent and 11.3 percent respectively during the dry season.

Antigua and Barbuda's Meteorological Services reports that 14 drought episodes ranging from severe to slight were recorded for the period 2000-2020. Five of those episodes were recorded as severe, three (3) were recorded as serious, four (4) were recorded as moderate and two (2) were recorded as slight. These are presented in Figure 6.

Given the foregoing, urgent and accelerated adaptation action is needed in Caribbean SIDS. At the National level, Antigua and Barbuda through its National Adaptation Planning (NAP) Framework have been identifying its 2000-2020 potential of the short-term drought was 13.3 percent and 1.9 percent respectively. For 1969-1978 and 1979-1998, during the wet seasons, 10.0 percent and 3.3 percent were recorded respectively for short-term drought. For long-term drought, the impact potential during 1969-1978 and 1979-1998 was 28.0 percent and 16.7 percent respectively during the dry season.

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Adaptation Assessments via a prioritization Approach

Given the foregoing, urgent and accelerated adaptation action is needed in Caribbean SIDS. At the National Level, Antigua and Barbuda through its National Adaptation Planning (NAP) Framework has been identifying its climate change vulnerabilities. The approach has been to prioritize the most critical actions needed over the short to medium term, develop strategies and plans and elaborating projects to respond to the observed and expected fallout of Climate Change.

Approaches, Methodologies and Tools Used to Assess Vulnerability and Adaptation

Recognizing the urgency of action required towards reducing Antigua and Barbuda's vulnerability to future impacts of climate change and to contribute to the Global Goal on Adaptation (GGA), Antigua and Barbuda undertook climate risk modelling work which was completed in 2021. This work was elaborated as part of the deliverables of Antigua and Barbuda's National Adaptation Plan NAP project. As a result, the country is poised to integrate risk information into its climate adaptation planning framework for informing policy development and implementing climate resilient investments.

The risk modelling undertaken covered physical assets and provided some qualitative assessments and case studies detailing climate risks to various sectors including ecosystems and the banking sector. The NAP risk modelling only used three climate models, strategically chosen to represent the various potential changes. The limitation of this approach is that some areas may not be adequately addressed.

Identification and Prioritization of Vulnerable Areas and Sectors for Antigua and Barbuda

Antigua and Barbuda has prioritized adaptation responses across various sectors. From its Initial National Communication (INC) to its fourth. The prioritized areas identified for the 4NC are:

i. Public Sector – with an emphasis on Infrastructure and Housing; Managed Areas and Finance

ii. Private Sector – with an emphasis on Wholesale and Retail, Tourism and Food Security; and

iii. Local Areas plans for watershed areas specifically - Willoughby Bay, Darkwood Beach, St. John's City.

Climatic events such as the 14 drought events between 2000–2020; the passage of Hurricanes Irma and Maria which made landfall over Antigua and Barbuda in 2017 resulting in the decimation of Barbuda and US$222.2 million in recovery needs[137], give credence to the prioritized adaptation sectors areas for this reporting period. This work of prioritization for the 4NC was conducted as part of the

[137] Ibid

implementation of Antigua and Barbuda's NAP Project.

The criterion used and steps taken to determine the prioritized areas include the following:

1. Alignment with the Public Works and Ministry of Finance five-year development plans. This would allow for co-financing by the Government for any identified projects and programs;
2. Consultations with Minister of Public Works, Ministry of Finance, and other government agencies
3. Findings of the post-Irma Report from World Bank.
4. Assessments of IMF Reports.
5. Consultations with the government agencies to inform the final selection of prioritized areas; and
6. Cabinet approval of the final list identified.

Direct and Indirect Climate Risks in Prioritized Sectors

Sector risks were assessed using the risk modeling methodology outlined above to determine the impact of climatic events and related hazards on the general building stock; essential facilities; infrastructure and key industries[138]. A visualization platform *Climate Risk Maps Antigua and Barbuda* was also developed. An output from the visualization platform for AAL in 2050 under RCP 8.5 scenario is presented in Figure 4.2.

Infrastructure – Housing i.e. General Building Stock

For the general building stock, direct losses resulting from storm surges, wind and sea level rise were calculated from 2020–2100. For general building stock, direct physical damage from storm surges and wind will amount to US$573 million by 2050 for a historic event under RCP 8.5 scenario and US$534 million under RCP 4.5 scenario. In addition, for properties located along the coast, direct losses will amount to US$184 million by 2050 under RCP 8.5 and US$95 million under RCP 4.5. For a one in 100-year event by 2050 the direct losses can result in US$4,831 million for RCP 8.5 and US$4,600 million for RCP 4.5. For a maximum credible event (MCE) by 2050 under RCP 8.5 the cost to Antigua and Barbuda can be as much as US$9,750 million and US$9,672 million under RCP 4.5. Using Average Annualized Loss (AAL), by 2050 Antigua and Barbuda can suffer direct losses to the building stock in the amount of US$176 million under RCP 8.5 and US$165 million under RCP 4.5. It should be noted that the island is already experiencing 1:50 events in five-year cycles.

The climate risk modelling report revealed that coastal building stock is high value, but also faces higher risk as they are more vulnerable to climate change than high winds internal to the island. For Antigua and Barbuda most of the general building stock inland is highly exposed and faces high risk.[249] Adaptation measures to improve resilience such as building at higher elevations; building elevated structures and building according to the 2021 updated building code are recommended.

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[138] Ibid

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Figure 4.2:Visualization platform output AAL in 2050 under RCP 8.5. Source: DOE

Infrastructure – Roads, Communication, and Commercial Buildings

Considering the AAL, under RCP 4.5 direct losses were calculated for essential facilities and industries. They are air and seaports, bridges, churches, schools (including colleges and universities), hospital and medical facilities, telecommunication, electricity services, portable water facilities, tourism plants such as hotels and resorts, emergency response services, government services, financial institutions, retail trade, and entertainment and recreation. These are captured in Figure 4.2. By 2050 overall direct losses to the buildings in key industries will amount to US$37.72 million. By 2080, the amount increases to US$45.27 million[141]. The risk modeling revealed that given their coastal proximity to resorts, seaport facilities are at high risk of losses. Accessibility issues because of the risk to roadways were also highlighted.

Managed areas - Ecosystems

Antigua and Barbuda's terrestrial and marine ecosystems are highly susceptible to various climate change impacts. Some aspects of its terrestrial ecosystem include scrubland and grassland. Marine ecosystems include mangroves, coral reefs, sea grass beds and sandy beaches. Extreme land and sea temperatures, extreme weather events, and sea-level rise have all affected and are expected to continue affecting Antigua and

[139] Environmental Science Europe 2021. Evolution of the threshold temperature of a heat wave vs evolution of the minimum mortality temperature; A case study in Spain during the 1983-2018 period. López- Bueno , J.A et al

[140] Ibid

[141] DOE. National Adaptation Plan Climate Change Risk Modelling Project- Project Summary Report. 2021

Barbuda's ecosystems and by extension ecosystem services. In the case of extreme land temperatures, an increase in the number of dry days can result in an increased number of wildfires. These wildfires are also expected to be more severe, threatening terrestrial forests, scrublands, and grasslands. Sea level rise can destroy marine mangroves while extreme sea temperatures can result in coral bleaching. Severe coral bleaching has been predicted to be approximately 60 percent over the 2020–2055 period for RCP 4.5. Damage to coral as a result of hurricanes increase by between 47 percent and 84 percent by the end of the century for RCP 4.5 and by between 136 percent and 270 percent for an RCP 8.5.

Finance – Banking and Insurance Sector

The climate risk modeling report indicates losses to buildings in the financial sector resulting from the impacts of climate on its infrastructure, with an AAL approach under RCP 4.5 ranges from US$705.3 million in 2020 to US$933.7 million in 2050 and US$1.09 billion by 2080. These losses by other sectors given their usual location away from the coast and the modern architectural designs demonstrate the physical risk to an economy and the need for a global transition to a low carbon economy.

Wholesale and Retail

The climate risk modeling report indicates losses to buildings in the retail sector resulting from the impacts of climate on its infrastructure, with an AAL approach under US$59 million in 2020, to US$117.6M in 2050, and US$22.3 billion in 2020 to US$27.4 billion in 2050 and US$32.5 billion by 2080. Shocks to industry by climatic events or by other crises such as the COVID-19 pandemic in 2020, can significantly reduce the revenue generation capacity of the island. Losses to hotels and resort because of their location along the coastline or because of direct hits from extreme rainfall events must be added to the losses of income due to reduce arrivals on based on climatic drivers.[254] Some of these drivers for the Caribbean are elaborated by Moore in a 2010 paper and includes cloudiness and visibility which can impact enjoyment and attractiveness of sites and by extension the quality of the visitors experience; wind and rain which can impact the visitor's belongings as well as reducing their visibility and enjoyment; severe weather which can pose a danger to visitors; air quality which can impact the health and physical well-being of visitors.

Food Security

"*Food availability, access, utilization, and stability are key dimensions of food security and as such, the health and sustainability of the agricultural sector are critical for achieving food security*" [142] . The fisheries sector is extremely vulnerable to climate change. This is or will manifest in sea level rise, extreme sea temperatures or marine heat waves, and extreme precipitation events. One issue identified was the loss of fishing vessels by fishers in vulnerable communities such as was the case with flash flooding in November 2020. This resulted in an inability to engage in their usual employment activity with implications for the financial stability of their households[143]. The agriculture sector currently boasts over 500 backyard farmers. These farmers support resorts and other accommodation or tourism-related establishments with their produce. Twenty-

[142] Ibid

[143] Ibid

five percent of the economically active population participate in the agriculture sector.[144]

Climate change, directly and indirectly, impacts tourism and this thriving sub-sector of agriculture. Climate impacts on water and heat stress to crops and livestock can adversely impact the ability of the sector to produce food. Although the sector's contribution to GDP increased from 2000 to 2013, it declined from 2014 to 2016, and increased slightly in 2017, only to decline again in 2018. The 2018 decline can be partly attributed to the passage of Hurricanes Irma and Maria which rendered the topography of the island from green to brown as evidenced by Nasa images. This was due to wind shear as well as the saline intrusion of soils.

The other channel through which climate change can impact food security is the impact on the transportation of food to the island. With a food import bill of $900 million in 2020, disruption to shipping routes as a result of hurricanes can adversely impact the island's ability to supply the nutritional requirements of the population.

STRATEGIES AND MEASURES FOR ADAPTING TO CLIMATE CHANGE

Public Sector

Sector plans are being developed for the priority areas identified under the public sector, private sector, and local areas, through the NAP project. For the public sector, plans being drawn up will focus on the financial sector, infrastructure and housing sector; and managed areas. For the private sector, plans are being developed for the wholesale and retail sectors, tourism and food security. For local areas, the plans will focus on Willoughby Bay, Darkwood Beach, and St. John's City.

It is anticipated that the process would include:

- Conducting a situational analysis of the sector to include review of key documents and policies; and consultations with key stakeholders to map climate risks to the sector;
- Assessing vulnerability of the sector based on national, regional, and global trends in climate and current and projected economic variables;
- Identifying entry points within institutional, policy and legislative frameworks for prioritized adaptation actions; and
- Developing a plan that outlines a step-by-step approach to integrate adaptation options in sectoral policies and plans with related indicators for monitoring and evaluation.
- Conducting stakeholder consultations to help develop the plan.

Financial Sector

The focus of this sector plan would be on the government's role in fiscal and monetary policy and the regulation of the banking and insurance sub sectors. It will also likely

[144] Ibid

consider the impact of climate change on lending policies, and financial planning.

Infrastructure and Housing Sector

This sector plan will concentrate on improving the resilience of public infrastructure, in particular the water and power utilities, the road network, and major ports will be considered. Improvement to the regulation and control of development to minimize risk associated with unplanned and or lack of enforcement with planned development for public and private housing will be covered. The sector plan will "provide strategic direction to key stakeholders and agencies involved in the sector to mainstream climate adaptation in development planning".

Managed Areas Sector

As it relates to managed areas, the primary focus would be on the operations of the Antigua and Barbuda's only UNESCO World Heritage Site, Nelson's Dock Yard National Park.

Private Sector

Wholesale and Retail Sector – For the wholesale and retail sector, a key focus of the plan would be to improve its resilience to extreme rainfall events by promoting its transition to renewable energy and away from fossil-based power generation. Large wholesale and retail businesses which focus primarily on food and beverage products will be prioritized. Efforts under this plan will supplement those related to the food security plan for Antigua and Barbuda.

Tourism – Transitioning to renewable energy will feature as a part of the adaptation approach proposed in this sector plan. The sector plan will seek to reduce the business risks to tourism plants and protect natural capital on which their businesses rely including beaches and other ecosystem services to reduce vulnerability and enhance resilience of the sector to climate change. The plan will also seek to target the large hotels within Antigua and Barbuda given the key importance of their contribution to GDP and the significant losses that they are projected to face due to climate change. These efforts will build upon ongoing climate change actions including incorporating renewable energy.

Food Security – The food security sector plan will focus on agriculture (crops and livestock) and fisheries. The approaches developed for building resilience in the sector will focus on the importance of the sector to nourishing the nation in the aftermath of climate related events such as hurricanes and other economic shocks such as the COVID-19 pandemic.

In developing the plan local knowledge gained through extensive consultations will be incorporated. The final sectoral adaptation plan (SAP) will outline the sectoral baseline; demonstrate the climate risks and vulnerabilities affecting the food security sector and provide a set of recommendations for appropriate adaptation action.

Local Area plan

Spatial development plans are being developed for Willoughby Bay, Darkwood Beach and St. John's city. These would be focused on proposing climate change adaptation measures to address the specific vulnerabilities of these exposed areas, as well as addressing other developmental challenges.

Through the VCA process the community identified drought (high risk); hurricanes and tropical storms; heavy rainfall; rough seas; and

coastal erosion (medium risk) as impacting the community. Fishing, farming and eco-tourism small businesses were identified as key livelihood activities affected by climatic events. Coastal residents and resource users were identified as the most vulnerable group to climate hazards (40 percent) followed by the elderly and youth (14%) each. Reasons for this vulnerability were cited as exposure due to location (35 percent); link to livelihoods (30 percent); dependance on natural resource ecosystems (20 percent); food security (30 percent) and lack of mobility (20 percent).

Factors identified as increasing the community's exposure impacts from climate hazards are as follows:

- Proximity to the coast makes community vulnerable to sea level rise, storm surges, strong wind impacts from hurricanes etc.
- Low lying, making it prone to flooding;
- Income level of the community and the level of family support system; and
- Level of political risk if that community does not have a parliamentary representative in the Cabinet.

Adaptation Policy Frameworks

The national adaptation policy and planning framework is founded upon national policy framework at the national, regional and sub-regional mechanisms such as the Caribbean Community's Regional Framework for Achieving Resilience to Climate Change and its Implementation Plan; and the Organization of Eastern Caribbean States (OECS) St. George's Declaration of Principles for Environmental Sustainability (SGD) 2040.

Antigua and Barbuda's Adaptation Policy and Planning Framework seeks to ensure that various national policies and institutional structures are responsive to the requirements of the 2019 Environmental Protection and Management Act (EPMA) and other key pieces of national legislation. The Environmental Protection and Management Act (EPMA) 2019 authorizes the DOE to *"coordinate climate change policies and activities... and all environmental management functions performed by all governmental and non-governmental entities and statutory authorities"* within Antigua and Barbuda. The ongoing national adaptation efforts under this framework culminated in the most recent NAP project.

Issues of vulnerability and adaptation to climate change are therefore incorporated into sectoral policies with a view to informing decision-making and improving the OECS St. George's Declaration of Principles for Environmental Sustainability (SGD) 2040.

The Government of Antigua and Barbuda's adaptation policy and planning framework seeks to ensure that various national policies and institutional structures are responsive the requirements the 2019 EPMA and other key pieces of national legislation. The level of climate change sensitization among various stakeholders across society is also a factor. The lines of communication between various groups from Parliament to partner agencies are depicted in the institutional arrangements supporting adaptation framework. The graphic also captures the interconnection between national legislation, policies strategies and plans including policies of gender and environmental and social safeguards. It also captures the various supporting functions for effective implementation of adaptation actions.

The Sustainable Island Resource Framework Fund (SIRFF) is an essential element of the institutional architecture which facilitates adaptation action implementation in Antigua and Barbuda. The DOE is mandated through the EPMA 2019 to manage and administer the SIRFF as a special fund of the Finance Administration Act 2006, and the financing mechanism for environmental management and climate change actions. To date, the SIRFF has administered 74 loans valued at EC$5.1 million. Some 66 percent of individuals (49) who accessed loans were female and 33 percent (24) were male. At least one loan was accessed by a business. This funding was provided through three projects channeled through the SIRFF.

National Adaptation Plan (under development) (NAPs)

Antigua and Barbuda is currently elaborating its NAP through a project seeks to:

- develop adaptation baselines through data collection, compilation, and comprehensive climate change risk mapping.
- conduct Vulnerability Risk Assessment (VRAs) and develop adaptation plans for up to three government agencies, three communities/NGOs and three Private Sector entities using a learning by doing capacity building approach.
- Conduct Strategic Impact Assessments (SIAs), approved by Cabinet, and published in the Gazette and prepare the NAP in accordance with national law.
- develop a sustainable financing strategy to facilitate the development of additional SIAs.

Key outputs from the NAP project have informed the development of this V&A Chapter including the identification of vulnerable areas; risk modelling for those identified vulnerable areas and sectoral adaptation guidelines.

Other Sectoral Policies

The sectoral policies in this section are presented and summarized in Antigua and Barbuda's Initial Adaptation Communication to the UNFCCC:

State of the Environment (SOE) Report 2021 – Antigua and Barbuda recently developed its first SOE Report. It presents information related to climate change and atmosphere, land use, water, biodiversity, culture and heritage, cross sectoral areas (tourism, health, and food security), energy and environmental governance. The importance of examining the state of these sectors, the impacts, and drivers as well as the changes being experienced in each is explored and responses to address those impacts are put forward.

Water Sector Adaptation Plan 2021 – Antigua and Barbuda's plan which focuses on providing access to safe, reliable, and resilient water supply services and to reduce operational risks associated with climate change and variability. It seeks to ensure that operations can meet levels of service during extreme weather events and future climate change. It is supported by an investment program which focuses on creating an enabling environment for climate resilient water supply, water resources management and planning, climate resilient water infrastructure, efficiency and demand management, developing the water energy nexus, and disaster recovery and risk management. Activities are discussed under

each aspect of the six investment program areas.

Updated Nationally Determined Contributions (NDC) 2021 – Antigua and Barbuda's contribution to the GGA has been updated in the latest iteration of its NDC with a focus on downscaled and GIS-based baseline data collection and climate risk assessment activities for adaptation action as a basis of vulnerability risk assessments and sectoral adaptation plans. Through these key actions, the country will be better equipped to assess exposure to climate risks, climate related hazards, and vulnerability to climate change at the sectoral level. Local Area Planning (LAP) will also be part of the adaptation actions which contribute to the GGA.

Medium-Term Fiscal Strategy (MTFS) 2021-2023 – The Ministry of Finance indicates in the MTFS 2021- 2023 for Antigua and Barbuda that "climate resilience of its population and priority sectors including energy, the built environment, agriculture, and the financial sector". Relatedly, engagement with external creditors on a debt for climate finance swap is prioritized. This was justified as allowing for redirecting monies towards local adaptation and mitigation action away from debt. This document is a living document and will periodically be updated based on national circumstances.

National Youth Policy 2021 – Antigua and Barbuda's National Youth Policy is the strategic framework for addressing youth empowerment and development. It covers nine thematic areas namely, quality education and capacity building; youth unemployment and human capital development; creative industries and entrepreneurship; environmental sustainability; gender leadership and social change; values and spiritual development; protection safety and security; health sports and psychosocial support and media and Department of Youth Affairs. Under the Environmental Sustainability thematic area, the policy focuses on strategies for climate change mitigation and adaptation. These include encouraging young people to join environmental groups and organizations; boosting climate change awareness among youth through social media; involvement of youth in planning and implementing stages of environmental programs; offering more climate change scholarships and innovative grants to youth; and creating an enabling environment to bolster youth engagement in climate adaptation.

Repositioning Antigua and Barbuda for dynamic, sustainable, and resilient growth-Report by the Technical Drafting Sub-Committee to the Economic Recovery Committee 2020- (Economic Recovery Plan) – The document highlights government priorities going forward in its quest for resilient growth. This is intended to be achieved through a two-pronged approach. The first focuses on stabilization and the second on re-positioning the economy for growth. It elaborates sector plans for Tourism; Housing and Infrastructure; Agriculture, Waste Management and Sustainability; Environment and Renewable Energy; Trade and Entrepreneurship and Culture Industries and Sports. Several of the planned and ongoing climate change projects including resilience building and adaptation are featured in the Environment and Renewable Energy Sector Plan.

GCF Country Program (GCF-CP) 2020 – Antigua and Barbuda presented an updated Country Program to the GCF featuring projects which will respond to the synergies

between climate change and sustainable development. It identified the following adaptation priorities:

- Improving water security
- Improving energy sector resilience
- Increasing flood and hurricane intensity resilience
- Increasing resilience in buildings
- Improving protection of beaches and coastal areas
- Protecting watersheds and waterways.

Country Program Strategy 2020 – The DOE elaborated a strategy for implementing its GCF-CP. This strategy situates the GCF-CP and the proposed pipeline withing the context of Antigua and Barbuda's climate change vulnerabilities. It also underscores the strategic impact of GCF support, and the approach taken to ensure that extensive baseline research undertaken through a consultative process to determine technical and financial feasibility of the pipeline as well as mapping the human, institutional, technical, and capacity requirements.

Department of Environment's Gender Policy – 2018: The DOE's Gender Policy details its approach to achieving gender mainstreaming that is responsive to the requirements of its key multilateral partners, while at the same time conforming to the legislative requirements of the 2019 EPMA. The policy calls for stakeholders' rights to privacy and confidentiality; requires that relevant information on a project or sub project activity's environmental, social or gender risks are made accessible and understandable to stakeholders; requires that DOE conducts gender due diligence through Gender Impact Assessments (GIAs) at the overall portfolio level as well as the individual project level for higher risk projects; and makes allowances for monitoring and compliance. In addition, it provides guidance on standards and practices related to the gender impact assessment of projects; environmental principles, substantive standards, and practices on environmental protection, building regulations, land use development and planning, and enforcement.

Department of Environment's Environmental and Social Safeguards Policy (ESS) 2018 – Drawing upon various laws in Antigua and Barbuda, including the 2019 EPMA, DOE's ESS policy seeks to promote social responsibility and sustainable development in its operations. The ESS provides for environmental, social and gender screening of projects; determination and assessment of environmental, social and gender risks and impacts of projects, including through consultations with stakeholders and vulnerable communities; ensuring access to information and full participation in the decision-making process for stakeholders, especially vulnerable communities; creating safeguards and mechanisms to mitigate risks and negative environmental, social and economic impacts associated with projects; ensuring access to justice in environmental matters in regard to social safeguards and gender issues for affected parties in the form of a functional and efficient Complaints Mechanism; cooperating with partners to build capacity in risk mitigation and facilitate implementation of environmental, social and gender safeguards and; monitoring and evaluation.

Gender and Social Inclusion in Adaptation

Antigua and Barbuda began integrating gender considerations related to climate change in the work of various national agencies in public and private sector. Its commitment to this mainstreaming is

evidenced by The DOEs elaboration of a 2018 Gender Policy in the absence of a more overarching national gender policy.

A knowledge, attitudes, behaviors, and practices survey completed in 2021 for Antigua and Barbuda, revealed a lack of understanding of gender concepts such as equity and equality and limited understanding of gender issues in the workplace by respondents. They were however aware of the gender dimensions in climate change and disasters SOE Report 2021.

Respondents also identified an issue with integrating gender considerations in institutions with a mandate for climate change and disaster risk reduction. The perception is that while there are individual level efforts, the institutional mechanisms suffer in some instances from a lack of mandate and in others, gaps in data, and technical expertise. The following recommendations have been proposed by the study.

- Raise awareness of gender policies and mandates across different institutions,
- Foster a safe and inclusive workplace culture,
- Promote continuous learning by investigating in gender training and mentoring.

In reviewing gender inequality of disasters and climate risks, a 2020 EnGenDER study examined this theme across the prioritized sectors for the FNC. These are summarized below.

Protected areas - livelihoods and small craft business operators: To make livelihoods more resilient to climate change and other disasters, supporting activities must be put in place. Additionally, improvements to facilitate ease of uptake with traditional access to microfinancing for craft vending or other small livelihood type activities in protected areas in needed. The study revealed that women are more likely to access micro-finance over men. Awareness raising on the importance of transitioning informal businesses to legal business as a means of resilience and improving recovery post disaster is also identified as a need.

Protected areas - Fisheries: More attention to education and awareness raising on gender related issues in disaster risk management is needed. Loss of fishing vessels during climatic events such as the November 2020 flash flooding event impacts local fishermen's (mostly male and elderly) ability to provide for their families.

Protected areas - Tourism: This sub-sector is mostly dominated by women who are also head of households and provide services which are adversely impacted by climatic events. This places them at risk of financial instability.

Finance Sector-Livelihoods and Finance: The sector covers banking, insurance, investment companies and real estate firms. Finance policy operations cover climate change resilience, but gaps persist. Despite this, female headed households find innovative ways of making money to support their households when unemployment arises because of natural disasters.

Finance Sector-Health: Many households, primarily female headed households are unable to afford private insurance for health and home coverage during natural disasters.

Infrastructure sector: Although climate change is minimally addressed, gender inequality issues are not addressed in policies

and strategies in this sector. For the communication sub-sector, many vulnerable households do not have smart phones to access messages through data systems such as WhatsApp in the aftermath of a hurricane or other natural disaster. This has hampered the distribution of food packages to needy persons including female headed households for example after Hurricane Irma.

For the transportation sub-sector, vulnerable households without access to personal vehicles, particularly female headed households, are challenged with mobility issues after natural disasters and find it difficult to make it to the city if they live in rural areas. For the transportation sector this is further exacerbated for those who are unemployed and unable to pay the bus fare.

For health sub sector, the health and safety of pregnant women was reported as a concern during disasters and the 2020 flash floods. Regarding utilities, women can be severely impacted by the increased cost of electricity and water, this impacts child-care, cooking and cleaning, among other things.

Human capital, economic empowerment, decision making processes and leadership, and gender capacity building were the gender dimensions utilized. Specific indicators were also developed for the just transition of the workforce generally, including for specific NDC targets. The associated gender equality outcome is "*the workforce transition into green businesses and jobs is implemented with an equitable approach including men, women and youth*".

Climate Promise Project Report 2020

Although the livelihoods of all individuals are impacted after a disaster, women were more likely to be out of work long than men who could easily take up work with re-construction. Individuals have developed several coping mechanisms to address the employment and livelihood gaps which they face during climate related hazards and the COVID-19 pandemic. Antigua and Barbuda recently developed socio-economic and gender specific indicators for climate action in recognition of the need the need for gender disaggregated adaptation metrics and standards in implemented with an equitable approach including men, women and youth.

Gender-Responsive and Socially Inclusive Adaptation Action

Gender affairs are coordinated in Antigua and Barbuda by the Ministry of Social Transformation and the Blue Economy. While the ministry has been working on elaborating a gender policy, a key partner, the DOE based on its responsibility for ensuring gender integration in its operations, developed its 2018 Gender Policy. DOE's 2018 Gender Policy seeks to promote "*the equal and equitable inclusion of men and women in all areas which would allow the DOE to accurately address gender vulnerabilities and risks*" as well as "*the equal inclusion of men and women in environmental management and implementation.*"

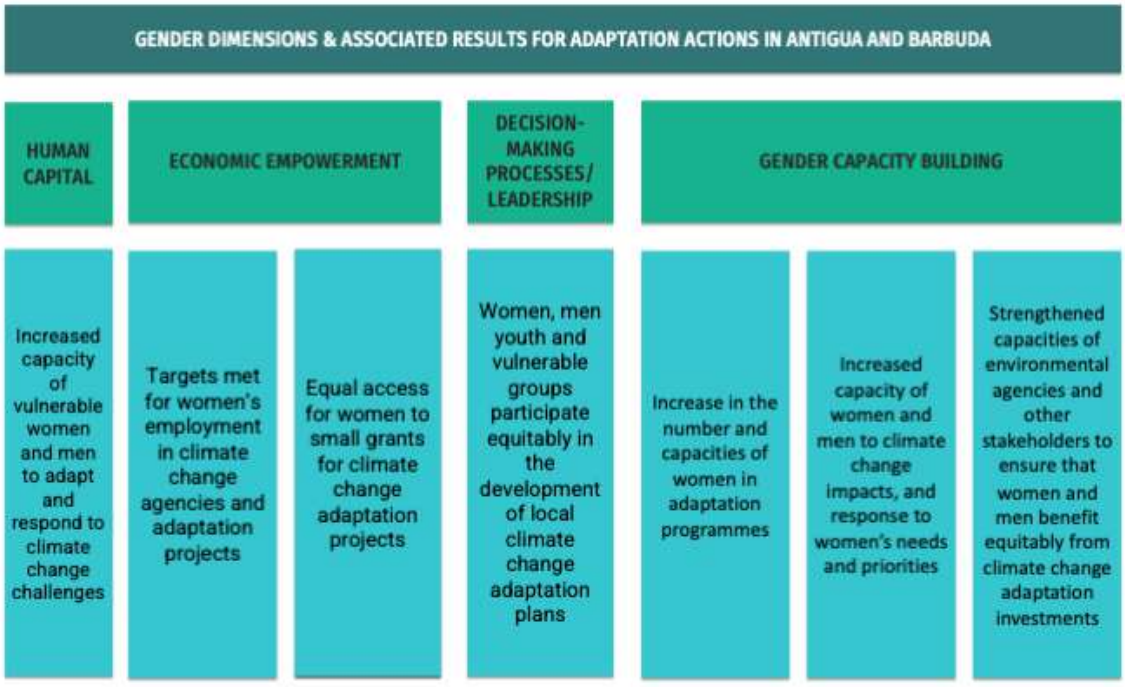
Additionally, DOE's 2018 Gender Policy provides the basis for environmental, socio-economic, and gender benefits to be equitably distributed in a non-discriminatory manner for all projects. These efforts are informed by the knowledge that effective adaptation requires an understanding of the impact of gender and social issues on vulnerability to climate change, and the specific capacities of men and women to proffer adequate and appropriate

responses[145]. Raising awareness about the existence of the DOE's 2018 Gender Policy and the importance of all stakeholders in attaining gender equality in the context of climate change[146] is pivotal to its effectiveness. This is particularly important in the context of prevailing misconceptions that gender equality has been attained in Antigua and Barbuda[147]. Despite these misconceptions, a knowledge, attitude, practice, and behavior survey conducted under the EnGenDER Project revealed that respondents were aware that vulnerability to climate change and disasters has a gender dimension[148].

This gender-responsive approach to adaptation planning in Antigua and Barbuda aligns with the SDGs, the Beijing Declaration and Platform for Action, and the Convention on the Elimination of all Forms of Discrimination Against Women.

The 2021 Youth Policy also addresses gender issues through one of its principles, which is to "*actively promote the values of equality*"[149]. It

Figure 4.3: Gender Dimensions and Associated Results for Adaptation Action in Antigua and Barbuda



Source: Gerbaldo, 2020

[145] NAP Global Network & UNFCCC. 2019. Toolkit for a gender-responsive process to formulate and implement National Adaptation Plans (NAPs). Dazé, A., and Church, C. (lead authors). Winnipeg: International Institute for Sustainable Development. Retrieved from www.napglobalnetwork.org

[146] UN Women and International Institute for Sustainable Development. 2021. Gender- Responsive Resilience Building in the Caribbean: Understanding the role of knowledge, attitudes, behaviours and practices in coordination mechanisms for climate change disaster risk reduction. A. Dazé and C. Hunter.

[147] Government of Antigua and Barbuda. 2020. Review of the Beijing Declaration and Platform for Action Report, 2014-2019 https://www.unwomen.org/-/media/headquarters/attachments/sections/csw/64/national-reviews/antigua_and_barbuda.pdf?la=en&vs=3336

[148] UN Women and International Institute for Sustainable Development. 2021. Gender- Responsive Resilience Building in the Caribbean: Understanding the role of knowledge, attitudes, behaviours and practices in coordination mechanisms for climate change disaster risk reduction. A. Dazé and C. Hunter.

[149] Department of Youth Affairs, Ministry of Health, Sports and Youth Affairs & National Youth Policy Task Force. 2021. Antigua and Barbuda National Youth Policy

outlines the commitment by youth to "*provide the critical mass of nationals who seek to raise awareness of gender equality.*" It recognizes that the current social complexities require "*solutions that reflect, respect, tolerance, justice and gender equality among other values".* Additionally, it names the responsibilities of the young to "*promote gender equality and respect for the rights and dignity of girls and women.*"

Findings on Gender and Climate Change Adaptation in Antigua and Barbuda

A 2020 report published by the World Economic Forum, suggests that the approach to gender disparities can be attributed to a policy process that addresses issues in their distinct and separate spaces, without due regard to the cross-cutting nature of issues such as gender. [150] This can be further exacerbated by gender norms, roles, and biases. The need to zone in on the inter-connectedness of societal issues is identified as critical to overcoming gender inequality. Some of the identified inequalities (against women) evident with the impacts of climate change include increased exposure to gender-based violence, limited mobility, reduced earning capacity, loss of assets, and loss of life.[151] Additionally, climate change can impact women differently and this may be unique to nationally and regionally circumstances.

Antigua and Barbuda do not widely assess impacts based on gender and social perspective in deciding on adaptation planning and actions. During the design of the ADCOM, national stakeholders were engaged for their feedback on the adequacy of government efforts to incorporate social and gender dimensions in their programming. Stakeholders indicated the need to retrain and re-skill government employees to anticipate technological changes and industry/sector needs related to incorporating gender and climate change considerations. Additional data gathering on gender and social considerations for adaptation was also identified as a need for Antigua and Barbuda. These observations are consistent with the results of a knowledge, attitude, behaviors, and practice survey conducted by UN Women and IISD to gain an understanding of gender-responsive resilience building in the Caribbean.

Monitoring, Reporting and Verification

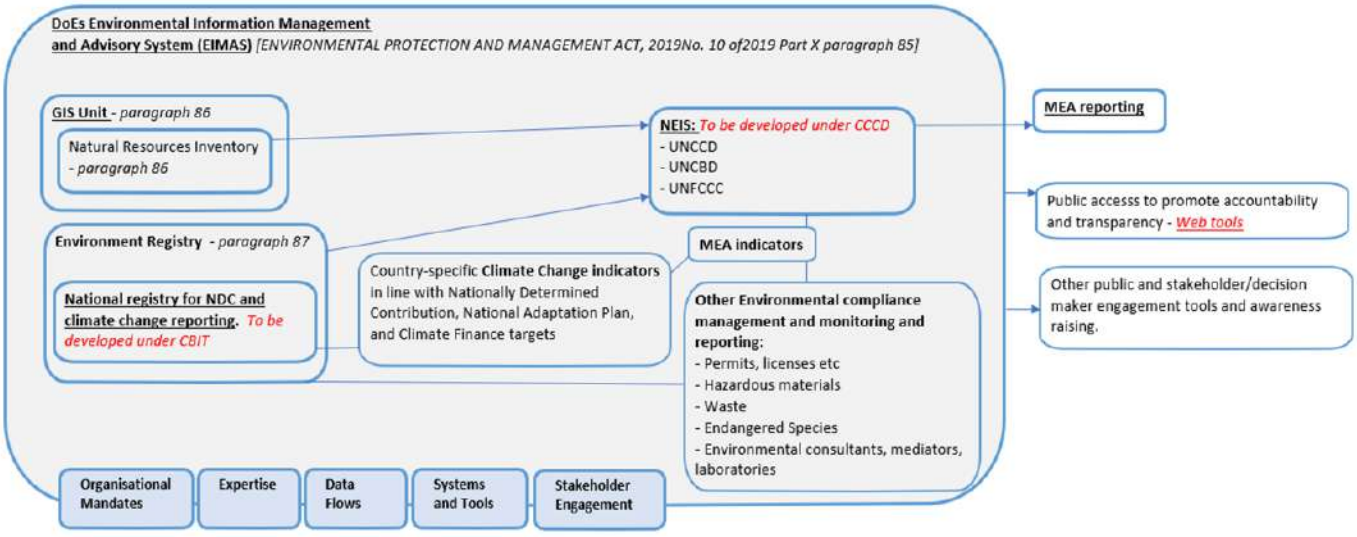
Antigua and Barbuda is currently finalizing its Climate Change Monitoring, Reporting and Verification (MRV) framework. The framework will be responsive to the 2019 EPMA, including Part VI – Environmental Management and Monitoring and Part X, sections 85–87. In this regard, it will support not only the implementation of climate change action but also environmental management in general and the tracking of indicators for multilateral environmental agreements (MEAs). Regulations to support an MRV

[150] Roy, Katika. World Economic Forum 2020. Gender Equity and climate change have more in common than you think. https://www.weforum.org/agenda/2020/07/gender-equality-and-climate-change-have-more-in-common-than-you-think/

[151] IADB. 2020. Study on the impact of climate change on Women and Men in the Caribbean. Pilot Program on Climate Resilience. https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledge-documents/study-of-the-impacts-of-climate-change-on-the-women-and-men-in-the-caribbean-pilot-program-for-climate-resilience-countries.pdf

Framework are included as part of the 2021 Paris Agreement Regulations to the 2019 EPMA, at Part V paragraphs 49–53. The graphic below is presented by Godwin et al. (2021) as a pictorial representation of the proposed MRV system. Antigua and Barbuda's CBIT project is also in direct support of Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC), which calls for clarity and tracking of progress towards achieving Parties' individual NDCs, and Principle 10 of the Rio Declaration on Access, Transparency, and Accountability in Environmental Matters through participation of all concerned citizens, at the relevant levels. The UNFCCC enhanced transparency framework demands substantial and immediate progress in the countries' domestic MRV systems and strategic decarbonization planning. This entails moving from often disintegrated and often different methodological approaches in data management to an integrated and robust system. The success of the Paris Agreement hinges on enhanced transparency of action and support, as a critical foundation to making its bottom-up, country-led approach work, as well as building mutual trust and confidence amongst Parties. GEF-CBIT will support Antigua & Barbuda in establishing an overarching structure across all sectors that will ensure high quality in its transparency instruments; and create the capacities to respond to UNFCCC's reporting requirements. CBIT's most important contribution will occur by building capacity and setting up systems to collect data and track NDC implementation.

Figure 4.4: Representation of Antigua and Barbuda's Proposed MRV System: Overview



Source: Goodwin, 2021

ADCOM submission to the UNFCCC

The DOE submitted its ADCOM in 2022[152], a new requirement of the UNFCCC whic has significant information related to Adaptation.

[152] https://unfccc.int/sites/default/files/ACR/2022-07/ATG%20-%20UNFCCC%20Adaptation%20Communication%20-%202022-06-29%20-%20Final.pdf

Contribution of Adaptation Actions to Regional and International Frameworks

The adaptation actions undertaken in Antigua and Barbuda occur within the context of the implementation of other environmental management actions that are responsive to various MEAs. Synergies exist between the goals and objectives of these agreements. For example, the work on supporting climate change adaptation in the water sector is also responsive to work being undertaken in the country, which responds to the United Nations Framework Convention to Combat Desertification (UNCCD) and actions under the Convention on Biological Diversity (CBD). This is demonstrated by the **Integrated physical adaptation and community resilience through an Enhanced Direct Access pilot in the public, private, and civil society sectors of three Eastern Caribbean SIDS** project. Adaptation actions undertaken to build the resilience of critical infrastructure such as roadways and buildings are also responsive to the United Nations Office for Disaster Risk Reduction.

The socially inclusive and gender-responsive approach to climate change Action in Antigua and Barbuda is consistent with the Convention on the Elimination of all forms of Discrimination Against Women (CEDAW). This is aptly demonstrated through the various projects, which seek to promote gender equality and gender responsiveness consistent with principles of Article 2 of CEDAW including through the ***EnGenDER*** Project currently under implementation.

The financial approach of building upon previous work as well as pursuing complementarity and coherence in climate change adaptation actions is consistent with OECD's Paris Declaration on Aid Effectiveness and its principles, as well as the move by donor agencies to promote the complementarity and coherence of climate finance.

The climate change adaptation actions being undertaken are not only in response to the UNFCCC and its Paris Agreement but also to several SDGs. Apart from SDG 13 on climate action, the projects currently under implementation and proposed are responsive to SDGs 1, 3, 5, 6, 7, 8, 9 10, 11, 14, and 15.

The linkages outlined above are by no means exhaustive, but serve to demonstrate the level of synergies between adaptation action in Antigua and Barbuda and regional and international frameworks.

Co-Benefits of Adaptation Actions

Although actions are important for climate change, a well-designed action plan can be best accepted if it has significant co-benefits for other sectors. The country is seeking high impact adaptation projects with as many benefits as possible.

Pursuing a Just Transition of the Workforce and adaptation

Antigua and Barbuda is pursuing a just transition of its workforce. This is articulated in its INDC and updated NDC. In so doing, result areas for human capital, economic empowerment, gender, capacity building, and social inclusion have been elaborated in these reporting documents to the UNFCCC.

There are several adaptation co-benefits that can be attained by taking advantage of the opportunities presented with a just transition

for the electricity and road transport sectors in Antigua and Barbuda. As a case in point, employment opportunities associated with the transition can equip vulnerable households with accessing concessional resources through the SIRF Fund to improve their resilience to extreme weather events associated with climate change. In the medium to long term, Antigua and Barbuda hopes to move beyond the energy sector and adopt an economy-wide approach to the just transition.

Engaging Local Knowledge Systems for Adaptation Action in Antigua and Barbuda

Antigua and Barbuda has an active third sector (civil society). The groupings are engaged along various interests, including those related to environmental management. Civil society is actively engaged as part of the consultative process for implementing climate change adaptation action. The adaptation project "An Integrated Approach to Physical Adaptation and Community Resilience in Antigua and Barbuda's Northwest McKinnon's Watershed" worked with civil society, placing them at the forefront of climate action.

One of the strengths of CSOs is their ability to incorporate local information for the successful implementation of projects and programs. Through a regional Readiness Grant, being administered by Caribbean Natural Resources Institute (CANARI), Antigua and Barbuda is working to strengthen CSO capacity to engage in climate change action. To this end, key CSOs working on climate resilience and planning have been mapped and a CSO forum conducted. Tailored communications products for local CSOs on climate change are being developed as part of the grant activities.

Environmental Awareness Group

The Environmental Awareness Group (EAG) has a track record of over 30 years of action on biodiversity, climate change, and advocacy on the environment in Antigua and Barbuda. EAG works with various national and local NGOs, government agencies, and regional and international partners. EAG conducted a VCA of climate risk resilience for a local community, with the potential for upscaling to others. Through its Environmental Conference, EAG seeks to conduct a stocktaking of the work currently being undertaken by all local CSOs, including climate change adaptation actions, with the intention to prepare and present a position paper to be included in the national climate change position for the 27th Conference of the Parties of the UNFCCC[153].

Gilbert Agricultural & Rural Development Center

The Gilbert Agricultural & Rural Development Center (GARD-C) is an NGO with an enterprise development facility thrust. They offer vocational, life, and entrepreneurial skills to youth at risk, through their training programs. In addition, GARD-C implements projects related to agriculture. The projects implemented in the community by GARD-C incorporate traditional knowledge related to climate change adaptation. Training courses also integrate knowledge of climate change and incorporate traditional knowledge related

[153] Hill, Erika. 2021, Environmental Awareness Group, "Raising Our Voice for Environmental Change- EAGs Inaugural Environmental Conference Proposal."

to climate change adaptation as appropriate.154

Adaptation at Historical sites - Antigua and Barbuda's National Parks Authority

The National Parks Authority is a statutory body in Antigua and Barbuda that has, over the years, incorporated traditional and local knowledge in its response to securing and building the climate change resilience of the historic buildings of Nelson's Dockyard. As identified in the UNESCO World Heritage inscription, the buildings represent a collection of adaptive practices for the Caribbean climate, including developments to reduce heat, increase airflow, and reduce cyclone and earthquake damage through specific architectural interventions.[155]

Through hiring, training, and promoting these styles within the boundaries of the Nelson's Dockyard National Park, this traditional knowledge is passed on. The style encourages open concepts, large ingresses promoting airflow, and hip roof styles which are architecturally resistant to tropical cyclones and encourage greater rainwater harvesting (a national building requirement in Antigua and Barbuda). Maintaining and repurposing historical hydro-engineering of the Dockyard's rainwater catchment and holding tanks is essential to its functioning. The holding tanks collect water from the roof of the Officers' Quarters, which is used to service the businesses and visitors in the Dockyard with fresh water. These cisterns were most recently refurbished using historical masonry techniques in 2021.[156]

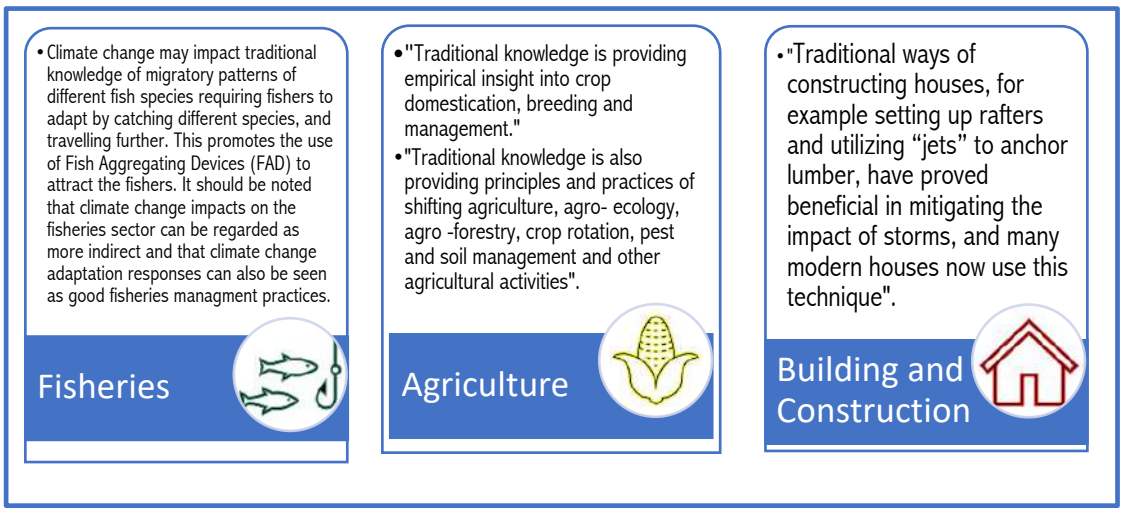
Incorporating local and traditional knowledge for adaptation action is prevalent not only in Antigua and Barbuda but across the Caribbean. This has been incorporated more visibly in the agriculture, fisheries, and building sectors. Responding to impacts of climate change such as water scarcity or heavy rainfall (agriculture), increased sea surface temperatures (fisheries), and heavy rainfall and hurricanes (building and infrastructure) can benefit from or be disadvantaged by traditional knowledge and practices (Figure

[154] The Gilbert Agricultural & Rural Development Center. 2021 https://www.gardc.org/about-us

[155] Waters, Christopher K. 2021 National Parks Authority "Use of traditional knowledge in the Building Sector in Antigua and Barbuda" Expert interview by Neranda Maurice-George, 21st September 2021

156 Ibid

Figure 4.5: Traditional knowledge in Fisheries, Agriculture and Construction



Adapted from CARDI, 2016; Joseph, 2021; Murray, 2021; and Hoffman et al., 2021.

4.5). Regional institutions such as the Caribbean Agriculture Research and Development Institution (CARDI), the Caribbean Regional Fisheries Mechanism (CRFM), and the University of the West Indies (UWI) have long been incorporating the use of traditional knowledge, alongside scholarly research and technology, as elements of climate-smart responses. In some instances, local and traditional knowledge must be set aside or modified as an adaptive response. One fisheries project in which Antigua and Barbuda is participating in the Climate Change Adaptation of the Eastern Caribbean Fisheries Sector (CC4FISH) Project. It seeks to integrate traditional knowledge with modern technology and equipment in its climate change response.

During the consultation process for elaborating this ADCOM, stakeholders were required to weigh in on two questions regarding traditional knowledge:[157]

1. Are you aware of local/traditional knowledge practices and systems which can support or deter adaptation action in Antigua and Barbuda? Please indicate what they are and if they help or hurt adaptation action.
2. In your estimation, are these local/traditional knowledge practices and systems adequately considered by government officials in adaptation planning?

On the areas of traditional knowledge practices and systems which can support or hinder adaptation in Antigua and Barbuda, stakeholders identified:

1. Water conservation actions currently implemented – (support)
2. Ecosystem restoration practices and methods utilized – (support)
3. Poor animal husbandry (roaming livestock) – (hinder)

[157] Maurice-George, Neranda. 2021. Final Consultation Report: Consultancy: Synthesize Adaptation Outputs within the Department of Environment (DOE) and Prepare an Adaptation Communication in Advance of COP 26

4. Clearing of vegetation down to the dirt because we want to see it "clean" – (hinder)

Stakeholders also noted that government could be reluctant to enforce traditional knowledge where it was deemed be unpopular. Some of the examples from the literature on how traditional knowledge are incorporated to promote climate change adaptation in the fisheries, agriculture, and building sectors.

Next Steps for Adaptation Priorities

This National communication, ADCOM and the NAPS processes serves as an important source of information on what Antigua and Barbuda is doing to adapt as it frames the country's adaptation priorities. These documents articulate national strategies, plans, projects and programs that contribute to strengthening national adaptative capacity and the country's resilience to a changing climate. The fact that the DOE is responsible for these allows for the use of limited resources to be used for detailed assessment and data collection in hard to assess sectors.

CHAPTER 5

OTHER INFORMATION CONSIDERED RELEVANT TO THE ACHIEVEMENT OF THE OBJECTIVE OF THE CONVENTION – INCLUDING GENDER AND CLIMATE CHANGE

Context

This chapter discusses issues relevant to the design and implementation of cross cutting factors, transitional risks, and opportunities realized when implementing adaptation and mitigation projects in a SIDS. The 4NC also features for the first time an entire section on gender.

As with the other chapters, the 4NC was developed in collaboration with different projects and processes, with the use of technical assistance from several key agencies. These include Global Green Growth Institute (GGGI), NDC partnership, the UNDP Climate Promise, the UNDP Engender Project, the GEF-UNEP TNA project, GCF readiness, the NAPs and the collection of lessons learned from the DOE and other projects.

Climate Change Mainstreamed into a National Development Process

The impacts of climate change are nationwide. The actions and activities of each entity must be incorporated, these include ministries, NGOs, individual citizens, regional agencies, and international agencies. The Government of Antigua and Barbuda (GoAB) addresses climate change through international negotiations and national implementation. International negotiations are executed by the Ministry of Foreign Affairs and national implementation by the Department of the Environment and the Ministry of Finance.

The mainstreaming strategy of the 4NC mirrors that of the TNC. Adaptation is addressed via the building code and land use while planning and mitigation will be undertaken by addressing the backup, grid, and transportation energy sectors.

The government is also assessing the financial sector, specifically the banking and the insurance sectors, to include policies and measures to ensure that climate change and climate action are considered in decision making.

Technology development, Introduction and Transfer

The Technology Needs Assessment (TNA) Project is a set of country driven activities funded by the Global Environment Facility (GEF) aimed at identifying and prioritizing

technologies for climate change mitigation and adaptation in developing countries. Antigua and Barbuda has completed Phase III of the TNA Project which is implemented by the United Nations Environment Program (UNEP) and executed through the UDP – a long standing partnership between UNEP and the Technical University of Denmark (DTU). Under this project, technologies in the buildings, transport and water sectors within the TNA project were assessed. The TNA Project is divided into three "Steps":

Step 1 - Identification and Prioritization of Technologies
Step 2 - Barrier Analysis and Enabling Framework
Step 3 - Technology Action Plans

Technology Assessment Program

Antigua and Barbuda's technology adoption is based on factors unique to SIDS. Island states pay at least twice as much for technologies than countries with large economies. A family in Antigua and Barbuda pays at least 200 percent more for technologies than a family in Miami. High shipping costs and limited access to credit result in the importation of low quality materials which often cannot withstand catastrophic hurricanes.

The 4NC along with other projects assessed several technologies which allowed for the DOE to collaborate with the Antigua and Barbuda Institute of Continuing Education (ABICE) to train students to use and better understand new technologies, the risks and barriers to adoption.

Factors for Technology Adoption

One of the most dangerous consequences SIDS face is the rise in Category 5 hurricanes, along with increased heat and drought, and the higher costs of the necessary adaptive technologies. Because of climate change and its effects, adaptation and mitigation strategies must be created and implemented to assist in reducing the impact on the island state and its population.

There is an increase in energy demand for cooling because of the increased temperatures which results in higher electrical production demand. As a result, electricity is becoming more costly. In light of this, alternate avenues for electricity generation should be explored to meet the demand of citizens at an affordable rate.

This project seeks to procure, test and analyze some of the technologies that can assist residents of the island with cheaper electricity generation and cooling technologies along with waste management. The technologies that were selected to help with climate change adaptation and mitigation are as follows:

Energy Generation:

Small scale wind turbine – A small-scale wind turbine, also known as a microgenerator of electricity, differs from a large commercial wind turbine. Wind energy is a clean and indigenous source of renewable energy. Certain areas in Antigua and Barbuda experience favorable wind conditions that could harness this natural resource, thereby increasing their resilience to climate change. Consequently, small-scale wind turbines would benefit homeowners and businesses by lowering electricity bills.

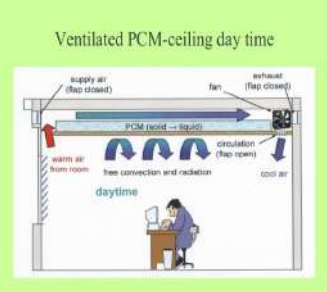
Portable solar system –. A portable solar system comprises solar panels (standard or foldable) and a lithium-ion battery system, along with essential electronic components like an inverter and charge controller. This system is designed to facilitate an easy transition for renters or individuals needing power in the field without grid access. It serves as a cleaner backup alternative to diesel generators, providing reliable energy during natural disasters

Waste Management

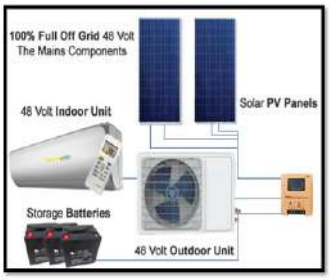
Home biodigester - This is a plug and play [158] biodigester system that would assist with household waste management while producing methane gas for cooking. This gas would replace liquid petroleum gas (LPG) currently used as fuel for cooking and potentially reduce the cost incurred by households. If produced in high quantities, this gas can also be used for cooling and water heating.

[158] Plug and play means no assembly or installation is required.

Cooling Technologies



Cooling using phase change material (PCM) - PCMs are materials that change state at specific temperatures, such as water turning into ice at 0 degrees Celsius. This system requires only a small fan for air circulation and can provide the same cooling effect as an air conditioning unit.



Solar air conditioner- Solar World Air condition systems work completely off grid using a combination of solar power and battery. This solution seeks to reduce the energy burden by integrating solar panels to supply energy needs. These panels would allow the system to work independently from other electric connections in the building.

Installation and Demonstration of Technologies

1. Small scale wind turbine – For the installation site of both grid-tied and off-grid wind turbines, an area with an average wind speed of 3 m/s to 8 m/s was chosen. Methodical weather data was collected and analyzed to assess the wind speed at the selected location and determine the appropriate size of the wind turbine. A graphical representation of the data was created to illustrate the wind direction.

   Based on the analysis, a suitable small-scale turbine with a power capacity between 1.4 kW and 10 kW was selected for purchase. This vertical wind turbine will be installed at the Department of Environment (DoE) located at #1 Victoria Park Botanical Gardens. Energy generation will be monitored over three to six months using an inverter, charge controller, and battery. Additionally, wind data will be collected and tested using a weather station over a six-month period.

2. Portable solar system - Two types of these systems will be examined: a plug-and-play system and a do-it-yourself (DIY) system. A 2.4 kWh plug-and-play system from Bluetti will be compared to a 2.4 kW DIY system. We will test for cost-effectiveness, reliability, scalability, and portability. The portable solar system will be tested on appliances commonly used in small businesses to determine the operational time of each device from the battery.

3. Home biodigester – The Homebiogas 2.0 system will be installed in a household that meets its specific requirements.

Firstly, the household must have sufficient space for the system, which measures 210x115x125 cm (83x45x49 in). Secondly, the household must generate a minimum of 6 liters of organic waste per day to feed into the system. Lastly, the installation area must maintain an average day/night temperature of 20°C (68°F). Once a site that has met this prerequisite has been selected, the system will be installed, connected and cooking hours measured. At minimum this system should be able to generate two hours of cooking daily.

4. Cooling using phase change material – A PCM from Rubitherm, with a phase change temperature of 24 degrees Celsius, will be installed in the ceiling of a building at the Department of Environment (DoE). At night, the PCM will be cooled by the ambient air, and during the day, it will absorb the heat inside the building, maintaining the temperature at 24 degrees Celsius and reducing the need for air conditioning. Temperature data will be collected before and after installation and compared to the energy usage of an air conditioning system for a building of that size.
5. Solar air conditioner – This plug and play system will be installed in one of the offices at the DOE to replace one of the grids connected systems. Since HVAC is one of the highest energy use and cost in buildings, the variance in energy bill over a three to six-month trial period will be compared to the previous bills to determine the energy saving cost.

Report on Outcomes

After the trial period of three to six months, a report on the performance of the technologies at their respective sites on installation will be provided. This document will outline energy generation and energy saved calculations along with an overall summary of performance over the period. Where possible a financial assessment will be done to determine the payback period and feasibility of the various systems.

The procurement of these technologies will be made directly from manufacturers in China. While most items imported into Antigua and Barbuda are made in China, they are typically sourced from the US market with a significant markup. This project will also test direct importation from manufacturers, which has resulted in over a 50 percent cost reduction for the beneficiaries.

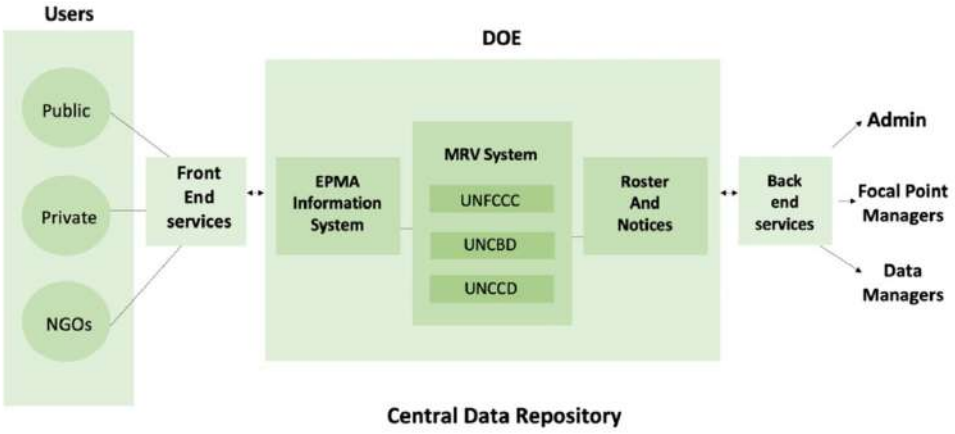
Climate Research, Systematic Observations and Information Sharing

The vision of the Environment Registry is to administer information on the environment, and provide assistance to the Department for monitoring, compliance, reporting and notification requirements under multilateral environmental agreements to which Antigua and Barbuda is a part. Also, to deposit information relating to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and access to genetic resources and any other purpose in accordance with the requirements of the EPMA, 2019.

Data for environmental and climate purposes have so far been separated and currently, climate data is being collected by the Antigua and Barbuda Meteorological Services. This data will be useful in monitoring and reporting on indicators developed within the MRV system. The registry will contain the EPMA Information Systems, MRV System, rosters and notices.

Part X, Section 87 of the EPMA (2019) outlines the types of data and information that will be placed on the Environment Registry. Additionally, Part V of the EPMA (2019) provides additional guidance as to the type of pollution related data and information it will contain. In addition to these listed documents, the registry will also serve as Antigua and Barbuda's National MRV System to support the UNFCCC, the CBD and the UNCCD.

Figure 5.1: Conceptualization of the Environment Registry



Part X of the EPMA 2019 establishes a legal mandate on environmental information through the establishment of a Geographic Information Systems (GIS) Unit to create and manage an Environmental Information Management and Advisory System (EIMAS) and a Natural Resources Inventory (NRI). The EIMAS serves the purpose of establishing and maintaining centralized information resources. The NRI is the subsection of EIMAS containing information concerning the natural resources of Antigua and Barbuda. The EPMA at paragraph 85 sub-paragraphs (2) (b) and (c) mandates the Government Information Service (GIS) Unit to:

1. *Create and maintain of the Environmental Information Management and Advisory System and the Natural Resources Inventory*
2. *Provide information for the management of natural resources*
3. *Produce public information materials relating to resource management issues*
4. *Liaise with the public, business community, and non-governmental organizations in relation to resource management issues*
5. *Provide access to environmental information to the public to enable public participation in decision making related to the environment in furtherance of the functions set out above.*

The GIS Unit may also "*carry-out surveys, inspections, and collate geographic and*

natural resource information; and collect, store, manage and disseminate information" (Government of Antigua and Barbuda, 2019).

In addition, section 42 requires that the DOE publishes notices of Environmental Impact Assessments (EIAs) by registering them with the Town and Country Planner and, further, review and provide the updated EIAs to the public based on the requirements of section 43.

Information Sharing and the Escazú Agreement

The foregoing also supports Antigua and Barbuda's ratification of the Escazú Agreement in 2020. The Latin American and the Caribbean regional agreement seeks to *"guarantee rights of access to environmental information, public participation in the environmental decision-making process and access to justice in environmental matters, and the creation and strengthening of capacities and cooperation, contributing to the protection of the right of every person of present and future generations to live in a healthy environment and to sustainable development*" (UN-ECLAC, 2018)[159]. Through this agreement, Antigua and Barbuda "*guarantees the rights of every person to a healthy environment and to sustainable development,"* focusing on vulnerable people and groups.

To date, Antigua and Barbuda has developed an *Issues Paper* that outlines the remaining gaps and proposes recommendations to satisfy the Escazú Agreement and a *Legal Manual for the Access to Justice Program.* The legal manual guides various stakeholder groups on how the Escazú Agreement applies to them and provides guidance useful for their specific area. The stakeholder groups identified are the public; the Antigua and Barbuda Legal Aid and Advice Centre; the Antigua and Barbuda Bar Association, and the DOE. Additional work that has taken place includes the development of an information factsheet, extensive stakeholder consultations, improvement in public access to information on environmental risks, vulnerability and exposure, and efforts to complete the 2021 Paris Agreement Regulations to the 2019 EPMA.[160]

Education, Training and public Awareness Compiled and Synthesized

Capacity Building based on Comprehensive raining and Capacity Building

Overall Context

Under the 2015 Paris Agreement, countries unanimously agreed to work toward global goals that would limit global average temperature rise. Individually, NDCs represent each country's climate priorities and vision for achieving sustainable development. Aggregated, they represent the world's

[159] UN-ECLAC. 2018. Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean. https://repositorio.cepal.org/bitstream/handle/11362/43583/1/S1800428_en.pdf

[160] DOE, Government of Antigua and Barbuda. 2020. Access to Justice Program for Environmental Matters to implement the Escuzú Agreement 2018.

collective efforts to fight climate change. The 4NC uses the NDC as the focus for capacity building for climate change. The capacity building process highlights the Just transition of the Workforce with gender and social inclusion as the key to managing the transition risks. As part of this process the 4NC benefitted from the following activities:

- The UNDP Climate Promise program, as part of its support to Antigua and Barbuda, has provided a structured approach to enhancing NDC capacity. This approach can be adapted to the specific context and priorities of the country. As part of the Climate Promise initiative, UNDP commissioned a report titled "An Institutional Capacity Assessment at the National Level to Identify Critical Skill and Knowledge Gaps for NDC Implementation." This assessment, which focuses on the country's energy, water, and agriculture sectors, is a key component of the UNDP support.
- The 4NC also benefitted from the support of the NDC and the ILO's "*Identifying Opportunities to Promote a Just Transition towards the Net-Zero goal in Antigua and Barbuda – Review of employment-climate nexus*"

The capacity building program is key to meeting the successful implementation of the objectives of the Paris agreement. The objectives of the transition/program are to:

- Reduce transitional risks;
- Support vulnerable groups, including women, the elderly and people living with disabilities;
- Support an inclusive, gender responsive approach to the energy transition with special focus on women fully participating in the new economy and providing support for men working within the power and transportation sectors as the transition advances;
- Support youth fully with a gender responsive approach for girls and boys of all income levels in meeting the new challenges and opportunities that this process can provide;
- Provide investment and business opportunities for local micro, small, and medium enterprises (MSMEs) and businesses in the informal sector; and
- Prepare to engage on loss and damage.

The NDC targets however represent a significant increase in scope and ambition compared to the INDC, specifically, in mitigation ambition and adaptation, with supporting actions in the areas of loss and damage response, gender-responsive approaches in access to finance, and the just transition of the workforce.

In November 2021, the country finalized its NDC Implementation Plan, which outlines the initial roadmap for achieving its NDC targets. This plan identifies the key government institutions, agencies, and third parties that will play crucial roles in reaching the NDC objectives and targets. Detailed information and plans from these documents are available in a separate report.

Updated Capacity Building - Comprehensive Training and Capacity Building Plan

The government of Antigua and Barbuda's commitment to the 2015 Paris Agreement extends to the transition to Low Carbon and

resilient economy. Achieving the goal of limiting the global average temperature increase to 1.5°C above pre-industrial levels necessitates transitioning the entire workforce to address this challenge. The targets for this transition are set in the NDC 2021, and the country is actively working towards meeting them.

A "just transition" towards sustainable economies is about achieving decent work for all and eradicating poverty through inclusive economic growth that meets the needs of the world's population while also protecting the environment and natural resources on which life on earth depends.

This report presents a sectoral analysis of the challenges and opportunities of climate action in relation to the world of work, specifically in policies related to green job creation, workforce reskilling and upskilling, enterprise development, social inclusion, social protection, and social dialogue. It seeks to generate ideas to answer the following questions:

1. How can environmental protection and pursuing the NDC targets improve the world of work?
2. How can transforming the country's economy simultaneously protect the environment?

A situational analysis on just transition was employed to examine the impact of climate change on national sectors and provide recommendations for appropriate policy responses. This methodology, developed by the ILO, assists in identifying high-potential entry-points for just transition policies and interventions at the national level, in line with specific country-level needs, priorities and policy processes.

The conclusion of this report is clear: protecting the environment and adapting to climate change can be positive for employment. Antigua and Barbuda has specific opportunities in certain sectors to create more and better jobs while protecting the environment and promoting the sustainable use of natural resources.

Key findings indicate that the transition to net-zero emissions by 2040 will lead to job losses in the short term, in particular in sectors dependent on fossil fuels. Therefore, appropriate social protection measures to assist impacted workers and communities secure income, as well as employment services to support with reskilling and upskilling in the renewable energy sector are necessary. In fact, in the medium to long term transitioning to net-zero will lead to job creation in the renewable energy sector, notably solar and wind. Job opportunities will primarily emerge from the installation and maintenance of solar PV systems. A skilled workforce is key to addressing this emerging demand. The energy sector will also benefit significantly based on reduced energy costs. Antigua and Barbuda imports 100 percent of its fossil fuel, the transition to renewable energy will lead to a reduction in fuel imports and its associated costs.

For the transport sector, while employment cuts are imminent in the short-term, data from several studies show that jobs in renewable energy will grow with the increased use of electric vehicles (EVs) and the installation of EV infrastructure. Opportunities will also emerge for training and upskilling based on reliance on renewable energy technologies. The transition process will create a demand for Electric Vehicle Maintenance Technicians, Charging Station Installers, Charging Station

Maintenance Technicians and Energy Efficiency Consultants.

For the tourism sector, which is highly vulnerable to climate change effects, the transition should focus on building resilience to climate shocks while adopting more environmentally friendly, low-carbon practices. There are potential growth opportunities in eco-tourism, which could be further supported as the country undergoes an energy transition, through policies that facilitate collaboration between the tourism and energy sectors. MSMEs, especially those run by women, will need financial and technical support to make necessary business, mitigation, and adaptation investments.

Strategies geared towards transitioning the labour force will have to adopt a gender inclusive approach. The sectors with the highest potential to create new green jobs are currently dominated by men (more than 95 percent of the male workforce). Therefore, the shift to net-zero must incorporate strategies to involve women in technical areas of work, notably in energy and transport. Cultural perceptions confining women to domestic and service-based work persist and must be addressed. A gender-sensitive approach must be embraced along with ILO decent work principles that promote equality in the workplace.

The report provides guidance to stakeholders that identifies the need to transition the economy by developing sustainable and socially inclusive policies that seek to preserve the natural environment. An inclusive approach is required to ensure that stakeholders in the tripartite group are a part of the decision process. This will build cooperation and allow key players to identify how transitioning to renewable energy can benefit the environment, economy and future generations.

Information and Networking at the Regional and International Levels

The Country is actively involved in regional and international processes and the implementation of projects in other countries via the DOE in its capacity as an accredited entity. The DOE SIRF fund is now able to implement Grant projects in the OECS region on behalf of the countries that do not have an accredited entity.

Antigua and Barbuda has a dedicated Ambassador for Climate Change and together with the Ministry of Finance the country serves on the Adaptation fund Board, the Green Climate fund Board, the Transitional Committee for the Loss and Damage fund and the Standing Committee on Finance. The Country takes its work seriously and focuses its efforts on access to financing especially microfinancing.

Gender and Climate change

Context

As a party to the UNFCCC, Antigua and Barbuda submitted its first NDC to the global response to climate change (NDC) in 2015 and submitted its updated INDC in 2021 in line with the United Nations Framework Convention on Climate Change 1992 and its Paris Agreement 2015. The NDC includes adaptation and mitigation targets for the period 2020 to:

- Energy Access (Electricity and Transportation)
- Water Security
- Finance and Insurance
- Just Transition of the Workforce

Through the Five–Year Enhanced Lima Work Program on Gender and its Gender Action Plan, the UNFCCC "aims to enhance the systematic integration of gender considerations into climate policy and action as well as ensure the respect, promotion and consideration of gender equality and the empowerment of women in the implementation of the Convention and the Paris Agreement." In line with this mandate, the Department of Environment has integrated gender in its policies through the Environmental Social Safeguard and Gender Policies and seeks to integrate gender in its updated NDCs in order to facilitate a just transition of the energy and infrastructure/construction sectors, which include the transition of men in these sectors as well as increased access for women in these sectors.

Background

The IPCC special report on the impacts of global warming of 1.5°C 2018 highlighted SIDS as one of the regions at a disproportionally higher risk of adverse consequences with a global warming of 1.5 °C. As a SIDS, Antigua and Barbuda has faced the reality of increased frequency and intensity of hurricanes tropical storms and flooding events, notably the passage of Category 5+++ hurricanes Irma and Maria in 2017; extended and intense drought periods; rising air temperature and sea levels. The passage of the 2017 hurricane in Barbuda resulted in damage to infrastructure, loss of access to energy, water, housing, health and education services , need for security services and a mandatory removal of the Barbudan population from the island. Revenue earning sectors like the fisheries and tourism sectors, male and female dominated fields respectively, were completely decimated compromising the ability of households to earn an income and required in increased expenditure for central government.

Climate change impacts have and will continue to dramatically transform the natural and socio-economic environment by furthering developmental challenges generally faced by SIDS and increasing gender inequalities for men and women. Considering this glaring reality, Antigua and Barbuda has recognized the importance of assessing the differential impact of climate change on men and women and ensuring this differentiation is addressed in all climate action. Rigorous data

collection and analysis have identified vulnerabilities to climate change among various groups, including men, women, single-parent female-headed households, youth, persons with disabilities, and male-dominated farmers and fishers (Barbudans). Additionally, transitional risks have been recognized for men in Antigua and Barbuda's energy and construction sectors.

Subsequent to analysis of the mentioned impacts on specific groups, Antigua and Barbuda has updated its INDCs to include gender responsive targets which aim to:

- Alleviate the cost of climate change impacts on vulnerable groups including single-parent female-headed households, persons with disabilities rural communities, farmers and fishers, among others. This includes preparatory and post disaster costs associated with these events;
- Increase levels of support, including financial, social and community support for women and other vulnerable communities for post-extreme weather event recovery, in recognition of the increased burden of responsibilities on women post disaster; and
- Increased energy security for female headed households through renewable energy sources, particularly after severe hurricane and storm events.

Legislative Context

The updated INDC gender chapter is in line with Antigua and Barbuda's legislative and policy framework, including specific policies on gender equality and women's empowerment and vulnerable communities. Below is an overview of the relevant legislation and policy.

Table 5.1: Legislative and Policy Context

LEGISLATION	DESCRIPTION AND RELEVANCE TO THE PROJECT
NATIONAL LEGISLATION	
Constitution of Antigua and Barbuda, 1981.	The Antigua and Barbuda Constitution prohibits discrimination on the grounds of sex, which refers specifically to the biological differences that determines an individual as male or female. Article 14 (3) states, "In this section, the expression "discriminatory" means affording different treatment to different persons attributable wholly or mainly to their respective descriptions by race, place of origin, political opinions or affiliations, colour, creed, or sex whereby persons of one such description are subjected to disabilities or restrictions to which persons of another such description are not made subject or are accorded privileges or advantages that are not accorded to persons of another such description."

LEGISLATION	DESCRIPTION AND RELEVANCE TO THE PROJECT
Physical Planning Act (2003)	This Act sets the standards for construction in Antigua and Barbuda, including the requirement of water supply and catchment for all buildings. Under the DOE Climate Change Program, the DOE seeks to increase the resilience of infrastructure to meet the increasing impacts of climate change. As such, a Building Code was drafted to upgrade building standards in line with climate change projections for Antigua and Barbuda and climate change resilience measures as well as develop capacity for delivering local area plans. The draft Building Code Act is currently under review.
Education Act 2008	The Education Act provides for a regulatory system for the delivery of educational services including vocational and training institutions in Antigua and Barbuda which is designed to deliver the following: • the establishment of a varied, relevant and comprehensive educational system that is characterized by excellence; • the promotion of the education of the people of Antigua and Barbuda by the establishment of educational institutions for the purpose of fostering the spiritual, cultural, moral, intellectual, physical, social and economic development of the community; • the framing of an educational policy designed to give effect to the purposes of this Act; • the effective execution of the educational policy of the Government; and • the establishment of a coordinated educational system organized in accordance with this Act.
Environmental Protection and Management Act (2019)	The EPMA serves as the principal guiding policy for the DOE. • It establishes and consolidates the implementation of the Multilateral Environmental Agreements in one legal regime and provides the financial framework for implementation. • It governs sustainable environmental protection and management to establish effective allocation of administrative responsibilities for environment management, coordination of environmental management, and the incorporation of international

LEGISLATION	DESCRIPTION AND RELEVANCE TO THE PROJECT
	treaty obligations with respect to the environment into national and law related matters. • It also recognizes the importance of evaluating the impact of social, human health, economic and ecological considerations issues and considerations in respect of policy.
Childcare and Protection Act, 2004	The CPA establishes a Child Protection Agency in Antigua and Barbuda and provides safety, care and protection for all children. It also provides standards for child-care facilities including reporting abuse or neglect of children and requirements of children's homes. It also ensures that child labour is not allowed.
Disabilities and Equal Opportunities Act l, 2017	An Act to make provision for the protection of the rights of persons with disabilities and for connected matters. The objectives of this Act are as follows— • to improve the general standard of living for persons with disabilities; • to provide a clear and comprehensive national mandate to facilitate the elimination of existing cases of discrimination against persons with disabilities, and to put safeguards in place to prohibit further discrimination against such persons; • to promote on a national level, the principle that a person with a disability is entitled to the same fundamental rights as a person who does not have a disability; and • to ensure full and effective participation in all aspects of society for a person with a disability on an equal basis with a person who does not have a disability.
Disaster Management Act, 2002	This Act provides for the effective organization of the preparedness, management, mitigation of, response to and recovery from emergencies and disasters natural and man-made in Antigua and Barbuda.
Antigua and Barbuda Labour Code	The Act stipulates that no employer shall discriminate with respect to any person's hire, tenure, wages, hours, or any other condition of work, by reason of race, color, creed, sex, age or political beliefs.
NATIONAL POLICIES	
Antigua and Barbuda Interconnection Policy, 2015	The Antigua and Barbuda Interconnection Policy was updated in 2015 and provides for Net Billing for systems between 0 – 5 kW for resident and commercial facilities. For

LEGISLATION	DESCRIPTION AND RELEVANCE TO THE PROJECT
	systems between 5 – 50 kW, the Policy mandates a Feed-in Tariff (buy-all, sell-all) at the avoided cost of fuel (EC$ 0.45).
National Poverty Strategy 2011-2015	The National Poverty Strategy 2011- 2015 has as one of its strategies, "Building Resilience through Environmental Sustainability – by making disaster risk reduction a feature of the planning process in the light of the high environmental risks that the country faces from hurricanes, earthquakes, and now sea rise, as a result of global warming."
Antigua and Barbuda National Youth Policy, 2021	The National Youth Policy identifies factors that are critical to youth empowerment and identifies eight key focus areas including strengthening social environments, education and training, employment and sustainable livelihoods, health, participation and empowerment, care and protection, crime, violence and rehabilitation and gender equality and gender relations.
DEPARTMENT OF ENVIRONMENT POLICIES	
Department of Environment Gender Policy	The Department of Environment Gender Policy formalizes the DOE's commitment to mainstreaming gender into its work program and project portfolio. Gender is defined as "the social attributes and opportunities associated with being male and female and the relationships between women and men, girls and boys, as well as the relations between women and those between men. These attributes, opportunities and relationships are socially constructed and are learned through socialization processes. They are context/ time- specific and changeable. Gender is part of the broader socio-cultural context and intersects with other important criteria for socio-cultural analysis including class, race, poverty level, ethnic group and age. As such, the DOE's gender policy sets out the principles on which the approach to environmental social safeguards, gender review and management by the DOE is based and the requirements that are applicable to each project.

Department of Environment Environmental Social Safeguard Policy	The DOE is required by regulations as well as polity and contractual obligations to respect ESS safeguards. The Environmental and Social Safeguards, regulations and Policies formalizes the DOE's commitment to promote environmental and socially sustainable projects.
MULTILATERAL AGREEMENTS, TREATIES AND CONVENTIONS	
Sustainable Development Goals	In September 2015, the General Assembly adopted the 2030 Agenda for Sustainable Development that includes 17 Sustainable Development Goals (SDGs). The integration of gender considerations in the updated INDCs will contribute to the implementation of the following SDGs: - GOAL 2 – Zero Hunger - GOAL 3 –Good Health and Well-being - SDG 4 — Quality Education - SDG 5 — Gender Equality - SDG 6 — Clean water and Sanitation - SDG 7 — Affordable and Clean Energy - SDG 8 – Decent Work and Economic Growth - SDG 9 — Industry, innovation and infrastructure - SDG 10 – Reduced Inequalities - GOAL 11– Sustainable Cities and Communities - GOAL 13–Climate Action
Convention on the Rights of the Child	A United Nations Treaty adopted by RES/44/25 at the 44th Session of the United Nations General Assembly in 1989 outlining the rights of children in the following areas: civil, political, economic, social, cultural and health.
United Nations Framework Convention on Climate Change (UNFCCC), 1992	The UNFCCC, which entered into force in 1994, provides a framework for intergovernmental efforts addressing climate change and its effects. Member States of the UN meet and share data on greenhouse gas emissions, national policies and best practices, with the goal of developing and implementing strategies for tackling emissions and providing financial and technical assistance for developing countries. The UNFCCC aims for gender balance in bodies established pursuant to the Convention and the Kyoto Protocol, to improve women's participation and inform more effective climate change policy that addresses the needs of women and men equally. The UNFCCC called for the national adaptation plan (NAP) process to be gender-sensitive and calls on the Green Climate Fund (GCF) to promote environmental, social,

	economic, and development co-benefits and take a gender-sensitive approach. Each country formulates its Nationally Determined Contributions (INDC) to the UNFCCC. By 2030, one of Antigua and Barbuda's climate action target includes preparing buildings for extreme climate events, including drought, flooding and hurricanes, which is aligned to targets for this project.
Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW)	CEDAW is the principal instrument utilized by the UN to protect the rights of women and eliminate all forms of discrimination against them. Adopted by the United Nations General Assembly (UNGA) in 1979, CEDAW was ratified by the Government of Antigua and Barbuda in 1989 and its Optional Protocol signed in 1996. This convention mandates states to ensure that women: i are equally represented in their governments and international organizations; ii have equal rights to bank loans, mortgages and other forms of financial credit; iii participate in and benefit from rural development; iv participate in development planning at all levels; v obtain training, education, and extension services; vi have access to agricultural credit and loans, marketing facilities and appropriate technology; and vii are treated equally in land, agrarian reform, and land resettlement schemes.
Beijing Declaration and Platform for Action from the Fourth World Conference on Women	This landmark declaration and Platform for Action (PoA) called for actively involving women in environmental decision making at all levels, integrating gender concerns and perspectives in policies and programs for sustainable development, and strengthening or establishing mechanisms at the national, regional and international levels to assess the impact of development and environmental policies on women.
Commission on the Status of Women (CSW)	The 52nd session of the CSW (2008) identified gender perspectives on climate change as its key emerging issue. The CSW, which is convened annually at United Nations Headquarters in New York, urged Member States to integrate gender into the design, implementation, monitoring and evaluation and reporting of national

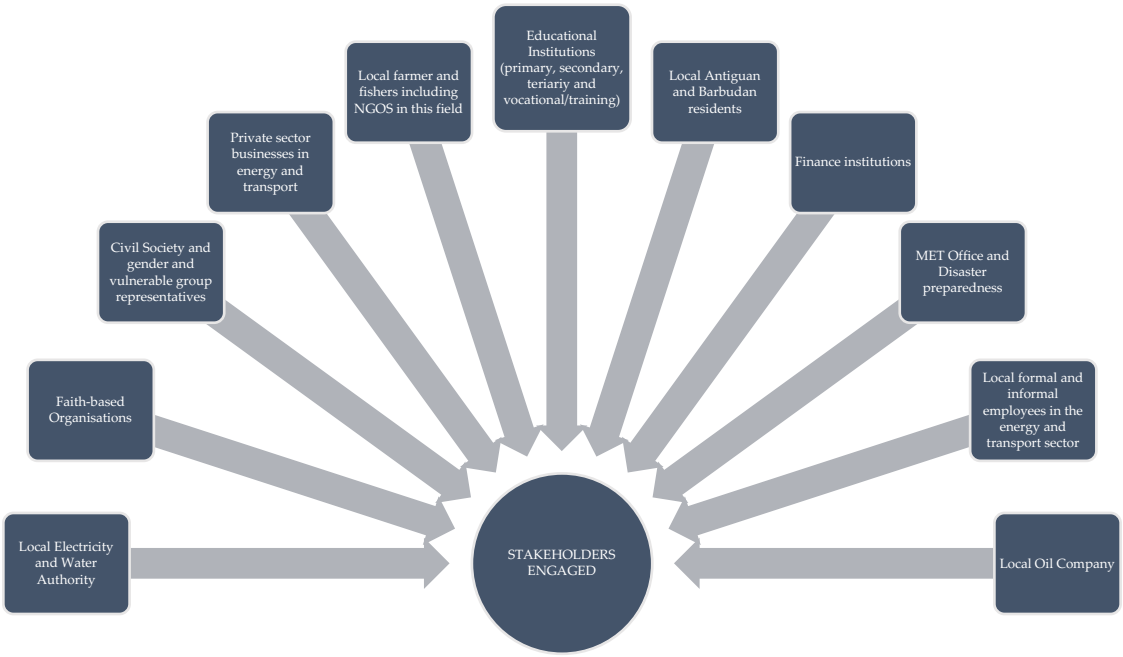
	environmental policies; as well as to strengthen mechanisms and provide adequate resources to ensure women's full and equal participation in decision making at all levels on environmental issues, with particular emphasis on strategies related to climate change and the lives of women and girls.
UN Convention on the Rights of Persons with Disabilities (CRPD)	The Convention is intended as a human rights instrument with an explicit, social development dimension. It adopts a broad categorization of persons with disabilities and reaffirms that all persons with all types of disabilities must enjoy all human rights and fundamental freedoms. It clarifies and qualifies how all categories of rights apply to persons with disabilities and identifies areas where adaptations must be made for persons with disabilities to effectively exercise their rights, areas where their rights have been violated, and where protection of rights must be reinforced.
United Nations Conference on Sustainable Development (Rio+20) outcome document	Rio+20 affirms that green economy policies in the context of sustainable development and poverty eradication should enhance the welfare of women, mobilize their full potential and ensure the equal contribution of both women and men. "*The Future We Want*" was adopted in Rio de Janeiro in June *2012*. It resolves to unlock the potential of women as drivers of sustainable development, including through the repeal of discriminatory laws and the removal of formal barriers. It also commits to actively promote the collection, analysis and use of gender sensitive indicators and sex-disaggregated data.
UNFCCC Gender Action Plan	The UNFCCC Gender Action Plan aims to increase the participation of women in all UNFCCC processes. It also seeks to increase awareness of and support for the development and effective implementation of gender-responsive climate policy at the regional, national and local levels.

Methodology and Approach

The Gender and Social Inclusion Chapter of the Revised INDC is the result of at least two years of rigorous data collection and analysis conducted by the UNFCCC Focal Point, the DepDOE, based within the Ministry responsible for the Environment. This effort was supported by the NDC Partnership's Climate Action Enhancement Package (CAEP) initiative, the United Nations Development Program's Climate Promise initiative, IRENA's Small Island Developing States (SIDS) Lighthouses Initiative, Green Climate Fund's Readiness (4) Project, and the 4th National Communications Project which produced technical papers and documents

The DOE completed desk research based on existing national and strategic priorities, policy and legislation as outlined in Chapter 3, and primarily relied on primary data collected through interviews and consultations with various government officials, members of the private sector, civil society, and NGOs as well as a survey of over 1,700 residents in Antigua and Barbuda.

FIGURE 5.2: List of Engaged Stakeholders



Socio Demographics - Details for Men and Women

TABLE 5.2: SOCIO-ECONOMIC DEMOGRAPHICS

Country	Total pop.	Population 0-14 years old	Population 15-24 years old	Population 64 years and over	Life Expectancy at Birth	%/Number of male or female-headed households	Maternal Mortality Rate	Infant Mortality Rate	Labour Force Participation	Unemployment Rate	Enrolment in Primary Schools	Enrolment in Secondary Schools	Enrolment in Tertiary Education	No. of males/ females in Parliament	Gender-based Violence (GBV)
Antigua & Barbuda	M-40,007 (48%) F-43,271 (52%) T-83,278 (100%) (GOAB Census, 2011)	M-11,333 (51%) F-10,979 (49%) T-22,312 or 24% of total pop. (CIA, 2013)	M-7,465 (49.5%) F-7,622 (50.5%) T-15,087 or 16.7% of total population (CIA, 2013)	M-2,771 (43%) F-3,659 (57%) T-6,430 or 7.1% of total population (CIA, 2013)	M-73.9 years F-78.1 years T-75.9 years	M-56.5% (2001) F-43.5% (2001) (GOAB Census, 2001)	0.81 (CARICOM, 2010)	10.9 (Health Information Division, Ministry of Health Antigua and Barbuda)	M-18,602 (47%) F-21,341 (53%) T-39,943 (Kairi, CPA 2005/2006)	T-12% (estimate) GOAB, 2012	M-100% F-88.1% T-94.0% (GOAB, Ministry of Education, 2009-2010)	M-78.9% F-82.1% T-80.5% (CEPAL, 2011)	M-689 (34.8%) F-1291 (65.2%) T-1980 (100%) (OECS, 2010-2011)	*H.O.R/ Lower House* M-16 (89.9%) F-2 (11.1%) T-18 (100%) *Senate/Upper House* M-10 (58.8%) F-7 (41.2%) T-17 (100%) (IPU 2014)	T-216 victims (DOGA, 2011)

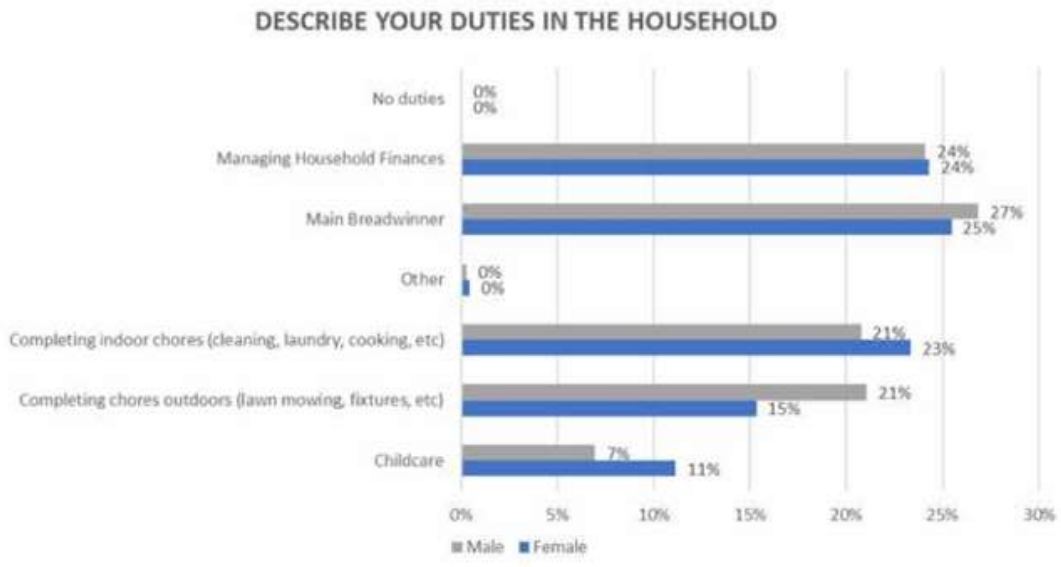
Findings of the Data Collection

The latest population census conducted by the Government of Antigua and Barbuda noted that women constituted 52 percent of the population while men constituted 48 percent.[161] Based on population estimates as of 2020, the current population is 97,928 persons, with a growth rate of 0.8 percent annually.[162]

A 2020 survey conducted by the DOE found that nationally, an equal number of male and female respondents considered themselves the head of their respective households while in Barbuda, men were 35 percent more likely than female respondents to consider themselves head of household. A higher percentage of women were noted as head of single-parent households. Household duties nationally were divided along gender lines with men represented in higher percentages as breadwinners. In comparison, women were noted to have higher percentages in childcare duties as well as managing household finances.[163] Based on the 2011 census, around 55 percent of persons in Antigua and Barbuda own land, while land in Barbuda is held in common.[164] There are no known gendered legal barriers to ownership of assets such as land.

The National Country Poverty Assessment Report of 2007 found that about 18 percent of the population had expenditure less than EC$6,318 (US$2,366) per year, putting them below the poverty line. Over 28 percent are considered to be at risk of falling into poverty[165].

Figure 5.3: Description of Household Duties by Gender



[161] Government of Antigua and Barbuda. 2011. Population and Housing census.

[162] https://data.worldbank.org/indicator/SP.POP.TOTL?locations=AG

[163] Department of Environment. Rep. *National Gender Assessment Survey: The Economic Impact of Climate Change on Men and Women in Antigua and Barbuda*. St. John's , Antigua: Department of Environment, 2021.

[164] Ibid 248

[165] Kairi Consultants Ltd in Association with the National Assessment Team of Antigua and Barbuda. "Living Conditions in Antigua and Barbuda: Poverty in a Services Economy in Transition." *Country Poverty Assessment Reports* 1 (August 2007)

Economic Access

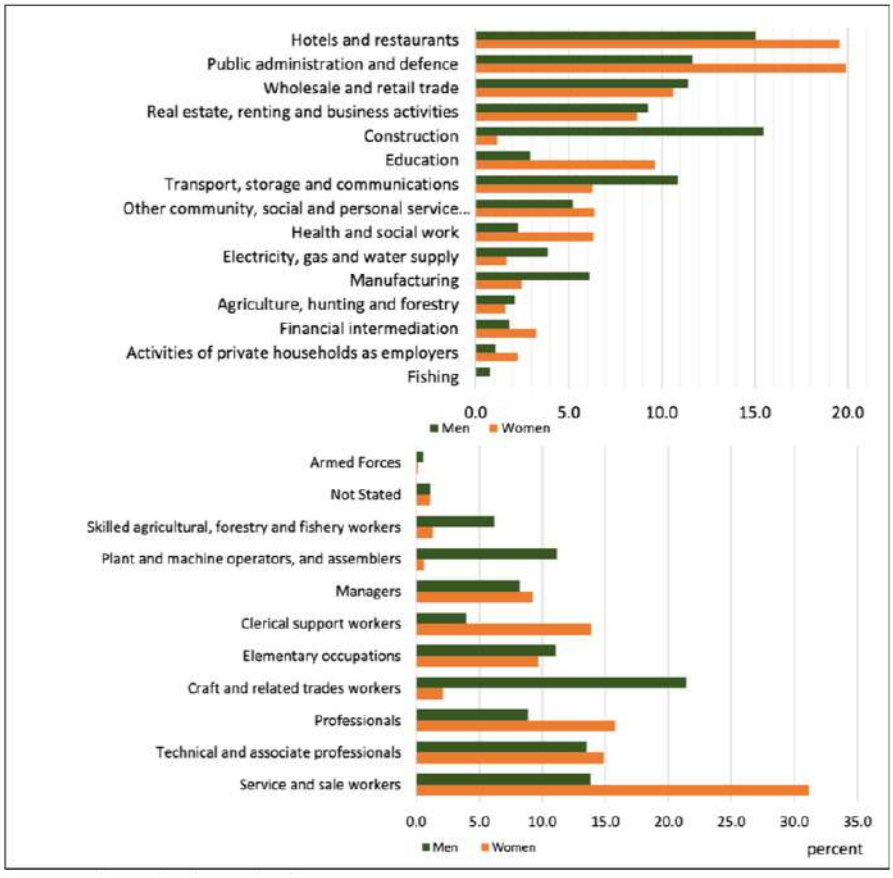
The economy of Antigua and Barbuda is primarily a service economy. Two out of every three workers (66.9 percent) in the country worked in services industries while under two in ten (17.2 percent) worked in goods-producing industries. In a labour force of 47,429 persons, men dominated in industries such as Construction, Agriculture, Transport and Energy while women dominated in Healthcare, Finance, Education, and the Hotel Industry.[166]

There was relative gender parity among managers. There were 2,283 female managers (representing 9.2 percent of the female employed population) and some 1,872 managers who are (representing 8.2 percent of the male employed population). Out of the 2,283 female managers, the top four industries that female managers worked in were public administration and defense (18.2 percent) followed closely by wholesale and retail (18.1 percent), the hotels and restaurants industry (17.4 percent) and transport, storage and communications (12.6 percent). The top four industries that male managers worked in were wholesale and retail trade (30.5 percent), construction (14.2 percent), hotels and restaurants (11.9 percent), and public administration and defense (10.7 percent)[167].

Generally, women in the labour force were on average better educated than their male counterparts. 58.1 percent of all Labour force participants with a university degree were women; 70.5 percent of Labour force participants who listed primary education as their highest education were men.[168]

The economy is highly dependent on tourism, therefore a decline in visitors poses a substantial threat to the economic stability of Antigua and Barbuda (Government of Antigua and Barbuda 2020). In 2016, the total expenditure of visitors was estimated to

Figure 5.4: Employment by Industry and Profession, 2018



Source: 2018 Labour Force Survey (Government of Antigua and Barbuda 2020)

[166] ibid

[167] Statistics Division. Rep. *Antigua and Barbuda 2018 Labour Force Survey Report*. St. John's, Antigua and Barbuda: Ministry of Finance and Corporate Governance , 2018.

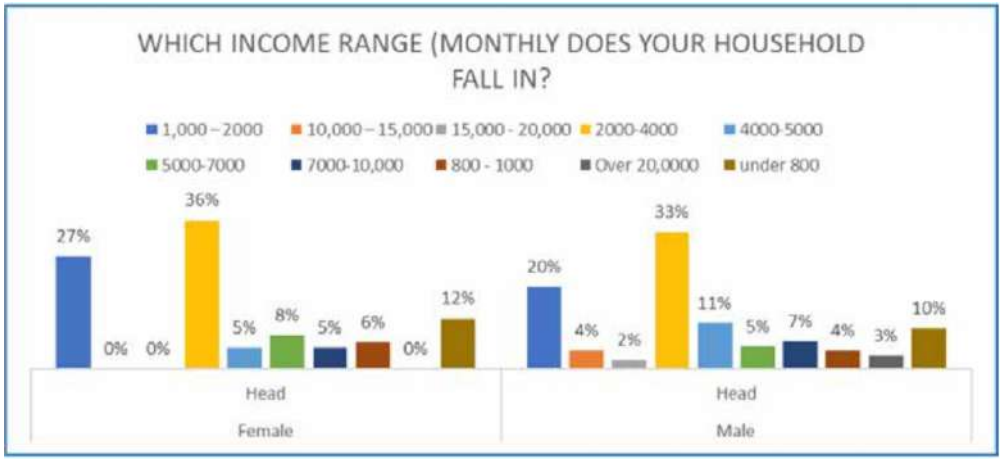
[168] ibid

account for up to 28 percent of the country's total GDP (Government of Antigua and Barbuda 2020a). It is expected that the COVID 19 pandemic will likely have severe impacts on employment, estimating that the share of the tourism sector in total employment may go down between 5.9 and 9.4 percentage points (Mooney and Zegarra 2020). Early evidence of the impact of COVID-19 on hotels and restaurants showed a decline in economic activity in the hotels and restaurant sector by almost 62 percent. With a limited recovery in the tourism industry, overall GDP was projected to decline by 18 percent in 2020 (Ministry of Finance and Corporate Governance 2020).

Based on a survey conducted in 2020, the average household in Antigua and Barbuda noted that they earned between EC$2,000 - $4,000 per month. Male headed households were noted in greater percentages in higher income brackets than female households and men were noted as more likely to have a secondary source of income than female respondents by over 15 percent. Female-headed households (for which a larger number were recorded as single-parent households than male-headed households) were noted in higher percentages in lower-income pentiles.[169] This relates to a large part of female employees being employed in service jobs which are typically associated with lower wages.[170]

At least 16 percent of the population, overwhelmingly within the north coast, experienced damages from torrential rainfall with women in these communities noting expenditure of over 85 percent compared to male respondents. Most respondents reported covering repairs caused by flooding out of pocket, and of persons displaced from their homes during flooding, the average period for women was three weeks while for men, it was one week[171].

Figure 5.5: Household Income by Sex

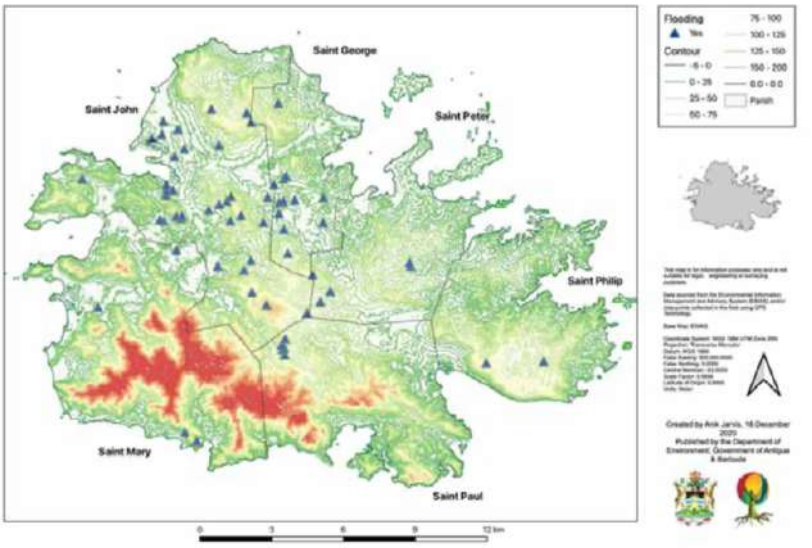


[169] Department of Environment. Rep. *National Gender Assessment Survey: The Economic Impact of Climate Change on Men and Women in Antigua and Barbuda.* St. John's , Antigua: Department of Environment, 2021.

[170] Statistics Division. Rep. *Antigua and Barbuda 2018 Labour Force Survey Report.* St. John's, Antigua and Barbuda: Ministry of Finance and Corporate Governance , 2018.

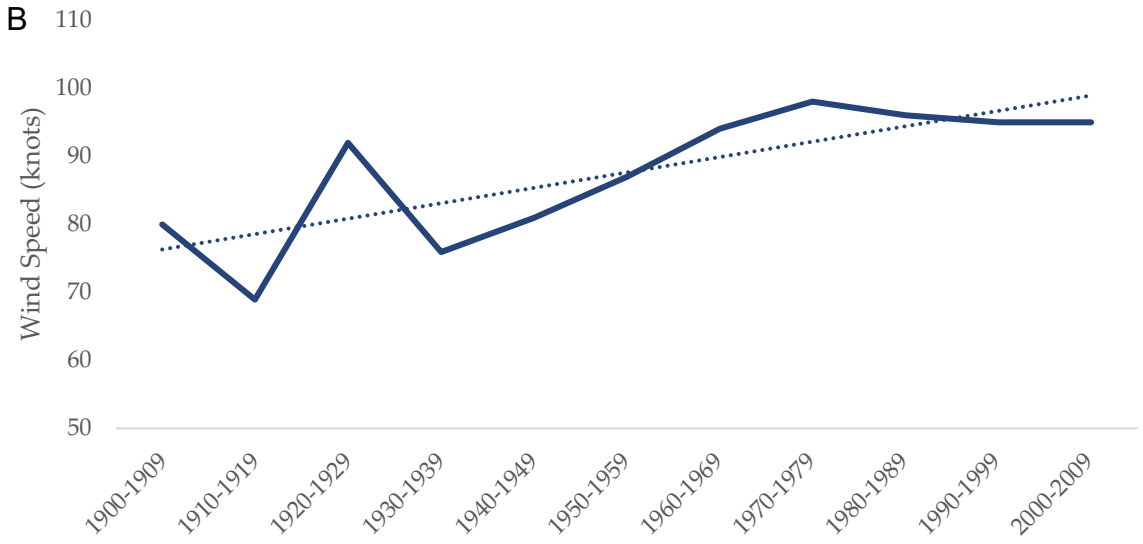
[171] Department of Environment. Rep. *National Gender Assessment Survey: The Economic Impact of Climate Change on Men and Women in Antigua and Barbuda.* St. John's , Antigua: Department of Environment, 2021.

Figure 5.6: Flooding Patterns in Antigua and Barbuda



Since 1995, the country has experienced 14 tropical storms and 15 hurricanes, five of which have been classified as category 4/5 hurricanes. The country experienced its first category 5 hurricane in 2017 with Hurricane Irma, followed by Hurricane Maria just a few weeks after. The return rate of Category 4 hurricanes in the first half of the 20th century was only one in 50 years, but a trend of increasing intense storms has been observed. The passage of Hurricane Irma/Maria in Antigua and Barbuda, with Barbuda bearing the brunt of this impact presents a case study for the devastating impact of increased hurricane intensity. In Barbuda, the combined value of destroyed assets and disruptions in the production of goods and services amounted to the equivalent of approximately 9 percent of the country's gross domestic product in 2016. The single most impacted sector was tourism which accounted for 44 percent of total damage costs, followed by housing which accounted for 37 percent of all damages. [172] In addition to the threat of another impending Category 4 hurricane to Barbuda, the severe impact to the provision of critical services such as education, healthcare, utilities and security resulted in the mandatory evacuation of Barbudans from the island for the first time.[173]

Figure 5.7: Average Wind Speeds of Tropical Storms and Hurricanes in the Eastern Caribbean



[172] Government of Antigua and Barbuda. 2018. Hurricane Irma Needs Assessment. Available at: https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda.

[173] ibid

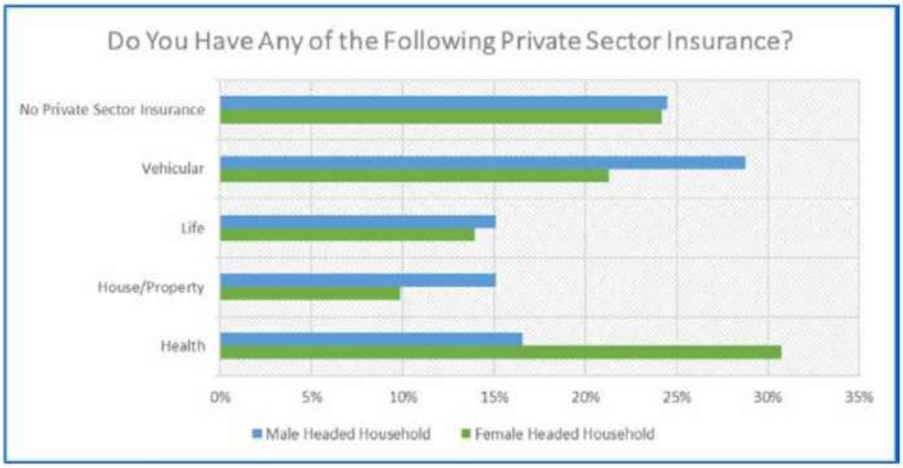
Figure 5.8: Aerial Image of Barbuda After Hurricane Irma 2017

The average personal damage for Barbudans was over Eastern Caribbean EC$25,000.00 with women paying over EC$1,000 more than male respondents for damages.[174] In Antigua, although the full impact of the disaster was not felt, persons reported paying EC$4000-EC$5000 on post disaster fixtures. [175] The inclusion of the yearly disaster preparedness cost meant that over 90 percent of Barbudans paid nearly Eastern Caribbean Thirty Thousand Dollars (EC$30,000.00) in hurricane expenditure for the year 2017 which accounted for between 50 percent to over 100 percent of their income. In addition, a survey of 100 Barbudans found that no Barbudans had house/property insurance. During consultations with Barbudan residents, businesses and local government in 2019, respondents noted the land tenure system in Barbuda as the reason for not having any form of house or property insurance, with the respondents indicating the requirements of the bank for land as an asset for insurance. Considering the option of other insurance packages for house/property which do not require ownership of land (e.g. Renter's Insurance), the lack of knowledge of other insurance options which local banks offer may be a reason for lack of house/property insurance in Barbuda.

Reconstruction expenses were reportedly covered through personal finances, the assistance of international NGOs and government[176].

In Antigua, less than 20 percent of households reportedly had house/property insurance with female -headed households less likely to have house/property insurance and most paid out of pocket for damages caused by Hurricanes Irma and Maria.

Figure 5.9: Private Sector Insurance Among Households in Antigua and Barbuda



[174] Department of Environment. Rep. *National Gender Assessment Survey: The Economic Impact of Climate Change on Men and Women in Antigua and Barbuda*. St. John's , Antigua: Department of Environment, 2021.

[175] ibid

[176] Department of Environment. Rep. *National Gender Assessment Survey: The Economic Impact of Climate Change on Men and Women in Antigua and Barbuda*. St. John's , Antigua: Department of Environment, 2021.

Critical Services

The passage of Hurricane Irma resulted in the following disruptions to critical services in Barbuda:

Healthcare

Healthcare in Barbuda is estimated to have suffered US$1,784,300 in damages with an additional US$65,200 in losses and incapacitated the ability of the hospital to deliver major services to the population. Labour and delivery services for example were no longer available on island, with women at 34 weeks advised to travel to Antigua to give birth.[177] Interviews with Barbudans placed in Antiguan shelters post Hurricane Irma noted mental health support as critical for Barbudans and all women interviewed noted psychosocial support as their top priority[178]. Workers in healthcare and education had to undergo three sessions of psychiatric evaluation prior to returning to work[179].

Education

Total damages and losses, including recovery needs for the education sector was estimated at US$4.62 million. Due to the mandatory evacuation from Barbuda, all Barbudan students were placed into primary and secondary schools in Antigua; a total of 162 primary students were placed in public primary schools while 66 students were

Figure 5.10: Barbuda Post-Hurricane Irma

accommodated by private primary schools. An influx of students was integrated into an already over capacitated public-school sector with limited space, and financial and human resources resulting in over worked teachers[180].

For both Antigua and Barbuda, the 2017 hurricane season with the passages of three consecutive hurricanes, delayed the 2017–2018 school year; in addition, some public-school buildings are identified as hurricane shelters for adjacent communities which require these buildings to be retrofitted for shelters during the season and returned to their intended state upon the reopening of schools, further delaying a return to normalcy.[181]

Security

Post Hurricane Irma, the police station in Barbuda was destroyed, causing police

[177] Interview with the Barbuda Health Officials

[178] Government of Antigua and Barbuda. 2018. Hurricane Irma Needs Assessment. Available at: https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda.

[179] Interview with the Barbuda Health Officials, 2019

[180] Government of Antigua and Barbuda. 2018. Hurricane Irma Needs Assessment. Available at: https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda.

[181] Environmental Social Impact Assessment/Management Plan for the project titled "Resilience to Hurricanes in the Building Sector in Antigua and Barbuda" 2020

officers and fire fighters to share the same building, most files from both the fire and police station were destroyed.[182] In addition to other essential services such as healthcare and education, the reduced capacity of security forces prevented a return to the island as well as normalcy for citizens. While crime remains relatively low in Antigua and Barbuda, post a natural disaster, global studies have found that, due to disorder property and gender crimes are more likely. Furthermore, post disaster scenarios require active security forces for stability and a return to normalcy.

Food Security - Water and Agricultural Produce

While largescale agricultural production has historically been limited in Barbuda, the island has had small productions of fruits and vegetables in home gardens for subsistence consumption with occasional sales. Livestock mainly comprised of goats, sheep, pigs and poultry[183]. The three main forms of water supply were affected in Barbuda after the passage of the hurricane. The damage consisted of (a) contamination of wells by floodwaters from the storm surge, (b) bacterial contamination of cistern water caused by debris resulting from extreme winds, and (c) damage to the osmosis plant infrastructure.[184]

Interviews with government officials in agriculture and residents engaged in home gardening in 2019 noted that since the hurricanes, they have been unable to engage in home gardening due to limited water supply and were thus heavily reliant on imported fruits and vegetables, more so than Pre-Irma.[185] In addition the increased use of can foods such as sugary drinks, salty food, pickled food and frozen vegetables has been incorporated in the Barbudan diet. Health officials noted more severe cases of diabetes and hypertension, with increased incidences in children due to the change in diet, stating that "the population can only eat what is available."[186]

Economic Access and Livelihood

Due to damages to the most productive sectors on the island, population also suffered loss of livelihood. As previously noted, the single most impacted sector was the tourism sector. While the majority of Barbudans are employed within the Public Sector (some 71 percent women and 60 percent of men) and would have continued to receive their salary after the hurricane passage, those within the informal sector, many with businesses in the tourism sector, suffered substantial loss of income through this avenue. In addition, many Barbudans utilize employment, whether formal or informal, in the tourism sector to supplement their primary income. This was identified as critical for the female labour force

[182] Interview with Security forces 2019

[183] Government of Antigua and Barbuda. 2018. Hurricane Irma Needs Assessment. Available at: https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda.

[184] Government of Antigua and Barbuda. 2018. Hurricane Irma Needs Assessment. Available at: https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda.

[185] Interview with Barbudan Council Member 2019

[186] Interview with Barbudan Residents 2019

in Barbuda where almost half (48 percent) were found to be employed in elementary occupations which falls into the lowest scale pay category. Of the 155 micro enterprises noted in Barbuda, around 42 percent are directly associated with the tourism sector.

Pre-Hurricane Irma in 2017, annual income estimates for tour guides who operate in the informal sector for example, through the use of conservative estimates, found that income before expenses could be as high as US$640,000 per year. An estimate of at least three (3) months impact on the tourism sector found that lost earnings for tour guides alone could be as high as US$160,000.00. [187] Considering the previous figure given for household income in Barbuda as of 2020, this data demonstrates the devastating income on livelihood caused by Hurricane Irma as well as the COVID 19 pandemic.

It was also noted that several of the businesses were carried out from the dwellings of the entrepreneurs, the census identified at least 40 such structures. These structures were also picked up as suffering damage during the housing survey, suggesting that small and micro enterprises have suffered both damage and loss which has not been estimated.

Table 5.3: List of Operational Micro Enterprises on Barbuda Before Hurricane Irma

Description of small business	Number
Tour Guides	10
Small hotels in the village area	5
Carpenters	10
Trucking	5
Guest Houses	20
Supermarkets	5
Small shops & clothing stores	10
Restaurants & Bars	10
Appliance & Furniture stores	2
Beauty Salon	5
Barbers	5
Bakery	2
Gas station	1
Taxis & Tour operators	10
Fishermen	20
Farmers	20
Mechanics	5
Contractors	10
Total	155

Source: Hurricane Irma Assessment

The incapacitation of the Fisheries sector by Hurricane Irma was detrimental for Barbuda as the fisheries sector impacts every Barbudan in some way, either as a source of income or as a food source[188]. Official statistics for Barbuda listed registered fisher persons as of 2016. informants indicated that almost all men on the island of Barbuda are involved in the fishing industry through various fishing activities while women were usually engaged in selling and preparing fish foods for sale. Using the sale of lobsters within the sector, three months lost within the fisheries sector due to the impact of Hurricane Irma was estimated to cost as much as US$72,000.[189]

[187] Government of Antigua and Barbuda. 2018. Hurricane Irma Needs Assessment. Available at: https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda.

[188] ibid

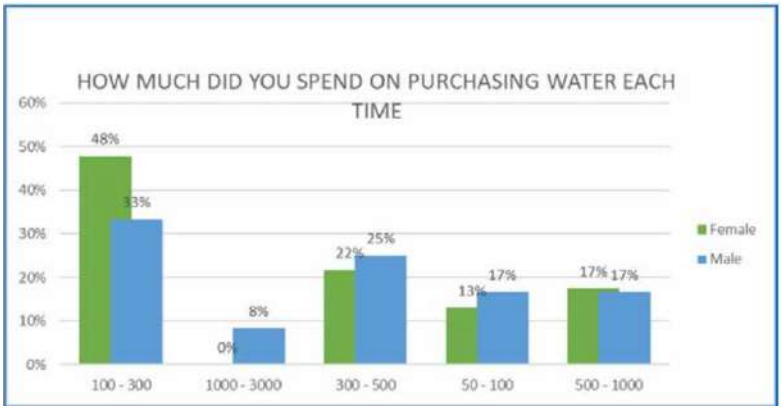
[189] ibid

In addition to direct hurricane events on Antigua and Barbuda , hurricane events in the wider region have had consequences for the country. During the passage of Tropical Storm Erika in 2018 and Hurricane Maria 2017, both of which occurred in Dominica, the GoAB coordinated the national and part of the international emergency relief and response to the affected population of Dominica including facilitating the evacuation of some Dominican families to Antigua. [190] This further compounded the capacity constraints of government agencies in Antigua in its goal to protect vulnerable families, including women.

Drought Conditions and Agriculture

Historically, Antigua and Barbuda has faced drought conditions; however, in recent years, these conditions have been prolonged, with the period 2013 – 2018 notable for its severity. During this period, it became more evident that water supply originated from rainfall accumulation in wells and run-off was not sufficient to meet the country's water demands. In addition, sea-level rise forced the country to abandon wells near coastal areas due to seawater intrusion into the freshwater lens. A combination of these factors resulted in overwhelming dependence on desalination plants with as much as 70 percent generated from reverse osmosis during what is considered the wet period and closer to 100 percent during very dry periods.[191] This is an energy-intensive activity, making the provision of water expensive for the country due to the dependence on imported fuel.[192]

Figure 5.11: Purchase of Water During Drought Period 2013-2019



Due to the expense of water provision, the country experienced water rationing in 2014 for the first time in 40 years, affecting 81 percent of the population whose main water supply is provided through the government[193] and forcing those, who were able, to purchase water from private companies in addition to paying their monthly utility bill when their cistern/tanks ran empty. Nationally, during this period, 12-13 percent of Antiguan households spent an average of EC$300 – 900 a month for additional provision of domestic water with rural communities paying over EC$1,000 on domestic water due to more severe water rationing; female headed households in rural communities paid even more due to the frequency with which they purchased

[190] Government of Antigua and Barbuda. 2018. Hurricane Irma Needs Assessment. Available at: https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda.

[191] Global Water Partnership Caribbean, and The World We Want. Rep. *National Stakeholder Consultations on Water: Supporting the Post-2015 Development Agenda - Antigua and Barbuda*, 2013.

[192] *Environmental and Social Impact Assessment and Management Plan for Variable Renewable Energy Integration to Decentralize Generation on Antigua*, 2019

[193] 2011 Census of Population and Housing. Report. St. John's, Antigua: Statistics Division (Ministry of Finance and Economy, 2014.

domestic water during a month.[194] Income disparity was also noted in the purchase of water whereby households earning less than EC$5,000 per month were less likely to purchase additional water, signaling that during severe water rationing, such persons are unable to access water once not provided through the local utility company or unavailable in their water tanks/cisterns.

Impact of Drought Conditions on Agriculture and Food Security

Figure 5.72: A Farmer in Antigua and Barbuda

Figure 6: Farmers in Antigua

As discussed throughout this report, persons within the agricultural sector are some of the most economically vulnerable to drought conditions and the impact to water security caused by hurricanes and tropical storms. During severe drought conditions, farmers indicated losses of 30-40 percent of their income despite the use of mitigation measures such as wide use irrigation, mulching to prevent evaporation from the soil, planting crops more resistant to dry spells or simply preparing the grounds for planting in the wet season which generally runs from September to November each year.[195] Farmers noted harmful effects on crops caused by intense drought periods, including the rise in pesticides which attributed to additional losses. Heavy rains as well as hurricanes are further attributers to losses for farmers due to fungus on crops caused by the residue of water as well as the loss of surface crops caused by the wind during hurricanes.[196]

[194] Department of Environment. Rep. *National Gender Assessment Survey: The Economic Impact of Climate Change on Men and Women in Antigua and Barbuda*. St. John's , Antigua: Department of Environment, 2021.

[195] Department of Environment. Rep. *Baseline Gender Assessment of Antigua and Barbuda Climate Change Program in Agriculture*. St. John's, Antigua: Department of Environment, 2021.

[196] Department of Environment. Rep. *Baseline Gender Assessment of Antigua and Barbuda Climate Change Program in Agriculture*. St. John's, Antigua: Department of Environment, 2021.

Income for livestock farmers is significantly dependent on the type of animal sold and the state of the animal – suggesting that drought and extreme heat would be significantly damaging to their income stream. In an instalment of "Vet Watch" in 2015, a weekly column in the Daily Observer highlighted the dramatic loss of local meat production, which is explained by a related anecdote with "Lennox at the Government Pound at Paynters says he is down to his last 100 bales of hay. Last year he made 15,000 bales of hay. This year he only managed 4,000.[197] This anecdote is supported by meat production figures provided through the Ministry of Agriculture for the years 2010-2014, in 2014, a severe drought period in Antigua, reduced meat production figures by over 50 percent.

The COVID 19 pandemic attributed to an already dire economic outlook for farmers in 2020 with farmers citing losses of 70 – 85 percent of their income due to the COVID 19 lockdown and other restrictions.[198] The adaptive capacity of farmers to respond to these impacts is incumbered by factors such as land insecurity, limited access to financial capital to respond to damages caused by climate change impacts as well as limited capacity within the few existing farmer associations.

Table 5.4: Meat Production Figures 2010-2014

Year	*Pork*	*Beef*	*Lamb*	*Goat*	*TOTAL*
2010	121,165	325,500	42,665	14,245	***503,575***
2011	164,689	336,000	25,515	7,140	***533,344***
2012	146,737	343,350	23,275	3,045	***516,407***
2013	90,977	267,750	12,478	5,040	***376,245***
2014	81,554	203,350	13,720	3,885	***302,509***

Over 90 percent of farmers in Antigua are reported to lease government land through the Ministry of Agriculture for farming activities. As the land is not privately owned, farmers are unable to use the land as collateral in order to access financing from financial institutions to implement adaptation measures or respond to the disaster costs caused by climate change impacts. Further, the climate risks associated with crops as well as livestock farming prevent farmers from accessing insurance. No insurance companies in Antigua currently provide insurance for farmers and only two (2) noted an interest in providing insurance if they received greater interest from farmers or by a case-by-case basis.[199]

An additional vulnerability for farmers as noted through interviews with local officials from the Ministry of Agriculture and local farmers was the lack of 'specialized personnel [particularly in business or financial management] on farms. Farmers were reported to replicate the same duties on the farm, i.e. planting, weeding, harvesting and utilizing agricultural equipment, with few demonstrating more advanced business initiatives. For example, the business plan required for leasing land through the Ministry of Agriculture only requires farmers to indicate the type of crop farmers intend to sell and the reason for selling this crop with no requirement for risk mitigation or investment strategies intended for the farm. During interviews and focus sessions conducted with farmers with an average acreage size of 20 or less indicated that they did not personally track their expenditure or spent more than they earned or had minimal profits from farming[200].

[197] Francis, Fiona (2015, July 27) Vet Watch "SOS: Goats and Sheep", The Daily Observer ; pp 20-21, Vol. 22 No. 172.

[198] ibid

[199] ibid

[200] ibid

Table 5.5: Insurance Companies Listed in Antigua and Barbuda

ABI Insurance Company Ltd	Provides marine insurance which covers fishermen's boats Have not yet considered farmers
Anjo Insurance Ltd.	- Does not cover fishing vessels, covers boats and yachts for leisure and businesses such as tours. - Have never considered providing insurance for farmers.
Caribbean Alliance Insurance	- Does not cover fishing vessels; covers boats and yachts for leisure and businesses such as tours. - Would only consider insurance for farmers which covered the building on their property.
State Insurance	- Provides coverage for fishing vessels but not the catch itself. A survey is done of the boat to determine whether the boat can be insured. - Provides the possibility of covering the building and equipment for farmers.
Sagicor General Insurance	- Provides coverage for fishing vessels but not the catch itself. A survey is conducted of the boat to determine whether the boat can be insured. - Has not considered providing insurance for farmers related to their business.
Kenneth Gomez and Sons (is an agency for Netherlands Insurance)	- Does not cover fishing vessels; covers boats and yachts for leisure and businesses such as tours. - Has never considered providing insurance for farmers.
Antigua Insurance Company Ltd.	- Does not cover fishing vessels; covers boats and yachts for leisure and businesses such as tours. - Have never considered providing insurance for farmers.
Selkridge Insurance (this company is connected to the American Life Insurance Ltd. Co)	- Does not cover fishing vessels; covers boats and yachts for leisure and businesses such as tours. - Has never considered providing insurance for farmers.
Sun General Insurance (Head Office in Barbados)	- Provides insurance for fishing vessels subject to an evaluation of the vessels. - Provides insurance for buildings on farms against fires - Would consider insurance for crops on a case-by-case basis through a written proposal.
PIC insurance	- Does not cover fishing vessels; covered boats and yachts for leisure and businesses such as tours - Has never considered providing insurance for farmers
General Insurance	- Provides coverage for fishing vessels although there are no fisherfolk currently covered by the company.

ABI Insurance Company Ltd	Provides marine insurance which covers fishermen's boats Have not yet considered farmers
	- Provided an opportunity for farmers to have business insurance, but did not receive enough applications to proceed with a farmer's program.

During interviews conducted with farmers, less than half of the respondents thought the assistance through the government was sufficient, and most, particularly crop farmers did not have confidence in existing farming associations to provide substantial assistance. [201] Based on the experience of Team Fresh, which has been unable to organize due to lack of leadership or gathering from farmers, this concern by farmers is warranted.

The Fisheries Sector is also affected by water quantity and drought conditions as water is needed for storage and icing of fish, cleaning and related processing activities; sanitation and hygiene are some of the factors unique to the fisheries sector. Fishers also noted winter-swells and groundswells, which are not directly elaborated in Antigua and Barbuda's Climate Change Program, as a continual cause of loss and damage for the fisheries sector. [202] Damages to the Fisheries Sector from hurricane passages are usually to the fishing vessels. Most fisher persons participated in and are entitled to social security benefits[203] based on interviews with insurance companies, there has been willingness by some insurance companies to insure the boats of fisher persons. [204] However, this only accounted for 36 percent of insurance companies contacted and these companies strictly provide insurance for fishing vessels and not the business or 'catch' (See Table 5.5). Notably, others were willing to cover boats and yachts for leisure or touring businesses, but not for businesses associated with fishing. In addition, as with farming, income through the formal fisheries sector can be seasonal, affecting their ability to respond to risk. This is concerning for the fisheries sector as more than half of the income of persons in the fisher sector is earned through fishing.[205]

Formally, both the farming and fisheries sector are male dominated; men accounted for over 70 percent of registered farmers while latest data collected as of 2017 did not record any registered females in the fisheries sector, either as fishers, fish processors or fish vendors.[206] The average age for individuals in the fisheries sector was 50. In the farming sector, although younger individuals were more prevalent in northern districts, it was

[201] Department of Environment. Rep. *Baseline Gender Assessment of Antigua and Barbuda Climate Change Program in Agriculture.* St. John's, Antigua: Department of Environment, 2021.

[202] Asesoramiento Ambiental Estrategico. Rep. *Baseline Conditions for the Mainstreaming Financial Resilience to Climate Change in Antigua and Barbuda Project.* St. John's, Antigua: Department of Environment, 2021.

[203] Tietze, U. and Van Anrooy, R. 2018. *Assessment of insurance needs and opportunities in the Caribbean fisheries sector,* FAO Fisheries and Aquaculture Circular No. 1175. Rome, FAO.

[204] Department of Environment. Rep. *Baseline Gender Assessment of Antigua and Barbuda Climate Change Program in Agriculture.* St. John's, Antigua: Department of Environment, 2021.

[205] Tietze, U. and Van Anrooy, R. 2018. *Assessment of insurance needs and opportunities in the Caribbean fisheries sector,* FAO Fisheries and Aquaculture Circular No. 1175. Rome, FAO.

[206] Tietze, U. and Van Anrooy, R. 2018. *Assessment of insurance needs and opportunities in the Caribbean fisheries sector,* FAO Fisheries and Aquaculture Circular No. 1175. Rome, FAO.

Figure 5.13: Dry-Docking Fishing Vessels ahead of Hurricane Irma, Point Wharf Fisheries Complex, Antigua

generally challenging to engage younger people in the sector.[207]

The dominant role of women was noted in the unregistered segments of the farming and fisher sectors. In the farming sector, women reportedly played a bigger role in backyard farming as well as trading produce, while interviews with officials in the fisheries sector noted women in processing and handling.[208] Unlike the formal segment of the sectors, there remains limited data on the impact of climate change and COVID 19 on persons in the 'unregistered' segments of the two sectors

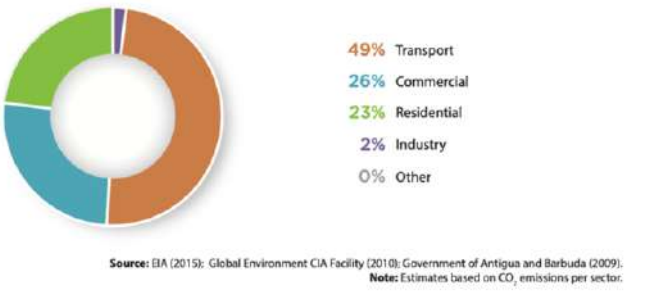
In addition, to the impact on persons employed directly and indirectly in the agriculture sectors, food security for the wider society is compromised due to less availability of produce, resulting in higher costs which impact the most vulnerable. Drought conditions resulted in low harvest yields which require vendors to depend on imported produce, increasing cost to operations. Small businesses are then forced to sell produce at a more expensive rate, disadvantaging the most vulnerable populations who depend on affordable agricultural produce from the local market or village shops.[209]

Gender and Energy Access

The energy sector includes *electricity generation* and *fuel use in transportation* and *fuel use for commercial or domestic consumption by households*. Electricity may again be used to supply several sectors, the residential sector (households), industry, businesses and services (e.g. tourism), and electricity for e-mobility in the transport sector. Figure 5.14 shows the shares of the different end-use sectors of energy for 2012 and illustrates the structure and interlinkages of the sectors in Antigua & Barbuda.

Antigua and Barbuda has a high fossil fuel import dependency, as it does not have any

FIGURE 5.8: Energy Consumption by Sector, 2012



Source: (Inter-American Development Bank 2015)

[207] Department of Environment. Rep. *Baseline Gender Assessment of Antigua and Barbuda Climate Change Program in Agriculture*. St. John's, Antigua: Department of Environment, 2021.

[208] Asesoramiento Ambiental Estrategico. Rep. *Baseline Conditions for the Mainstreaming Financial Resilience to Climate Change in Antigua and Barbuda Project*. St. John's, Antigua: Department of Environment, 2021.

[209] Department of Environment. 2020. Innovative technologies for improved water availability to increase food security in Antigua and Barbuda.

known fossil fuel resources, the country imports 100 percent of the petroleum-based products it uses. Fuel types imported are used for different purposes, motor gasoline and diesel are used in road transport, with diesel also being used for diesel generators and marine transport.

Electricity

By virtue of the Public Utilities Act 1973, the Antigua Public Utilities Authority (APUA), a government-owned and operated company, is the sole distributor of electricity on island. Antigua and Barbuda has achieved universal access to electricity and around 98.75 percent of the country's population had access to clean fuels and technologies for cooking in 2016 (World Bank 2020). However, electricity prices in Antigua and Barbuda are among the highest in the Caribbean region with the cost of electricity having increased to over US$0.40 cents per kWh.[210]

These high electricity prices harm the provision of essential services, small businesses and low- and middle-income households. A national survey conducted by the DOE found that most households in Antigua and Barbuda paid 7-10 percent of monthly income on electricity with the share spent on electricity decreasing as household income rose, thus providing greater benefits for richer households than for poorer households. [211] This cost is notable considering that respondents predominately indicated utilizing the energy conservation tips published by the local utility company with most noting that their electricity bill did not change despite applying these tips. Most respondents did not consider their electricity cost reasonable relative to their usage.[212] A further survey conducted through Global Green Growth (GGG) found that 10 percent of households in Antigua are spending more than 20 percent of their household income on electricity. These households had the lowest monthly income and were in receipt of financial support. [213] Female headed households, which were generally single-parent households, were overrepresented in the lower-income percentile with a high

Figure 5.9: Average Cost of Electricity in Homes

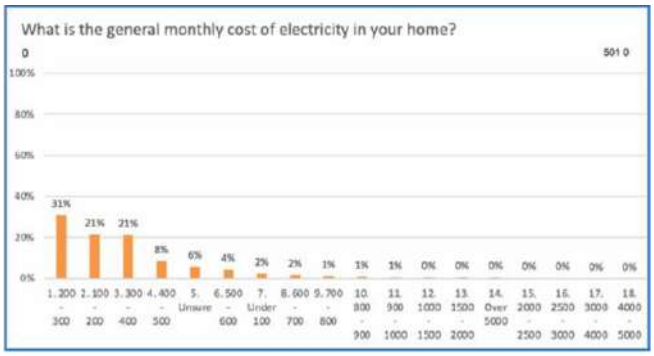


Table 5.6: Number of Households by Parish, Number of Air Conditioning Units in Dwelling Unit

		Number of Air Conditioning Units in Dwelling Unit				
Parishes	Total	0	1	2-3	4+	Not stated
Total	*30,213*	*26,292*	*2,081*	*813*	*190*	*837*
St. John City	7,879	6,958	308	83	12	518
St. John Rural	10,568	8,697	1,100	493	130	148
St. George	2,932	2,496	206	55	8	167
St. Peter	1,829	1,731	68	19	8	3
St. Philip	1,139	1,069	57	9	4	0
St. Paul	2,809	2,613	144	44	8	0
St. Mary	2,512	2,243	151	98	19	1
Barbuda	545	485	47	12	1	0

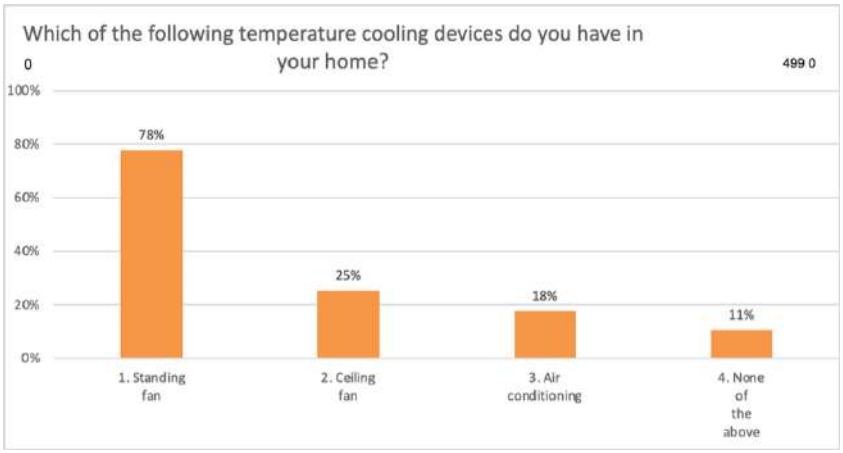
[210] Department of Environment. Rep. *Antigua and Barbuda's First Biennial Update Report*. St. John's, Antigua and Barbuda: Department of Environment, 2020.

[211] Department of Environment. Rep. *Baseline Gender Assessment of Antigua and Barbuda Climate Change Program in Agriculture*. St. John's, Antigua:

[212] ibid

[213] Global Green Growth Institute. Rep. *Acceptability and Affordability of Renewable Energy Household Survey Report*. St. John's, Antigua and Barbuda: Department of Environment, 2020.

Figure 5.10: Temperature Cooling Devices Within Households



electricity cost to income ratio, adding to the increased cost of living during the COVID-19 pandemic. [214] As Antigua and Barbuda continues to be impacted by increased air temperature, the need for household cooling devices such as air conditioners will increase. This has already been observed as the 2011 Population and Housing Census noted household air conditioning units among 8 percent of the population while a 2020 survey has noted an increase of 10 percent in households with air conditioning in their dwelling unit.[215] Coupled with the impact of hurricanes on the grid, the current energy system, is expected to cost 20-50 percent more by 2025, further increasing electricity costs for households.[216]

In addition to electricity costs frequent power outages on island also impact electricity access for the population and has been reported to also cause damage to household electric devices due to a surge or other form of instability once the power returns. This is evidenced by recent surveys conducted through the DOE which found that as much as 30 percent of households and around 65 percent of businesses (hotels, restaurants, private businesses) in Antigua and Barbuda have back-up energy. [217] An increase in hurricanes and superstorms also result in power outages due to possible damages to the grid. In 2017 for example, the passage of Hurricane Irma resulted in the entire power system including, diesel generators, overhead cabling, and the majority of the island's power distribution poles being damaged, resulting in some residents reporting loss of power through the local power utility company for as long as six months.[218]

Electricity access for critical services on island such as healthcare and education is also compromised by frequent power outages

Figure 5.17: Local Clinic in Antigua

[214] Department of Environment. Rep. *Socio-Economic Impact of Electricity Costs in Antigua and Barbuda*. St. John's: Department of Environment, 2020.

[215] Government of Antigua and Barbuda. 2011. Population and Housing Census.

[216] Department of Environment. Rep. *Socio-Economic Impact of Electricity Costs in Antigua and Barbuda*. St. John's: Department of Environment, 2020.

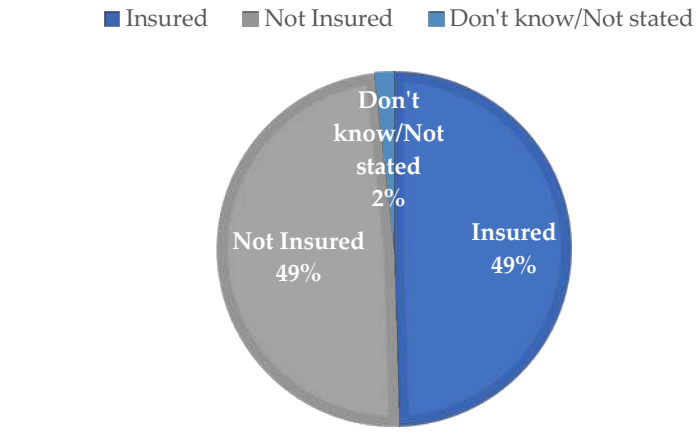
[217] Department of Environment. 2020. *Antigua and Barbuda Fourth National Communications: Mitigation Chapter*

[218] Government of Antigua and Barbuda. 2018. Hurricane Irma Needs Assessment. Available at: https://www.gfdrr.org/en/publication/hurricane-irma-and-maria-recovery-needs-assessment-antigua-and-barbuda

annually as well as after a natural disaster. A technical evaluation of around 33 percent of registered educational institutions on island found that only 18 percent had back-up energy, leaving the vast majority without electricity during power outages. This was found to be a deterrent for providing education services and after a storm, delayed the resumption of schools. This delayed women from returning to their respective livelihoods or any form of normalcy as they occupied the central role for childcare within an average household. Local educators noted the impact of limited formal educational services for boys who reportedly continue to struggle in schools and thus require continued formal education[219]

Healthcare services, such as local clinics, particularly those in rural areas, also reported impacts to electricity access due to lack of back-up energy. Around 50 percent of the Antiguan and Barbudan population rely solely on the public health clinics, majority of whom are persons in poverty or within a lower income bracket , those in critical medical conditions, HIV/AIDS patients and the mentally ill.[220]

Figure 5.11: Population by Health Insurance Status



Source: Antigua and Barbuda 2011 Population and Housing Census

Transportation

The Transport Sector is heavily dependent on fossil fuel imports, with around 97.3 percent of the vehicle fleet running on gasoline and the balance powered by diesel oil. According to the Antigua and Barbuda Transport Board, there were a total of 54,891 registered vehicles in the country as of 2020.[221] A 2020 survey of residents in Antigua found that most respondents owned a private vehicle with male respondents noted in a higher percentage of persons with a private vehicle. Over 50 percent of respondents owned a used vehicle rather than a new vehicle. Women were more likely than male respondents to depend on public transportation and were thus most affected by any deficiencies in public transportation or increase in fares related to an Energy Transition.[222]

Energy Transition

Due to Antigua and Barbuda's dependence on fossil fuel imports, Antiguans are reported to pay on average 7 – 10 percent of monthly household income on their electricity bill, with 10 percent of households, notably those with the lowest monthly incomes, spending more than 20 percent of their household income on electricity. The electricity cost is despite the

[219] Department of Environment. 2021. Environmental Social Impact Assessment for the Increasing the Resilience of the Education System to Climate Change Impacts in the Eastern Caribbean

[220] Department of Environment. 2020. Environmental Social Impact Assessment for the Resilience to Hurricanes in the Building Sector in Antigua and Barbuda.

[221] Department of Environment. 2020. *Antigua and Barbuda Fourth National Communications: Mitigation Chapter*

[222] Department of Environment. Rep. *Baseline Gender Assessment of Antigua and Barbuda Climate Change Program in Agriculture*. St. John's, Antigua

uptake of energy conservation tips by households such as limited use of air conditioning generally as well as other conservation tips proposed by the local utility company.

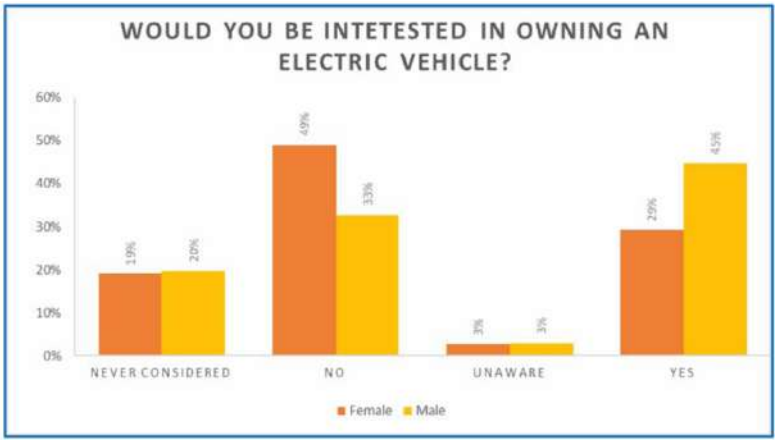
The impact is particularly notable for female-headed households who are overrepresented in the lower-income pentile and have a higher income to electricity cost ratio. In Barbuda, electricity cost is reported to be heavily subsidized in comparison to Antigua with the government bearing the cost borne by fossil fuel. Based on estimates from the local utility company, continued dependence on fossil fuel for electricity generation is expected to result in an increase in annual electricity generation from the 2020 value of 370GWh to 425GWh by 2031, an approximate 15 percent increase over the next 11 years. [223] The popularity of used vehicles in Antigua and Barbuda regardless of income is a good indicator of the importance of 'low upfront cost' or affordability when purchasing vehicles.

In addition to electricity costs, the electricity grid is susceptible to the impact of hurricanes with damage to the grid resulting in limited access to electricity for long periods of time. Roughly 30 percent of households reportedly have back-up energy, with low-income households and female-headed households less likely to have back-up energy. Other critical sectors including education and healthcare still suffer from power outages and many institutions, particularly in education, remain without back-up energy.

The updated NDCs seek to reduce Antigua and Barbuda's dependence on fossil fuel in electricity generation by over 80 percent. The levelized cost of energy (LCOE) is expected to reduce under a renewable energy transition with a likely reduction in electricity cost for households. The NDCs continue its vision for back-up renewable energy in 100 percent of identified critical services with the updated NDCs recognizing the difference in access to back-up energy for men and women; as such, the updated NDCs particularly notes the provision of back-up energy through renewable sources for 100 percent of female headed households.

Energy Transition in the transport sector is marred by high upfront cost for electric vehicles in comparison to ICE vehicles as well as limited knowledge of EVs, particularly among women. Nationally, men remained more supportive of an energy transition in the transport sector through EVs while women were less receptive to this change mainly based on limited knowledge on electric vehicles and its operations, a belief that the Antiguan and Barbudan infrastructure was not equipped for such vehicles and misinformation on electric vehicles.[224]

Figure 5.19: Interest in EVs by Sex



[223] Department of Environment. 2020. *Antigua and Barbuda Fourth National Communications: Mitigation Chapter*

[224] Department of Environment. Rep. *National Gender Assessment Survey: The Economic Impact of Climate Change on Men and*

Income notably played a part in a respondent's interest in EVs; nationally, persons who earned over EC$4,000 a month indicated interest in owning an electric vehicle while on a community level, only persons who earned over EC$7,000 a month indicated an interest in owning an electric vehicle.[225]

The proposed energy transition in the Transport sector is heavily dependent on increased knowledge of EVs, particularly among women who appear less knowledgeable and likely to use EVS and the reduced cost of EVs over time due to limited maintenance compared to ICE vehicles. In addition, through its 'coupling of the energy sector, the DOE is introducing the use of EVs as energy storage for households, thus maximizing the economic benefits of EVs. Financial mechanisms can also be explored to support households in covering the up-front cost of EVs as based on the income of persons more likely to be interested in purchasing an EV (persons earning in excess of EC$4,000.00 per month), the average person is less interested in purchasing an EV due to upfront cost (the average person earns between EC$3,000 - EC$4,000 per month).

Just Transition of the Workforce

The proposed energy transition is dependent on a transition in the workforce, among other infrastructural and legislation changes. Preliminary estimates of the proposed NDC energy transition in the workforce note that substantial employment benefits are expected compared to the fossil-fuel dominated Business-as-Usual scenario, particularly in the infrastructure field and provides the opportunity for more women to enter technology-related fields in electricity and transport as the technical fields in these areas are male dominated.[226]

It is also expected that learning effects would also increase productivity over time and the employment impacts may settle at a more moderate level like the employment in the BAU. [227] However, while the overall employment transition is expected to be positive, with transferable skills in administrative fields, certain job groups may face challenges due to less adaptable skill sets that hinder a smooth transition. The two most notable fields identified were mechanics for ICE vehicles as well as service attendants at the relevant gas stations; these are gendered fields, with men overwhelmingly as mechanics

Figure 5.120: Promotional Shoot from the West Indies Oil Company

Source: West Indies Oil Company

Women in Antigua and Barbuda. St. John's , Antigua: Department of Environment, 2021.

[225] ibid

[226] Climate Analytics (2021). Towards a Just Transition of the Workforce – Baseline Analysis for the Electricity and Road Transport Sectors in Antigua and Barbuda.

[227] Climate Analytics (2021). Towards a Just Transition of the Workforce – Baseline Analysis for the Electricity and Road Transport Sectors in Antigua and Barbuda.

and women predominately identified as gas station attendants.

Based on expert interviews, in the long term, EVs are less repair intensive than ICEVs as they require less maintenance compared to ICEVs. While official data identify around ninety (90) employed mechanics in Antigua and Barbuda, further interviews suggest a substantial number of self-employed or informally employed mechanics for ICEVs which are likely not represented in official statistics exist. The estimated actual number of jobs related to ICEV repair including self-employed and informal mechanics is likely around 225 jobs and the field is overwhelmingly male.[228] Based on interviews with agencies such as MegaPower, which imports and maintains electric vehicles in Antigua, a higher share of electronic components as compared to mechanical components require different and additional skills for EVs as compared to ICEVs, including training for proper and safe handling of high voltage components

While formally trained mechanics may be able to transition based on the assumption that they would have generally received required technical understanding at an educational/vocational institution, interview partners highlighted that many of the self-employed or informally employed mechanics have often not undergone formal training for repairing cars and may find it challenging to access or afford successful formal retraining to acquire these skills and transition to EV repair. [229] During interviews with students currently enrolled at ABICE for mechanical training, most students noted that enrollment for mechanical training generally meant that they could no longer work, or their work hours were decreased to facilitate their training, thus leaving them completely dependent on family for financial support.[230] According to ABICE officials, this was a major deterrent for many in the field as most men were breadwinners or expected breadwinners for their home and could not afford to risk access to income.[231] Considering that informally employed mechanics appear to compose of more than 50 percent of persons in the field, a transition of the workforce would be challenging for this group, making them particularly vulnerable during an EV transition. In response to these challenges, the updated NDCs include the development of a gender-responsive approach to the just transition of men in the energy and construction sectors with the consideration that these sectors are over 90 percent male and should consider the roles

Figure 5.131: A Mechanic in Antigua

and responsibilities for men which may impact their transition. The updated NDCs also

[228] ibid
[229] ibid
[230] Interview with ABICE Students 2020
[231] Interview with ABICE Officials 2020

identify opportunities women-led businesses in the transition.

Another group identified by the DOE's Energy Transition study is the service attendants at gas stations, most of whom were identified as female household heads, including single mothers. Data suggests that about 190 people currently work in gas stations in Antigua and Barbuda.[232] With an envisaged phase out of ICEVs in the NDC scenario, it is expected that the demand for this kind of job will decrease proportionately to the decrease in the ICEV stock; for these service jobs, there is no direct equivalent which would require comparable skills with regard to charging of EVs[233], leaving these group particularly vulnerable in a transition. The updated NDCs note opportunities for advancing women in the transition through women-led companies in energy. Policy measures may also be explored for identifying new employment opportunities for this group.

[232] Climate Analytics (2021). Towards a Just Transition of the Workforce – Baseline Analysis for the Electricity and Road Transport Sectors in Antigua and Barbuda.

[233] ibid

CHAPTER 6

CONSTRAINTS AND GAPS

Context – Constraints and Gaps

The constraints from the first National Communication to the fourth remain consistent, but as climate change is having an actual impact the financial, technical and institutional are all providing additional perspectives. The mainlines being:

1. Capacity for Risk Management and Mitigation. Transitional and political risks are not well known, documented and mitigation measures put in place.
2. The Financial gaps include loss and damage and funding for readiness have been put in place and currently being designed and implemented.
3. The just transition of workers and businesses to allow them to survive the transition.
4. The ability to meaningfully include women, and social inclusion and the use of NGOs and other sectors to co-implement projects and programs.

This chapter will speak to the various constraints and the cross-cutting gaps.

FINANCIAL CONSTRAINTS

Overcoming Financial Constraints

Sustainable Island Resource Framework Fund

Another critical part of the institutional architecture that facilitates climate action in Antigua and Barbuda is the Sustainable Island Resource Framework Fund (SIRF Fund). One of the functions of the DOE is "*managing and administering*" the SIRF Fund. The SIRF Fund, a special fund of the Finance Administration Act 2006, was established to "*serve as a financing mechanism,*" inter alia:

1. "For the implementation in Antigua and Barbuda of Multilateral Environmental Agreements;
2. To build ecosystem resilience to the impacts of climate change;
3. To support programs and measures for climate change adaptation, climate change mitigation, climate change loss and damage; and

4. To give financial support to vulnerable groups and communities for disaster preparedness, disaster recovery and rehabilitation."

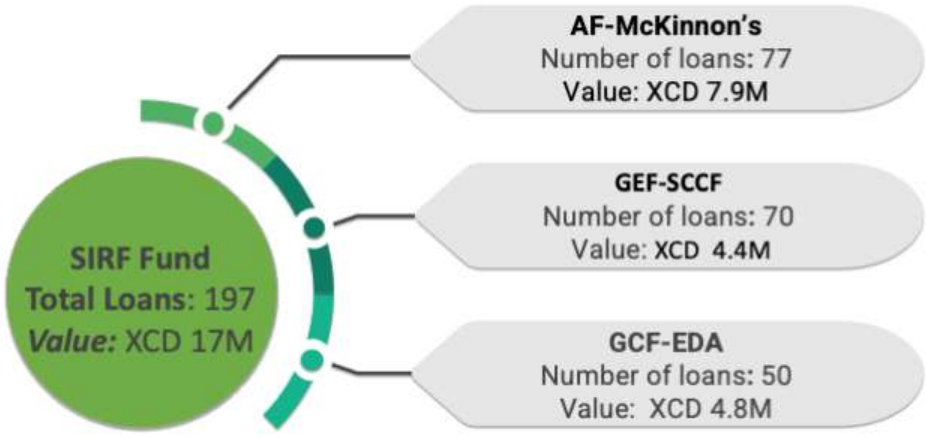
The 2019 EPMA, Part XII Section 91 establishes the SIRF fund and states that it shall be administered in accordance with the provisions of of the Finance Administration Act 2006. Additionally, the 2019 EPMA requires that the SIRF Fund "prepares periodic environmental, social and gender impact statements of the Fund's operations, projects and programs."

The SIRF Fund will be used to pilot innovative financial mechanisms to promote locally led adaptation action. As of May 2022, funding from three projects has been channeled through the SIRF Fund to provide low-interest loans to support the implementation of adaptation projects. The total channeled into SIRF Fund loans as of May 2022 is EC$17 million, with 66.5 percent of females (131) accessing loans, while 32.5 percent male (64), and 1 percent as businesses (2). The projects under which these loans were accessed are as follows:

1. Building Climate Resilience through innovative Financing Mechanism for Climate Change Adaptation funded through GEF's SCCF;
2. An Integrated Approach to Physical Adaptation and Community Resilience in Antigua and Barbuda's Northwest McKinnon's Watershed project funded by the AF; and
3. Integrated Physical Adaptation and Community Resilience Through an Enhanced Direct Access Pilot in the Public, Private, and Civil Society Sectors of Three Eastern Caribbean Small Island Developing States Project (EDA Project), funded by the GCF.

These programs are discussed in the Ongoing Adaptation Actions section below. Another project identified that will soon be channeled through the SIRF Fund is the Path to 2020 project, which will pilot a mix of grants and loans to support farmers, biodiversity conservation, and mainstreaming activities.

Figure 14: SIRF Fund Loans Disbursed



Safeguards and Prohibited Practices

The DOE is subject to the Prevention of Corruption Act No. 21 of 2004, which elaborates the definitions and scope of corrupt and fraudulent activities and outlines the legal penalties for such actions for public officials. The execution of its functions, including managing and implementing Antigua and Barbuda's climate change portfolio, is therefore governed by this legislation. The DOE as an Accredited Entity to the GCF is also required to adhere to its Prohibited Practices Policy that establishes the specific conduct and activities that are prohibited by the GCF, the obligations of Covered Individuals and Counterparties to and the actions which the GCF may take when prohibited practices are alleged to have occurred in funded activities.[234]

Technology Constraints

The cost of technology in Island states are at least twice that of countries with larger markets. Further the transitional risks from one technology to another can be very high. With the high cost and high and unknown risks the cost of borrow for transitions can be high. This is one of the main reasons that the SIDS are so vulnerable to high debt to GDP ratio as they try to adopt technologies that is driven by public debt rather than the private sector leading the way as in the case in larger markets.

To minimize this risk the country has prepared a TNA with associated policies that details the risks and barriers. The DOE is also testing a bulk purchasing approach to procuring technologies to reduce cost and monitor quality. This approach is being tested and will be ready for report in 5th National Communication.

Institutional Constraints

The Government of Antigua and Barbuda has also emphasized strengthening and reforming its national policies and institutional structures in support of the country's efforts to address the adverse impacts of climate change.[235] The framework allows for undertaking Climate action in an inclusive, participatory, and gender-responsive manner. The 2019 EPMA conferred to the DOE the legislative authority to *"coordinate climate change policies and activities… and all environmental management functions performed by all governmental and non-governmental entities and statutory authorities,"* within Antigua and Barbuda. In that regard, the DOE identified the need for continued strengthening of national systems to facilitate climate change adaptation implementation, building resilience to climate change and enhancing the adaptive capacity of nationals. The ongoing national adaptation efforts under this framework have culminated in the most recent NDC 2021 and the NAP project (2024). Each of these documents expands on the overarching adaptation goal for Antigua and Barbuda and the key national documents (policies, strategies, and plans) to support Antigua and Barbuda's adaptation goals.

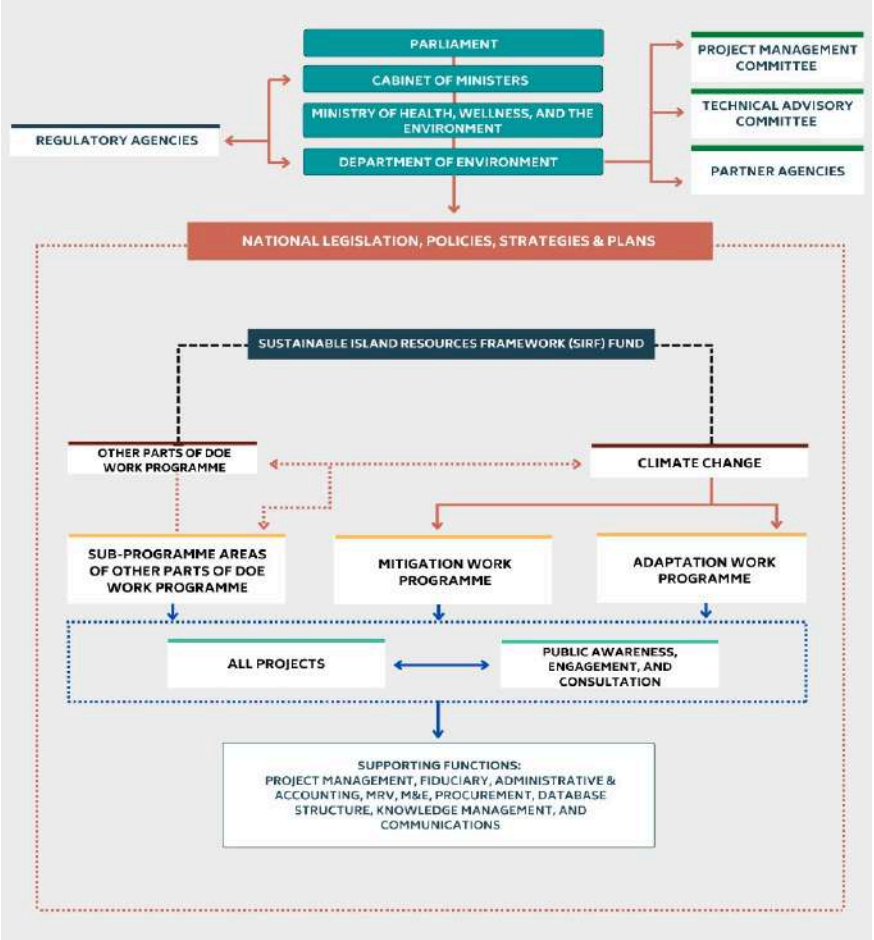
The Climate Change Work Program is one of four priority areas on which the DOE coordinates. The other programs are Biodiversity, Pollution Control, Monitoring and Evaluation and Data Management. The Adaptation Work Program is one of two sub-

[234] https://www.greenclimate.fund/sites/default/files/document/policy-prohibited-practices.pdf

[235] DOE. 2020. Antigua and Barbuda, Country Program Strategy

programs under the Climate Change Work Program area of the DOE. All DOE Work Program areas are supported by key functions, namely: Monitoring and Evaluation, Measuring, Reporting and Verification, Fiduciary Functions, Database Structures, such as the National Environmental Data and Information System (NEIS) and Natural Resource Inventory (NRI), and Accounting and Administrative support.

Figure 15: Institutional Arrangements to Support Climate Change Adaptation and Mitigation



Climate Action NAPs and NDC

Ongoing NAP projects currently under implementation are supported by this structure, as are other adaptation priority projects identified herein. The DOE reports to the highest level of government through the Minister responsible for the environment. The DOE is also accountable to regulatory agencies such as the Development Control Authority (DCA) and Transport Board. The Ministry of Agriculture, Fisheries and Barbuda Affairs, the Ministry of Social Transformation and Ocean Governance, and the Ministry of Urban Development all play supporting roles in the work of the DOE.

To support the DOE's work, including its Adaptation Work Program, a Technical Advisory Committee (TAC), which includes representatives from 17 key government agencies, three non-governmental organizations (NGOs), and one private sector coalition, meet monthly. This multi-sectoral consultative body provides technical guidance and policy recommendations and facilitates communication and cooperation between relevant stakeholders during project identification, development, and implementation.[236] Engaging the TAC allows for incorporating socio-economic and environmental considerations, broader dissemination of information, understanding the expectations of stakeholders, and managing challenges which may arise in executing activities under the Adaptation Work Program. It also allows these agencies to report on the actions of their agencies with

[236] Ibid

respect to climate change adaptation. Additionally, the Project Management Committee and partner agencies also support project activities.

Human Resource Constraints

Antigua and Barbuda faces the challenges of a much larger country, despite having a population of only 100,000. This requires the government and its citizens to strategically manage their limited resources. Through sector coupling and strong technical assistance, the country is making significant progress in securing financing and implementing impactful projects. Further details on these efforts are provided in other chapters of this report and will not be repeated here.

Cross Cutting Constraints

1. Capacity for Risk Management and Mitigation. Transitional and political risks are not well known, documented and mitigation measures put in place;
2. The Financial gaps include loss and damage and funding for readiness have been put in place and currently being designed and implemented;
3. The just transition of workers and businesses to allow them to survive the transition;
4. The ability to meaningfully include women, and social inclusion and the use of NGOs and other sectors to co-implement projects and programs.

These cross-cutting issues are discussed in other chapters and will not be repeated here. The Country however has completed detailed assessments in all four cross cutting areas and can be made available.

Regional and Sub-Regional Architecture for Climate Change Implementation

The Caribbean Community (CARICOM) Heads of Government (HOGs) mandated the Caribbean Community Climate Change Centre (CCCCC) to support Member States in their climate change response. Through legacy initiatives such as Caribbean Planning for Adaptation to Climate Change (CPACC), Antigua and Barbuda embarked upon a path to build capacity for climate change adaptation along with other CARICOM states.

The Organization of Eastern Caribbean States (OECS) St. George's Declaration of Principles for Environmental Sustainability (SGD) 2040 identifies its climate change goal as *adequately addressing at all levels "the risks and vulnerabilities associated with climate change and natural/environmental hazards and their impacts on natural and human systems"* (OECS, 2020)[237]. SGD 2040 contains eight objectives to support this goal.

These regional and sub-regional frameworks and their associated early actions sought to foster an enabling environment for the implementation of climate change adaptation actions in CARICOM and OECS Member States, including Antigua and Barbuda.

Integrating Climate Change into Systems and Processes in Antigua and Barbuda

Through overarching policy frameworks like the Medium-Term Development Plan, the 2021 Medium-Term Development Strategy,

[237] OECS. 2020. SGD 2040- An Environmental Agenda for the Eastern Caribbean

and the 2020 Economic Recovery Plan, Antigua and Barbuda provides a strengthened enabling environment. This will facilitate the public and private sectors, as well as CSOs, to prioritize climate change adaptation and mitigation in their systems and processes. Several sectors and agencies in Antigua and Barbuda have embarked upon the process of integrating climate change responsiveness into their planning processes and systems.

The youth sector specifically identifies ways to amend processes to factor in climate change adaptation, as elaborated in the 2021 Youth Policy. Similarly, through a collaborative approach, the Ministry of Social Transformation and the Blue Economy has also embarked on this approach for its two priority areas: Gender and the Blue Economy. On gender, in the absence of a gender policy, it has worked with the DOE to ensure that its processes are gender responsive while elaborating a more overarching policy framework with support from the Caribbean Development Bank.

Additionally, the 2021 National Youth Policy also addresses gender issues. Regarding the Blue Economy, its policy framework identifies action items that are responsive to climate change. The tourism sector will continue its steps through its sustainable tourism initiative, where environmental protection features as a key pillar of the approach. The water sector recently developed an adaptation plan that focuses on all aspects of operations to ensure resilience in the face of climate change. In the infrastructure sector, the resilience of buildings has been factored in as well with the updating of the building codes.

The Overarching Climate Goals for Antigua and Barbuda

Antigua and Barbuda's contribution to the GGA is being undertaken through the previously described national adaptation planning framework. This goes beyond the ongoing work within the DOE and extends to work currently being undertaken by various sectors, both public and private, as well as CSOs, in reframing processes, elaborating policies and strategies, and implementing actions that are responsive to climate change adaptation. Through the monitoring and evaluation of currently implemented and planned adaptation actions, Antigua and Barbuda will be able to report on their contribution to the GGA.

The NAP project for Antigua and Barbuda undertaken through a NAP readiness grant from the GCF is providing an evidence-based adaptation planning approach, which will continue to mainstream climate change adaptation in the operations across sectors in Antigua and Barbuda. It focuses on a "*hybrid approach, incorporating sector focused adaptation planning with broad national assessments, to form a comprehensive strategic plan for national adaptation planning.*" Finance, protected/managed areas, infrastructure and housing, tourism, food security, and wholesale and retail have all been identified as priority sectors to contribute to the GGA through the NAP Readiness project.[238]

238 Department of Environment. 2020c. Antigua and Barbuda Updated Nationally Determined Contribution for the period 2020 – 2030.

Key Policies, Strategies, and Plans to Support the Adaptation Goal

National Adaptation Planning (NAP) Readiness Project 2017–2022: Antigua and Barbuda's NAP is seen as instrumental in supporting the country's contribution to the GGA. The NAP implementation seeks to be responsive to DOE's 2018 Gender Policy as well as its 2018 Environmental and Social Safeguards Policy. Through this project, Antigua and Barbuda seeks to:

1. Develop adaptation baselines through data collection, compilation, and comprehensive climate change risk mapping;
2. Conduct Vulnerability Risk Assessments (VRAs) and develop adaptation plans for up to three government agencies, three communities/NGOs, and three private sector entities using a learning-by-doing capacity building approach;
3. Conduct Strategic Impact Assessments (SIAs)—approved by the Cabinet and published in the Gazette, and prepare the NAP in accordance with national law; and
4. Develop a sustainable financing strategy to facilitate the development of additional SIAs.

The DOE has advanced significant work under the NAP project. Under outcome one, Habitat Mapping and Exposure, datasets have been developed through the climate change risk modelling component. Sectoral guidelines with step-by-step guidance on how to conduct vulnerability and adaptation planning assessments in public sectors are well advanced.

The NAP project also advanced work under the Escazú Agreement, promoting access to justice and access to information under project Outcome 2. In addition, under Outcome 3, sectoral adaptation plans for the finance, infrastructure and housing, food security, tourism, wholesale and retail, and public sector are underway. Local area adaptation plans for Antigua and Barbuda's MRV System Framework 2021 supports the country's efforts towards the GGA by tracking outcomes related to various strategies and plans, including[239]:

1. Outcomes that formed the focus for the 2015 Intended Nationally Determined Contribution (iNDC 2015);
2. The updated 2021 NDC and associated emission reduction strategies;
3. The NAP;
4. Antigua and Barbuda's Climate Finance Strategy developed from the report on the *Assessment and Overview of Climate Finance Flows: Antigua and Barbuda 2014- 2017*; and
5. Associated strategies around the transition of the workforce from fossil fuel-based energy systems to renewable energy systems.

The Repositioning Antigua and Barbuda for Dynamic, Sustainable, and Resilient Growth – Report by the Technical Drafting Sub-Committee to the Economic Recovery Committee 2020- highlights the governments' priorities in its quest for resilient growth. This

[239] Goodwin, Justin. GGGI. 2021. Antigua and Barbuda Climate Change Monitoring Reporting and Verification (MRV) system framework

is intended to be achieved through a two-pronged approach. The first focuses on stabilization and the second on repositioning the economy for growth. It elaborates sector plans for tourism, housing and infrastructure, agriculture, waste management, and sustainability, environment and renewable energy, trade and entrepreneurship, and cultural industries and sports. A number of the planned and ongoing climate change projects, including resilience building and adaptation, are featured in the Environment and Renewable Energy Sector Plan.

GCF Country Program (GCF-CP) 2020: Antigua and Barbuda presented an updated Country Program to the GCF featuring projects that will respond to the synergies between climate change and sustainable development. It identified the following adaptation priorities:

1. Improving water security
2. Improving energy sector resilience
3. Increasing flood and hurricane intensity resilience
4. Increasing resilience in buildings
5. Improving the protection of beaches and coastal areas
6. Protecting watersheds and waterways

Country Program Strategy 2020: The DOE elaborated a strategy for implementing its GCF Country Program (CP). This strategy situates the GCF-CP and the proposed pipeline within the context of Antigua and Barbuda's climate change vulnerabilities. It also underscores the strategic impact of GCF support, and the approach taken to ensure that extensive baseline research is undertaken through a consultative process. This approach involves determining the technical and financial feasibility of the pipeline, as well as mapping the human, institutional, technical, and capacity requirements.

Department of Environment's Gender Policy – 2018: The DOE's Gender Policy elaborates its approach to achieve gender mainstreaming that is responsive to the requirements of its key multilateral partners while at the same time conforming to the legislative requirements of the 2019 EPMA. The policy:

i Calls for stakeholders' rights to privacy and confidentiality;
ii Requires that relevant information on a project or sub-project activity's environmental, social, or gender risks be made accessible and understandable to stakeholders;
iii Requires that the DOE conducts gender due diligence through Gender Impact Assessments (GIAs) at the overall portfolio level as well as the individual project level for higher risk projects; and
iv Makes allowances for monitoring and compliance.

In addition, it provides guidance on standards and practices related to the gender impact assessment of projects, environmental principles, substantive standards, and practices on environmental protection, building regulations, land use development and planning, and enforcement.

Department of Environment's Environmental and Social Safeguards Policy (ESS) – 2018: Drawing upon various laws in Antigua and Barbuda, including the 2019 EPMA, the DOE's ESS policy seeks to promote social responsibility and sustainable development in its operations. The ESS provides for:

1. Environmental, social, and gender screening of projects;
2. Determination and assessment of environmental, social, and gender risks and impacts of projects, including through consultations with stakeholders and vulnerable communities;
3. Access to information and full participation in the decision-making process for stakeholders, especially vulnerable communities;
4. Safeguards and mechanisms to mitigate risks and negative environmental, social, and economic impacts associated with projects;
5. Access to justice in environmental matters related to social safeguards and gender issues for affected parties in the form of a functional and efficient Complaints Mechanism;
6. Cooperation with partners to build capacity in risk mitigation and facilitate implementation of environmental, social, and gender safeguards; and
7. Monitoring and evaluation.

Intended Nationally Determined Contributions (iNDC) – 2015: Adaptation targets identified in Antigua and Barbuda's iNDC are as follows:

1. By 2025, increase seawater desalination capacity by 50% above 2015 levels.
2. By 2030, all buildings will be improved and prepared for extreme climate events, including drought, flooding, and hurricanes.
3. By 2030, 100% of electricity demand in the water sector and other essential services (including health, food storage, and emergency services) will be met through off-grid renewable sources.
4. By 2030, all waterways will be protected to reduce the risks of flooding and health impacts.
5. By 2030, an affordable insurance scheme will be available for farmers, fishers, and residential and business owners to cope with losses resulting from climate variability.

Readiness and Reporting

Preparatory activities are critical to ensure the successful implementation of climate change actions, including those specific to adaptation. Antigua and Barbuda received funding through various channels to support the capacity building and readiness work required to facilitate successful climate change action.

To date, Antigua and Barbuda has received approval for five readiness grants through the GCF totaling US$4.8 million, with US$2.8 million accessed. This amount includes US$3 million for NAP actions.[240] These Readiness activities have supported the strengthening of CSOs, regional and sub-regional institutions, as well as national agencies in Antigua and Barbuda, including the DOE.

It has since implemented four of the Readiness proposals from the GCF, which aimed at supporting the county in delivering progress in institutional strengthening, country

[240] GCF. 2017. https://www.greenclimate.fund/sites/default/files/document/readiness-proposals-antigua-and-barbuda-ministry-health-and-environment-adaptation-planning.pdf

coordination, meeting fiduciary and ESS standards of the Fund, accrediting a Direct Access Entity, national adaptation planning and accelerating its pipeline development. This resulted in the approval of two GCF-funded activities (FP061 and FP133). The country is preparing to implement its fifth GCF Readiness proposal. This proposal focuses on NDC implementation to support the country's transition to a low emission, climate resilient economy able to reasonably withstand the new climate projections from the IPCC.

Through the AF, US$0.025 million in grants was accessed to support the review of the DOE's Environmental and Social Safeguards (ESS) and Gender Policy, as well as the review of the DOE's manual for processing loans and revolving funds. Additionally, Antigua and Barbuda received support for its reporting requirement to the UNFCCC, with funding allocated primarily through the GEF for its three national communications previously submitted as well as its fourth, which is currently being implemented. Funding for elaborating its First Biennial Update Report (BUR1) was also provided through the GEF. Antigua and Barbuda accessed US$0.020M through the NAP Global Network and the International Institute for Sustainable Development (IISD) for the elaboration of this ADCOM.

Synopsis of Some Ongoing Climate Projects in Antigua and Barbuda

In keeping with the overarching adaptation framework, Antigua and Barbuda has implemented several climate change adaptation projects and programs with adaptation components over the years. These projects and programs are not only undertaken by government agencies, but also by the private sector and CSOs. Funding sources for projects vary and include local communities, the Government of Antigua and Barbuda, other friendly governments, private sector organizations, and international agencies. A summary of some key adaptation projects and programs reflecting this mix of funders and implementers is provided below.

Climate Change Adaptation of the Eastern Caribbean Fisheries Sector (CC4FISH) Project:[241] - Antigua and Barbuda is one of seven participating islands in this project, which benefited from a US$5.4 million grant through the SCCF administered by the GEF, with the FAO as the implementing agency. In addition to strengthening the capacity of 772 fisherfolks in information and communications technology through training, providing information and communications technology (cellphones, global positioning systems) and 1,100 VHF radios, this project seeks to develop the *mFisheries@sea mobile* application and the *mFisheries@sea* web portal in five of the project countries. The project also seeks to rehabilitate existing aquaculture centers and establish new ones. The project has developed the Regional Vulnerability and Capacity Assessment (VCA) Framework and Methodological toolbox for the sector. Training of trainer activities have been carried out in four countries, with one country having carried out VCAs. In addition to COVID-19 related challenges, limited human and technical capacity has contributed to project delays.

[241] The GEF. 2021. FAO-GEF Project Implementation Report 2020

Green Barbuda Electricity Project: This project demonstrates funding for adaptation action from various sources. Funders were the Government of the United Arab Emirates, the CARICOM Development Fund, the Government of New Zealand, the Government of Antigua and Barbuda, the Barbuda Council, and the Antigua Public Utilities Authority. The project consists of the installation of a new electricity power station supported with a 720-kilowatt (kW) solar photovoltaic facility and an 863-kilowatt-hour (kWh) battery storage solution that will store and stabilise electricity from the solar plant. Site clearance, detailed engineering and procurement, and shipments of equipment were completed in early 2021.[242] This project sought to respond to the devastation on Barbuda during the 2017 Atlantic Hurricane season with hurricanes Irma and Maria.

VCA and Disaster Risk Reduction Planning in Parham Town: Under the Inter-American Foundation-funded CSOs for Disaster Resilience (2019-2022) Project, the Environmental Awareness Group of Antigua and Barbuda supported the highly vulnerable fishing community in Parham Town by conducting VCAs and disaster risk reduction (DRR) planning activities. These would inform the design of pilots to address the identified issues. Parham Town is located within one of the six main watersheds with a mangrove system, seagrass beds, and a coral reef system which has been adversely impacted by development and observed climate impacts. These actions have reduced the climate resilience of this fishing community. Some of the climate-related impacts observed by the community based on this project activities are fishing grounds including coral reefs and seagrass beds (fish nurseries) affected by sargassum; coral reefs damaged by storms and hurricanes causing a decline in fishing grounds and the inability of fishers to get a good catch of fish; backyard farming affected; and soil erosion and flooding undermining property. The top priority identified by the community is addressing the major hazard of drought.[243]

An Integrated Approach to Physical Adaptation and Community Resilience in Antigua and Barbuda's Northwest McKinnon's Watershed: This US$10M AF project with the DOE as the implementing agency, sought to reduce vulnerability to the impacts of extreme rainfall by improving the built environment within McKinnons. This project benefited 200 individuals directly and 4,500 individuals indirectly. Three kilometers of waterways were restored, complying with new adaptation requirements for flooding and vector control, factoring in environmental, social, and gender considerations.[244] The project sets an initial target of five percent of this vulnerable community accessing low-interest loans through the SIRF Fund to engage in climate-proofing of their dwellings.[245] A good practice of this project was its emphasis on improving the adaptive capacity of community groups and incorporating social and gender considerations in its implementation.

[242] Antigua Newsroom. 2020. Green Barbuda Electricity Project Implementation Proceeding. https://antiguanewsroom.com/green-barbuda-electricity-project-implementation-proceeding/

[243] Environmental Awareness Group. 2021. Report on Vulnerability and Capacity Assessment (VCA) and Disaster Risk Reduction (DRR) Planning in Parham Town, Antigua.

[244] Adaptation Fund. 2021.

[245] Ibid

Building Climate Resilience through innovative Financing Mechanism for Climate Change Adaptation (SCCF)[246]***:*** This project aimed to facilitate access to adaptation finance for citizens of Antigua and Barbuda through the establishment of an adaptation window of the SIRF Fund. Five million United States Dollars (US$5 million) in grant funding was provided from the SCCF and administered through the GEF with the UN Environment Program (UNEP) as the implementing agency.

In addition to the adaptation window, the project seeks to, *inter alia*, improve the capacity for integrating innovative financing for adaptation into the policy and planning of key agencies—such as the DCA and Ministry of Works (MoW)—and conduct pilot interventions for climate change adaptation in vulnerable communities and sectors. To date the following has been accomplished:

1. The Revolving Fund loans program was developed, and consultations were undertaken with government and homeowners. All funds under the program have since been disbursed to its target community;
2. The SIRF Fund Board has been constituted;
3. Detailed costings for adaptation actions for roads and waterways have been determined;
4. Hydrological, topographical, and other data for inputs into the development of three Local Area Plans for the targeted watersheds have been collected;
5. Cost-effective pilot interventions in McKinnon's watershed, Woods Pond, and the waterway, as well as Friars Hill Road, have advanced.

The project also reviewed the previously updated building code to ensure resilience to major hurricanes. A good practice of this project is its demonstrated coherence and complementarity with ongoing projects. The project had to overcome delays in the bidding process for rehabilitation works and local area plans.

Integrated physical adaptation and community resilience through an Enhanced Direct Access (EDA) pilot in the public, private, and civil society sectors of three Eastern Caribbean SIDS[247] [248]: This US$20 million project seeks to improve the resilience of communities, homes, governments, and business in Antigua and Barbuda, Grenada, and the Commonwealth of Dominica. The EDA utilizes grants and loans, managed through a transparent process, as a means of supporting individuals in the participating countries with their continued efforts of financing climate change adaptation and disaster recovery. The project will award US$ 9 million to pilot public adaptation infrastructure projects and provide US$3 million in small adaptation grants to CSOs and US$6 million in concessional micro-revolving loans to households and businesses. To date, 78 homeowners in Antigua and Barbuda have

[246] The GEF. 2019. UN Environnent GEF PIR Fiscal Year 2019

[247] GCF. 2021. Projects and Programs-FP061- Integrated physical adaptation and community resilience through an Enhanced Direct Access pilot in the public, private, and civil society sectors of three Eastern Caribbean small island developing states https://www.greenclimate.fund/project/fp061 and DOE. 2018. *Project Factsheet*-Integrated physical adaptation and community resilience through an Enhanced Direct Access pilot in the public, private, and civil society sectors of three Eastern Caribbean small island developing states https://www.environment.gov.ag/assets/uploads/attachments/8d5f4-eda-factsheet_eda-rfp-eastern-caribbean_v2.pdf

applied for loans; thus far, 45 have been approved. No loans and grants have been distributed in Dominica and Grenada.

A major strength of this project is its efforts in the sub-regional scaling of policy, oversight, and fiduciary functions. COVID-19 has been a major drawback for the implementation of this multi-country project. One of the lessons learned is the challenge of working across multiple governments with agencies at various levels of capacity, which can have implications for the pace of progress of the overall project. This project is currently under implementation.

Resilience to Hurricanes in the building sector in Antigua and Barbuda:[249] [250] With a US$32 million grant from the GCF, Antigua and Barbuda commenced addressing the resilience of the national building sector. This will be done by climate-proofing critical public service and community building; mainstreaming climate change adaptation in the building sector and a relevant financial mechanism; and strengthening climate information services to allow for early action in responding to climate events. This project seeks to benefit 73,000 individuals directly by reducing their vulnerability in the aftermath of an extreme climatic event, contributing to their health by improving the provision of clean water and increasing the operability of clinics during a storm. This project is currently in the early stages of implementation and was launched in late 2021.

Enabling Gender-Responsive Disaster Recovery, Climate and Environmental Resilience in the Caribbean (EnGenDER):[251] The project seeks to "*further integrate gender equality and human-rights based approaches into disaster risk reduction (DRR), climate change (CC) adaptation and environmental management frameworks and interventions and identify and address some of the gaps to ensure equal access to DRR and climate change and environment solutions for both men, women, boys and girls.*" Antigua and Barbuda is one of nine participating countries. Intermediate and immediate outcomes are as follows:

1. Enhanced practices of relevant actors for the sustainable implementation of gender-responsive climate change action and disaster recovery;
2. Improved national capacity for gender-responsive climate change adaptation and mitigation planning and implementation among state and non-state actors in the target countries;
3. Improved integrated recovery planning and frameworks at the national and regional levels for gender-responsive and resilient disaster recovery by key vulnerable groups;
4. Improved governance by relevant actors for gender-responsive climate and risk resilience planning and decision-making in nine Caribbean countries; and
5. Increased application of gender equality and rights-based approaches by national climate change and DRR coordinating bodies.

Through the EnGenDER Project, Antigua and Barbuda sought to elaborate a Sectoral

[249] GCF. 2021. Projects and Programs- FP133 Resilience to Hurricanes in the building sector in Antigua and Barbuda https://www.greenclimate.fund/project/fp133

[250] DOE. 2020 FP133 Resilience to Hurricanes in the building sector in Antigua and Barbuda. https://www.greenclimate.fund/sites/default/files/document/fp133-doe-atg-antigua-and-barbuda_0.pdf

[251] UNDP. 2021. Enabling Gender-Responsive Disaster Recovery, Climate and Environmental Resilience in the Caribbean https://www.bb.undp.org/content/barbados/en/home/about-us1.html

Adaptation Plan (SASAP) for the financial sector. To date, a capacity needs assessment for the financial sector has been undertaken and the SASAP has been elaborated. The capacity assessment highlighted the following needs:

1. Governance, leadership, and structure with which to address and adapt to climate change;
2. Processes, procedures, and tools used to integrate climate change into planning and prioritisation;
3. Access to and quality of climate change information, data, and analysis, as well as the capacity to monitor, generate, and use climate change information, data, and analysis;
4. Implementation, monitoring, and evaluation; and
5. Resources (human and financial) for addressing climate change.

Additionally, an in-workshop ranking exercise was conducted and the following four recommended activities for building climate resilience in the financial sector were proposed. They are listed in the order prioritized.

1. Develop, adopt, and employ climate risk management practices;
2. Develop and adopt gender-disaggregated adaptation metrics and standards;
3. Build the capacity of the sector to integrate climate change considerations into operations and governance; and
4. Promote and accelerate adaptation investment opportunities for all.

Proposed Future Actions to Support Climate Change Actions

As mentioned previously, the Government of Antigua and Barbuda has identified its priority areas for resilience building and adaptation action through its NAP project. These are Finance, Protected/Managed Areas, Infrastructure and Housing, Tourism, Food Security, and Wholesale and Retail. Sectoral adaptation guidelines, also developed under the NAP readiness program, allow for a more tailored approach to adaptation planning across the sectors and serve as a blueprint for future use. The NAP will also facilitate the development of a private sector engagement strategy that will explore soliciting domestic finance to fund adaptation actions. This is in addition to a legal manual to support the integration of access to information related to environmental management and climate change action among the public and other key stakeholders, such as the Antigua and Barbuda Bar Association. Work under the NAP project, therefore, supports the adaptation framework by contributing to the strengthening of capacities and processes in key sectors to build a robust system for continued adaptation action. This supports the whole-of-country approach in Antigua and Barbuda's efforts towards the GGA through adaptation actions by all stakeholders in the public and private sectors as well as civil society. The guidelines and tools developed through the NAP project all facilitate the strengthening of the enabling environment by improving systems and building capacities to facilitate long-term adaptation.

Efforts by NGOs such as the EAG, which conducted VCAs, provide a good example of this approach. By working with Parham Town—a fishing community with an

approximate population of 1,500—key vulnerabilities in the community, as well as possible solutions and the priorities for taking action to reduce risk, especially from hurricanes and climate extremes, were identified. [252] The solutions and priorities identified will form part of the continued work to be undertaken outside of government, albeit supporting the national efforts towards the GGA.

Through its GCF Country Program, Antigua and Barbuda identified various projects which will support its proposed contribution to the CCA, if approved. In that regard, debt for climate swaps and social inclusion investment programs are featured. Major adaptation investment opportunities focus on an economy-wide just transition associated with a reduced reliance on fossil fuels for energy and transport. Antigua and Barbuda's proposed pipeline for the GCF includes the following four adaptation projects and one Multi-year Readiness Program, which will address both adaptation and mitigation needs, (indicated in Table 2). The Multi-year Readiness Program has been approved by the GCF.

Table 6.1: GCF Country Program Priority projects

Title	Objective/ Description	Funding amount requested	Implementation Timeline
A blueprint for adapting road infrastructure to projected climate extremes in Antigua and Barbuda[253]	This project seeks to respond to extreme climate events which Antigua and Barbuda is already experiencing, and which are expected to become more severe based on climate projections. It will build on the existing Road Infrastructure Rehabilitation and Reconstruction Program (RIRRP) to increase the climate resilience of critical road infrastructure and utilities in Antigua and Barbuda. In particular, the proposed project will climate-proof four primary roads and their associated infrastructure as well as adapt target utilities to withstand the impacts of extreme climate events, including Category 4 and 5 hurricanes, as well as climate-induced floods and droughts.	USD 27M (grant)	TBD
Transformation of the Finance Sector Fund to	The project will mainstream climate-resilient investment and de-risking options into Antigua and Barbuda's key	TBD	TBD

[252] Environmental Awareness Group. 2021. Report on Vulnerability and Capacity Assessment (VCA) and Disaster Risk Reduction (DRR) Planning in Parham Town, Antigua.

[253] DOE. 2020. "Antigua and Barbuda Climate Change Country Program 2020".

Title	Objective/ Description	Funding amount requested	Implementation Timeline
meet the needs of climate change insurance and resilience in the fisheries and agriculture sector in Antigua and Barbuda. [254]	economic sectors, including agriculture and fisheries. It has two primary objectives: 1. To build climate resilience in the financial sector; and 2. To strengthen the resilience of farmers and fisherfolk to improve food security. Financial resilience will be created by developing alternative finance models, focusing on financial tools to de-risk investments and improve insurance options, particularly for farmers and fisherfolk. The project will also increase climate resilience prior to and after extreme climate events by engaging the private sector to facilitate investment in climate-smart adaptation interventions in these sectors, as well as rebuilding following extreme events. In addition to the financial resilience, the project will work with farmers and fisherfolk to build the resilience of their livelihood activities to extreme events, including exploring options for renewable energy and land/ocean management frameworks by: 1. Assessing financial exposure to climate change; 2. Developing and piloting climate-resilient financial products/solutions targeting the private sector, including agriculture and fisheries, households, and public sector management frameworks;		

[254] Ibid

Title	Objective/ Description	Funding amount requested	Implementation Timeline
	3. Developing new legislation and regulations for new climate-resilient financial services that are in line with OECS standards; 4. Establishing the knowledge base and data systems to implement financial risk reduction solutions that are scalable and replicable nationally, as well as across the Caribbean region. A GCF concept note and Project Preparation Facility application are currently under development to inform the full funding proposal.		
Antigua and Barbuda Debt for Climate Swap	The proposed project considers options for a trilateral Debt for Climate Swap with the GCF and the country's Paris Club member creditors. Under the proposed debt swap arrangement, GCF funds would support or partially finance the redirection of Antigua and Barbuda's ~USD 147M in debt towards domestic investment in climate change projects. This would include: (i) financing: (ii) negotiations with creditors; (iii) establishment of legal and contractual frameworks; (iv) reaching of agreements with all relevant participating institutions (e.g., GCF, DOE, MOF, and Paris Club); (v) capacity building and institutional development of relevant government and financial institutions; (v) development of the operational procedures and policies for the SIRF Fund. A GCF Multi-year Readiness, currently under review will produce some of the outputs to inform this project.	TBD	TBD
Supporting the transition to a	To respond to the impacts of climate change on Antigua and Barbuda's	TBD	TBD

Title	Objective/ Description	Funding amount requested	Implementation Timeline
low-carbon and resilient economy in Antigua and Barbuda through the just transition of the workforce[255]	energy sector and achieve the mitigation targets in the country's updated 2020 NDC, the Government of Antigua and Barbuda is initiating a transition within the sector from a centralized grid dependent on fossil fuels, towards the long-term national goal of 100 percent renewable energy. This shift will have considerable negative impacts on the livelihoods of workers in fossil fuel-dependent industries, as well as downstream industries which support, *inter alia*, electricity generation and road transportation, in the absence of urgent interventions to facilitate the transition of the country's workforce towards operating in a low-carbon economy. To ensure that all members of the labour market can maintain an acceptable standard of living both during and after these transitions, the proposed project will initiate a just transition of the workforce. This will be achieved through the: provision of skills and capacity development; ii) facilitation of access to financial resources; and iii) creation of a knowledge-sharing system to record best practices and lessons learned. The Department of Environment will execute the project.		
Multi-year Readiness Supporting Antigua and Barbuda's	Antigua and Barbuda's 2021 NDC targets outline the government's climate targets to accomplish its catalytic role in a gender-responsive transition to a low-emission, climate-	USD 2.74M	2021-2023

255 DOE. 2021. Concept Note- Supporting the Transition to a low carbon and resilient economy in Antigua and Barbuda through the Just Transition of the Workforce.

Title	Objective/ Description	Funding amount requested	Implementation Timeline
NDCs implementation towards a transformation to Climate Resilient and Low-Emission Development Pathway by 2030[256]	resilient economy. The country's readiness needs are consequentially linked to accomplishing its 2021 NDC targets. Moreover, the government envisions that it will perform this catalytic role through its proposed climate change project pipeline while managing transitional risks via programs for the just transition of the workforce, enhancing respective enabling environments for thematic areas, and social investment. This readiness will support Antigua and Barbuda's efforts at addressing these targets and goals by establishing a sound foundation for this accomplishment of these medium- to long-term commitments via the proposed project pipeline and accompanying strategy. The multi-year approach to addressing these readiness needs will support the effective and efficient completion of the comprehensive baseline work for these goals and targets and the corresponding project pipeline.		

During the consultation process for elaborating the ADCOM, stakeholders were asked to identify priority adaptation needs for Antigua and Barbuda. The following were submitted through an online survey:

1. Coastal areas strengthening
2. Water conservation
3. Food, water, and energy security
4. Populating baseline data
5. Financial resources

Noteworthy is the fact that the NAP project is addressing the priorities identified by stakeholders. Additionally, the GCF Country Program and its supporting strategy mirror some of the priorities identified by stakeholders, in particular, the emphasis on food, water and energy security and financial resources.

[256] DOE, 2021. Multi-year Readiness Supporting Antigua and Barbuda's NDCs implementation towards a transformation to Climate Resilient and Low-Emission Development Pathway by 2030

Economic Diversification Plans

The Medium-Term Fiscal Strategy (MTFS) 2021-2023, presented by the Ministry of Finance and Corporate Governance of Antigua and Barbuda, sets out the steps that the government wishes to undertake in charting its course towards economic recovery in the wake of impacts of the COVID-19 pandemic. Fiscal resilience guidelines and a Medium-Term Fiscal Framework support this strategy. Short- to medium-term economic recovery for Antigua and Barbuda will be assisted by the development of entrepreneurship, food security, energy and environmental sustainability, and enhancing the role of the public sector. One of the revenue enhancement initiatives identified by the MTFS 2021-2023 is the capitalization of a Climate Resilience and Development Fund (CRDF) from a Tourism Accommodation Levy (TAL) applied to hotels, AirBnB rentals, guest houses, apartments, and villas.

The Economic Recovery Plan 2020, identifies the need for actionable projects to catalyze the private sector, fuel employment and stimulate the economy over the short to long term. The focus on repositioning the economy through continued diversification, improving linkages between energy, sustainability, and resilience; improving food security and specifically, water sustainability and agriculture, and diversifying tourism products are all identified as priorities.

Just Transition of The Workforce

Following COP 21, many nations have realized the need for assistance in achieving goals established in Paris and outlined in their NDCs. Antigua and Barbuda requested support from the UNFCCC Climate Technology Centre and Network (CTCN) for developing a workforce strategy to mobilize local labour to implement projects in fulfillment of the country's First NDC. The CTCN selected the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) to partner with the DOE on this endeavor, the key outcomes of which were a stakeholder workshop and a workforce strategy.

Building on the information collected during a stakeholder workshop, the workforce strategy identifies short, medium, and long-term actions for Antigua and Barbuda to enhance local capacity to implement priority energy sector projects that can help the country to meet its NDC. The workforce strategy includes the purpose and objectives, a budget for program development and implementation, and key stakeholders and their roles in implementation. The document also describes the expected workforce breakdown, the baseline skills profile of the islands of Antigua and Barbuda, and anticipated areas of skills shortages. The strategy defines the objectives of the workforce and training activities, as well as actions needed to achieve these objectives. The document then goes on to note potential partner organizations, including regional and international finance and development institutions.

Meaningful Stakeholder Involvement

Over the past decades, many Multilateral Environmental Agreements (MEAs) have been developed in response to global challenges associated with the loss of biodiversity and the production and use of chemicals. One established goal is strategic partnerships which includes civil society and private sectors working together to achieve global results through concerted action and coordination.

Many Caribbean countries in Latin America and the Caribbean (LAC) region have signed on to MEAs which are agreements between three or more states to assist with addressing specific environmental problems at regional and global levels. However, most countries, similar to Antigua and Barbuda, still struggle with mainstreaming them into national policy, management, and legislative frameworks. Notwithstanding this, the country is determined to embark on an ambitious GCF program geared toward transformational change and addressing climate change.

This program is coordinated with the other MEAs and their respective objectives e.g., protecting critical and threatened biodiversity, and effective management of substances and chemical components. To accomplish this, the environmental governance system needs to be reviewed for meaningful participation of all. There is a need for more attention to the full and effective application of Principle 10 of the Rio Declaration which guarantees that everybody, including individuals in vulnerable situations, has access to timely and reliable information, and can participate meaningfully in the decisions that affect their lives and have access to justice in environmental matters. Many MEAs including the Climate Change Convention, and the Paris Agreement do not contain a compliance mechanism but include robust Principle 10 provisions as an accountability mechanism, an example of which is Article 13 of the Paris Agreement on transparency. MEAs can only be effectively implemented if spaces are created for informed, robust, timely, and effective participation of local communities, youth and those most likely affected by failures to implement the polluter pays principle.

Stakeholder Analysis for Climate Action in Antigua and Barbuda

To better understand the range of stakeholders in Antigua and Barbuda, it is important to understand the drastic effects and impacts of climate change on the country. Millions of people are already suffering from catastrophic effects of extreme weather disasters exacerbated by climate change from prolonged drought to devasting tropical storms. Scorching temperatures have caused concerning events from deadly heat waves in Europe to wildfires in South Korea.

The Intergovernmental Panel on Climate Change (2014) as well as the latest report on 1.5 degrees, predicts that greenhouse gas emissions will continue to reach record levels over the coming century. Global temperatures will rise, precipitation will increase, and extreme climate variability will occur. This will lead to increased frequencies of drought, flooding, extreme temperatures, and storms, most of which will appear gradually (Stewart et al. 2015). To address the impacts of even the lowest projected climate change predictions, it is likely that both short and long-term adaptation measures will be necessary. This means there will be an increasing need for governments, planners, and investors to include adaptation and mitigation in planning.

Future Work in Stakeholder Baseline Analysis

Everyone has a role in climate action. Under the auspices of the United Nations, people and organizations across the globe are urged to collaborate in tackling climate challenges and fulfilling the commitments set forth in the 2015 Paris Agreement. This accord continues to align with actions undertaken by

governments, businesses, civil society, youth, and other stakeholders worldwide.

It's our planet, and while we know it is in crisis, we also know that solutions are in reach. Progress is already well underway, from more green energy to more secure food supplies. And the benefits are clear as well, such as green jobs, clean air, and sounder economies. A more sustainable, prosperous world is in reach. Join us in taking action to claim it, starting now.

Over the past few decades, Integrated Assessment (IA) has emerged as an approach to link knowledge and action in a way that is suitable to accommodate uncertainties, complexities, and value diversities of global environmental risks. Responding to the complex nature of the climate problem and the changing role of climate change in the international climate policy process, the DOE has started to include stakeholder knowledge and perspectives in their assessments. The DOE has a considerable amount of experience in the involvement of stakeholders. Many of the stakeholders already involved in climate change programs and projects are well known and information is published in all DOE projects, policy, and other documents. There is a need, however, for the DOE to conduct detailed stakeholder assessments to broaden the list of stakeholders. The gaps to be addressed include:

- To determine capacity building needs of executing agencies in both the public and the NGO sectors;
- To assess the most appropriate partnership with the private sector that can meet the needs of the program;
- Conduct a detailed gender-based assessment of the communities that will be impacted by the projects and programs
- Based on the above, prepare risk assessment reports to carefully identify and efficiently approach the management of risk among stakeholders.

The result of these studies will assist the DOE in carefully tracking the impact and risk of the implementation of this transformation program.

Opportunities for Mitigation and Adaptation in Antigua and Barbuda to Meet Social and Well-Being Objectives

The impacts listed above cut across many aspects of life in Antigua and Barbuda. In response, the country has identified mitigation and adaptation activities in the National Climate Change Policy (NCCP) and the First NDC that aim to both reduce emissions and increase climate resilience. The government and people of Antigua and Barbuda recognize that the human impact of climate change falls, for the most part, on the poor, and very often on women and children, the elderly, and the physically challenged. As such, social protection and social safety nets to smooth out inequities and build a more cohesive society are vital for climate resilience and national development. Climate-change-linked opportunities such as low-carbon economic growth could generate significant development benefits.

Programs like the SIRF Fund to meet the needs of the vulnerable and grants for the NGOs and community levels are the main

approach to achieving transformation in the NGO and private sectors.

Policies That Impact the Well-Being and Actions of Stakeholders

Policies that impact the national response for effective mainstreaming in the government and private sectors and consistent efforts to reduce vulnerability in natural and social systems include:

- National Energy Policy and Strategy;
- Renewable Energy Act;
- National Water Policy;
- Sanitation Policy;
- Food and Nutrition Policy; and
- Poverty Studies for Antigua and Barbuda

Environmental and Social Safeguards

Environmental and Social safeguards are considered by the country as a critical risk mitigation measure as well as an effort to improve the quality of design of projects and programs. For Antigua and Barbuda, these "safeguards" are considered key to impacts and essential as implementation partners. The consideration of safeguards is mainstreamed into the normal processes of the government to meet the requirements of the Funding agencies. However, the Government has developed stand-alone gender and other policies. These are available on the DOE's website.

The government is still working on improving the appropriate indicators of ESS impacts and mitigation success since the current indicators are not considered appropriate. The development of meaningful indicators will be an activity using funding from GCF readiness as well as resources from the 4NC.

The Workforce Development Plan

For Antigua and Barbuda to achieve its First NDC commitments, a sufficient and appropriately trained workforce must be in place. This workforce will include a variety of personnel who will be needed to contribute different skills to support the high-quality development, construction, and operation of best-fit technologies at reasonable labour rates. Antigua and Barbuda has a strong commitment to training and developing an appropriate workforce. Training and development are also key to empowering employees with the knowledge and skills required to meet the health, safety, and environment standards specified in employment, in permitting regulations, and encountered when developing clean energy projects. This strategy is designed with the local context in mind, focusing on Antigua and Barbuda's climate and development priorities. This strategy has been prepared to address particular social opportunities and issues, including:

- Encouraging economic development with increased private sector participation and entrepreneurship in developing new energy projects;
- Increasing labor-force participation and local skills capacity, including maximizing employment opportunities for residents and under-represented groups;
- Establishing apprenticeships, scholarships, vocational training, and other programs;
- Supporting readiness work programs and pre-trade training concepts; and
- Identifying necessary enabling activities to promote successful initiatives.

Scope of the Workforce Strategy

Antigua and Barbuda's First NDC priority sectors are:

i. Energy, including: distributive renewable energy, Energy storage, energy efficiency, audits, and WTE;
ii. Buildings and Construction, including climate-resilient buildings and infrastructure;
iii. Transportation, including setting and enforcing new standards for vehicles; and
iv. Finance and Fund Management, including the national SIRF Fund

The workforce strategy focuses on the energy and buildings sectors with actions in the transportation and finance sectors pertaining more specifically to internal government capacity. Within the energy sector, the strategy centers on opportunities to develop and operate solar photovoltaics (PV), WTE, and wind energy generation projects, as well as improve the resiliency and energy efficiency of buildings via retrofits and new construction.

The workforce strategy involves all workforce and training activities, including those of primary contractors. The actions and activities outlined extend across the construction, operation, and decommissioning phases of clean energy projects. This can also include conducting price assessments, developing viable projects, and maintaining systems. Initial recommendations from Antigua and Barbuda indicate capacity development will target small and medium enterprises (SMEs) and will focus on in-person, learning-by-doing training leading to internationally recognized certifications. The training would be designed for working individuals with at least a primary education. Given the extensive capacity-building requirements, the workforce strategy includes specific activities to facilitate the successful recruitment and retention of an appropriate workforce by optimizing direct and indirect employment opportunities, while managing challenges around the availability of, and competition for, local labour.

Most of the categories of labour could be provided by small and medium enterprises. Labour for engineering, design, construction, inspection, operation and maintenance, distribution, and retail services can all be provided by SMEs. Some of the services not likely to be provided by SMEs include financing, insurance, and manufacturing. In the analysis of job creation, statistics from Hawaii rather than the mainland United States were considered as a model. In Hawaii, a significantly larger portion of work is carried out by SMEs compared to the mainland, with a greater focus on service sectors. In contrast, the mainland workforce is more diversified, encompassing manufacturing and other industries that SMEs in Hawaii typically do not engage in.[179]

Antigua and Barbuda Project Pipeline – Programmatic Approach

Antigua and Barbuda plans to use a programmatic approach to the GCF. The program will include projects that are strategically linked to coordinate with the country's overall developmental agenda (Table 32). This maximizes the availability of co-financing and therefore program impacts. Together this will provide a systematic and impactful approach to the full implementation of the NDC and the climate elements of the government's developmental programs. The

program is designed to have the following characteristics:

- The project pipeline will be executed over a 6–10-year period;
- The projects will be implemented by a variety of external partners including the OECS Commission;
- Some projects will also be implemented by the DOE as a direct access entity;
- The projects will require executing agencies in the public sector as well as NGOs to undergo capacity-building programs;
- Co-financing will be maximized to have project support from the government as well as the Board of the GCF; and
- The program will have to be able to distinguish between development and climate.

Antigua and Barbuda demonstrates leadership in the work of promoting climate action among SIDS both within the Caribbean and wider afield. The twin island nation's contribution to climate diplomacy has been realized with the Chairmanship of the Alliance of Small Island Developing States (AOSIS) and Membership to the Board of the Green Climate Fund. The DOE attained the feat of first Direct Access Entity Accredited to the GCF from a Government Agency in the Caribbean and is also accredited to the Adaptation Fund.

Figure 16: Ambassador for Climate Change and Director of the Department of Environment, Diann Black-Layne

Recognizing the importance of attaining impactful climate change action at scale, Environment Ministers at the 3rd Council of Ministers on Environmental Sustainability (COMES) in May 2016, mandated the Commission to pursue opportunities for climate financing, to support climate resilience in the OECS. This was affirmed at the 4th COMES in April 2017 where Antigua and Barbuda committed to utilizing an allocation from its GCF readiness resources to provide support to the OECS Commission for pre-accreditation to the GCF. After the completion of this initial work where gaps were identified, further resources were committed by Antigua and Barbuda to pool with resources from other OECS UNFCCC Parties within the OECS to address those gaps. Antigua and Barbuda's DOE (DOE) also sits on the OECS Climate Finance Working Group.

DOE is piloting internships and apprenticeships to support climate change action based on training needs identified in the country. Citizens from OECS Member States will also be beneficiaries. The internship and apprenticeship training will cover inter alia proposal development and management; M&E of projects and programs; climate action MRV; geographic information systems; environmental assessment and monitoring; socio-economic assessment and stakeholder outreach; ecosystem valuation – data collection and analysis, economics, biodiversity, renewable energy, and ESS and gender.

Figure 6.4: Ambassador Diann Black-Layne Representing Antigua and Barbuda (far left) at COMES-6 in 2019, held in Martinique

Another area of cooperation among Caribbean SIDS is the implementation of the GCF Enhanced Direct Access project. It seeks to strengthen the resilience of three Caribbean islands (Antigua and Barbuda, Grenada, and the Commonwealth of Dominica) to climate change-related threats such as more intense hurricanes, higher temperatures, and lower overall rainfall. The resilience of community buildings, homes, and businesses will be improved, with the DOE as the executing entity. This is currently the first Enhanced Direct Access project in the Caribbean.

Antigua and Barbuda has been described by many regional reports as one of the most disaster-prone countries in the OECS subregion. It is subject to hurricanes, earthquakes, and frequent droughts. Therefore, Antigua and Barbuda was one of the first countries in the hemisphere to implement technology like desalination, drip irrigation as well as renewable energy. The threat of disaster has always been an issue for financing and the economy of Antigua and Barbuda. The country is very keen therefore to ensure that it uses limited finances effectively. Antigua and Barbuda requires international support from multilateral and bilateral sources and currently receives considerable funding. The country has received support from the GCF, the GEF and the AF, for capacity building, climate finance and technology transfer to be able to strengthen its current programs, policies, and regulations. Since the submission of the TNC in 2015, these partnerships have aided in development and implementation of new initiatives, and to fully assess and address the impacts of climate change, as defined in the adaptation and mitigation targets.

However as outlined in Section 1 there are considerable challenges to Financing Actions related to addressing Climate Change. Gaps and Constraints as well as capacity building needs related to GHG inventory and to the mitigation actions are extensively reported on in Sections 3 and 4 respectively. Additional gaps and constraints related to activities requiring support for implementation of the new and ambitious actions of the country include:

i. Technology, human resources, and financial capacity assessment;
ii. Support for the development of a Technology Strategy and Road Map that includes repurposing, decommissioning, and disposing of stranded assets;
iii. Comprehensive assessment of the national costs of adaptation and mitigation;
iv. Elaboration of a National Adaptation Plan;
v. Enhancing Measurement, Reporting and Verification (MRV) processes;
vi. Development of standardized baselines to assess and monitor the impacts of implementing NDC adaptation and mitigation initiatives and CC program as a whole;

vii. Support for data collection, storage, and management; and

viii. Support for education, training, public awareness, public participation, public access to information, and international cooperation throughout implementation of the NDC target.

Progress Towards Addressing Gaps and Constraints

Antigua and Barbuda has been making efforts to address previously identified Gaps and Constraints. Table 30 presents a summary of gaps previously outlined in the TNC and the progress made towards addressing those as well as new gaps related to the production of this First BUR.

Monitoring Framework and Evaluation

Antigua and Barbuda does not have a culture of tracking impacts of national actions. This is a major gap and a constraint to project implementation, building consensus and confidence in climate action. To assist in this regard, the OECS Commission initiated a process to assist the country. The OECS Commission has a monitoring and evaluation unit with specialized expertise and experience monitoring projects financed by EU DEVCO, USAID, and other international donors. The OECS Commission's M&E Unit will perform independent monitoring and evaluation services for the DOE, pending capacity building efforts. The M&E arrangements will be designed to build capacity at the national level and eventually have a culture change to track impacts of national actions.

Additional Actions Required to Meet Gaps and Constraints

Antigua and Barbuda has taken progressive actions towards overcoming the various gaps and constraints. Further actions are required that will lead to:

- Strengthened institutional and fiduciary capacity to enable national entities to access local and international funds;
- Enhanced coordination among stakeholders and institutions at regional and national entities to manage and deliver climate action;
- Supported strengthening of climate change regulations, policies, plans and budgeting especially for Adaptation (NAPS);
- Increased stakeholder access to information and knowledge products on climate change (EIMAS, Environment Registry and website);
- Development of a system for identifying, prioritizing, and developing climate change programs/projects;
- Developed templates and guidance for monitoring and evaluation (MRV).
- Leverage private sector resources to scale up climate change solutions through market, microfinancing, and output-based and inclusive value chain business model;
- Facilitate private sector resource mobilization and engagement on climate change activities; and
- Strengthened technical and financial capacity of public, private and CSO stakeholders in inclusive business development and marketing of climate change solutions.

Technology Transfer Needs

Antigua and Barbuda participated in Phase III of the Technology Needs Assessment (TNA) project. The project originated within the *Strategic Program on Technology Transfer* approved by the GEF in 2005. The national aim of the TNA was to allow for a stakeholder process to assess and raise awareness of the technologies present in Antigua and Barbuda that are often disregarded. The purpose of the TNA is also to analyze technology priorities for climate change adaptation and mitigation, determine a portfolio of Environmentally Sound Technologies (ESTs), along with context-specific programs/projects that would facilitate the transfer of and access to selected ESTs, and progress towards implementation of Article 4.5 of the UNFCCC.

Antigua and Barbuda's first national communication on climate change in 2001 outlined the national inventory of GHG, climate change vulnerability and adaptation profile and target sectors for GHG mitigation. The second national communication that followed in 2009 used regional climate change projections to detail impacts on climate-dependent and climate-sensitive economic sectors for which adaptation and mitigation programs needed to be developed. Building on these and the overall national development agenda, Antigua and Barbuda communicated the INDC's to the UNFCCC in 2015. These were later approved and submitted as the country's first NDC. Chapter 1.9.3 of this BUR document highlights *building, water, energy and transportation* as the nation's priority sectors for climate change adaptation and mitigation and outlines the role that the finance sector can have in promoting new growth in business related to these sectors. However, since the country previously addressed the energy sector in the TNC and the 4NC, the building, water and transport sectors were chosen for the TNA project.

This initial step was aimed at prioritizing adaptations and mitigation technologies for Antigua and Barbuda. The resulting TNA report provides the outcome of a participatory process where relevant stakeholders identified and assessed climate-smart technologies that would aid in achieving targets outlined in the INDCs, increasing overall resilience to the negative impacts of climate change, and supporting the national development agenda.

Project activities are organized from within DOE – the TNA Coordinating Agency – where the coordinator acts as the core of the national TNA team, maintaining and managing communication between the TNA Steering Committee, the Technical Advisory Committee (TAC), national consultants, and sectoral working groups. To facilitate a fully participatory process, stakeholder consultations, which encouraged candid feedback from all participants, were organized at strategic points in the prioritization process to garner input from a representative group from across the local society. Also essential to the TNA process is ensuring that gender considerations were streamlined throughout all TNA activities. To this end, gender equity was mainstreamed by considering how climate change impacts affected women and female-led households, ensuring gender balance in stakeholder selection, and identifying technology options that would benefit both males and females equally.

The following list of seven technologies was created after a screening workshop and approval by the TAC:

- Rainwater Harvesting
- Stormwater Reclamation and Reuse *for controlled groundwater recharge and watershed rehabilitation*
- Wastewater Reuse for Irrigation
- Climate-proofing Assets *(Resilient infrastructure)*
- Solar Pumping Systems
- Atmospheric Water Generators
- Water Savers.

In reference to adaptation in the building sector, it was specified that by 2030 buildings must be prepared to withstand extreme climatic events. Therefore, the ESTs chosen sought to directly address this policy and target. Simultaneously, it was important that the selection of the building sector technologies would directly contribute to the goals set out in Antigua and Barbuda's INDCs.

The transportation sector focused primarily on mitigation efforts. The INDCs emphasized the establishment of efficiency standards for vehicles by 2020, to reduce CO2 emissions. Therefore, the chosen technologies aimed to meet this goal both directly and indirectly based on the level of projects adopted for technology implementation.

Technology fact sheets were prepared for each of the abovementioned technologies and shared with sectoral working groups to help facilitate discussions and the Multi-Criteria Analysis (MCA) process which was used to prioritize the technology options that would be taken into the next step of the TNA.

Antigua and Barbuda continues to evaluate technologies via pilot projects and programs to demonstrate their technical and financial feasibility in the country. Technologies are evaluated and recommendations developed for uptake within the private sector. This approach using project "incubators" is fully supported, particularly by the education sector that has ready access to individuals eager to test and verify new technologies. The draft TNA is being considered for adoption at the Cabinet of Antigua and Barbuda.

CHAPTER 7

TECHNICAL ASSISTANCE

Introduction

Throughout the DOE's accreditation journey, partnerships have been essential to its efforts to fulfill its ambitious climate action and environmental conservation and management goals. The DOE has recognized that such partnerships have significant value at the local, national, regional, and global levels. These relationships have led to opportunities for technical assistance, capacity building; financial support, technology transfer, and infrastructure development; and supported engagements with the private sector, civil society, and academia. These partners have understood the local context of Antigua and Barbuda and its limitations in human, technical, institutional, and technological capacity. As the lead agency in the updating of the Nationally Determined Contributions, a key lesson learned was the benefit of establishing relationships with partners that saw value and opportunity in moving to a green economy and who believed in the country's energy transition goals. The DOE continues to work with partners to gain knowledge for the development of innovative projects and programs. This report captures information on the resources gained through partnerships and benefits of the work undertaken. The report also delves into efforts to navigate energy transition plans and COVID-19 recovery.

Overview of Technical Assistance Projects

As a SIDS, Antigua and Barbuda contributes less than 0.002 percent of emissions that drive climate change. However, the twin-island state is especially vulnerable to the adverse impacts of climate change. It faces more frequent and intense tropical storms and hurricanes and is prone to droughts, intense floods, rising air temperatures, decreased annual rainfall and suffers from sea level rise. These impacts increase the country's economic vulnerability and puts pressure on the use of its resources to respond and recover from such events. Given the risks it faces and its vulnerability to climate trends, the country is highly motivated to transition.

To address key barriers to implementation and shaping policies and strategies, the country's DOE as the focal point to the UNFCCC, has ensured that the NDC update process has active involvement of stakeholders from across government, civil society organizations, trade and industry groups, training institutions, unions, and other key groups. These stakeholders have been instrumental in defining mitigation and adaptation actions.

Furthermore, the technical assistance received from IRENA's SIDS Lighthouse Initiative, UNDP's Climate Promise, and the NDC Partnership's Climate Action Enhancement

Package (CAEP) has enhanced the quality and increased the ambition of its climate pledges.

Technical assistance from implementing partners have advanced the following activities:

- **National GHG Reduction Report:** assesses progress in reducing GHG emissions and meeting current NDC targets.

- **Renewable Energy Roadmap:** presents pathways for the scale-up of renewables in both the energy and transport sectors. Currently, Antigua and Barbuda is heavily dependent on the importation and use of fossil fuels to serve the energy needs of the twin island state. Its dependency upon petroleum-based fuels for energy is due to an absence of indigenous fossil fuel resources thus resulting in the importation of 100% of its petroleum-based products. This dependence on fossil fuels leads to an increase in national GHG emissions that contribute to climate change.

- **Framework for Monitoring, Reporting and Verification System.** The system is being designed in keeping with four transparency themes:

  i. *Adaptation*: adapting in anticipation for the adverse effects of climate change
  ii. *Mitigation*: mitigating the cause of climate change
  iii. *Loss and Damage*: responding to the loss and damage associated with the adverse effects of climate change
  iv. *Support*, which includes climate finance, technology transfer, and capacity building used for: (a) adapting to the adverse effects of climate change; (b) mitigating the cause of climate change; and (c) responding to the loss and damage associated with the negative effects of climate change.

- **Green Paper for a mandatory national insurance scheme for farmers and fishers, residential and commercial building owners.** Given the country's increased exposure and vulnerability, the Government of Antigua and Barbuda has proposed a national insurance scheme that will offer risk sensitive financial tools, such as parametric insurance to provide funding to farmers, fishers, residential and commercial business owners to allow them to recover after events such as hurricanes, droughts, and floods.

- **Just Transition Framework:** The government envisions a just transition of the workforce by 2030. The transition to a fossil-free society implies changes on several levels and needs to be accompanied with adequate policies to ensure sustainable and socially inclusive growth. Enabling a just transition for workers and communities will be at the core of transition policies. The just transition framework will look at proposing certified training opportunities for persons at all ages, sex, and education to facilitate the transition in an appropriate and just manner.

- **Technology Needs Assessments (TNA):** The first TNA to be done by IRENA will support the country to plan the technical implementation and upscaling of the electrification and decarbonization of the transport sector

supported by key technologies, and what needs to be considered to accelerate it.

- **Social Inclusion and Investment Programme:** Will offer affordable RE options to the population and make it more accessible, particularly for vulnerable groups. The programme will also target key groups who often are excluded for a variety of reasons from investing. This will result in the development of domestic and small-scale commercial investment in renewable energy. Such a programme will help the government meet increasing demand for energy. Also, investment in renewable energy provides energy resiliency and back-up power during service interruptions, times of emergency and critical for post-disaster recovery. This will help to reduce the time and expense of recovery for the government and for households and businesses thus improving national resilience.

- **Creating an enabling environment to drive implementation of NDCs**: This involves establishing an NDC Implementation Plan and a Stakeholder Engagement and Communications Plan to support the coordination of policies and actions, including capacity building initiatives for government ministries and authorities, and guidelines for periodic update to the NDCs.

Collaboratively Enhancing Climate Ambition – NDC partnership

From 2019 to 2021, the Government of Antigua and Barbuda (GoAB) embarked on the process of revising its Nationally Determined Contributions (NDCs). Individually, NDCs represent each country's climate priorities and vision for achieving sustainable development. Combined, they represent the world's collective efforts to fight climate change. As the lead Focal Point to both the NDC Partnership[257] and the United Nations Framework Convention on Climate Change (UNFCCC), the DOE served as the counterpart for the GOAB in the revision process. On 2nd September 2021, the Government communicated and submitted its updated, enhanced NDC to the UNFCCC. The updated NDC covers the period 2020 to 2030 and it includes targets for mitigation and adaptation as well as targets that are designed to:

- Reduce transitional risks;
- Support vulnerable groups, including women, the elderly and people living with disabilities;
- Support an inclusive, gender-responsive approach to the energy transition with special focus on women fully participating in the new economy and providing support for men working within the power and transportation sectors as the transition advances;
- Support youth fully with a gender-responsive approach for girls and boys of all income levels in meeting the new

[257] As a global coalition of countries and institutions, the NDC Partnership collaborates to drive transformational climate action through sustainable development. It works directly with national governments, international institutions, civil society, researchers, and the private sector to fast-track climate and development action.

challenges and opportunities that this process can provide; and

- Provide investment and business opportunities for local micro, small, and medium enterprises (MSMEs) and businesses in the informal sector.

The DOE's leadership in the revision process was supported by continuous participation from line ministries, civil society, community interest groups, and the private sector in the country. The revision process was designed to be inclusive and follow a whole-of-society and whole-of-government participatory approach to the extent permitted by the COVID-19 pandemic.

The NDC Partnership served as a key partner and provided tremendous support for the revision process through its Climate Action Enhancement Package (CAEP) initiative, along with funding from the German Ministry of Environment (BMU), IRENA Small Island Developing States (SIDS) Lighthouse Initiative , the United Nations Development Program's (UNDP) Climate Promise, Green Climate Fund's (GCF) Readiness Projects, and the 4th National Communications Project.

NDC Partnership's CAEP Initiative

The NDC Partnership's CAEP initiative provided fast-track support to Antigua and Barbuda to enhance its NDCs, raise ambition, and accelerate NDC implementation. The DOE on behalf of the GOAB requested technical assistance from the Partnership to inform a renewable transition in the power and transportation sectors that would position Antigua and Barbuda towards a cleaner, more resilient future. The country gained much needed capacity building support and technical assistance to inform science-based targets for mitigating national greenhouse gas emissions that cause climate change and for adapting to adverse climate impacts. With CAEP support, Antigua and Barbuda has strengthened the quality and the process of developing its NDCs, making them more science-based, transparent, and implementable, with greater buy-in from key stakeholders.

The NDC revision process was supported by an array of implementing partners through CAEP including Climate Analytics (CA), International Renewable Energy Agency (IRENA), Global Green Growth Institute (GGGI), Organization of Eastern Caribbean States (OECS), and the United Nations Framework Convention on Climate Change Regional Collaboration Centre (UNFCCC RCC). With the support of these implementing partners, an inclusive stakeholder engagement process was undertaken to ensure that the whole of society was involved in the NDC revision process. Key outputs from this process included:

- Development of a National Greenhouse Gas (GHG) Reduction Report undertaken by Climate Analytics to lay out a possible pathway to achieve initial NDC goals
- Strengthening of Monitoring, Reporting and Verification (MRV) Systems for Tracking of Mitigation and Adaptation Actions, Technical Support and Climate Finance
- Policy Paper and Strategy on a Social Inclusion and Investment Programme that will offer affordable RE energy options to vulnerable groups. The program will target vulnerable groups, who often are excluded for a variety of reasons from investing. This will result in development of domestic and small-scale commercial

investment in RE that will help the GOAB meet increasing demand for energy across the twin-island state.

- Draft NDC Implementation Plan
- Stakeholder and Communications Plan

NDC Technical Assistance Fund

During the update process for the NDCs, Antigua and Barbuda was supported by the NDC Partnership in the drafting and submission of the revised NDC. The work was done as part of the NDC Partnership's Climate Action Enhancement Package (CAEP), which was led by Climate Analytics (CA) with support from the Partnership's Technical Assistance Fund (TAF). This support was executed from late 2020 through to 2021. The request from the Government of Antigua and Barbuda was to draft the revised NDC text. Climate Analytics responded to this request and provided technical assistance to Antigua and Barbuda. Part of the support included workshops, focus groups and other stakeholder consultations.

While Climate Analytics led the drafting of the NDC, it was a nationally driven process and occurred in coordination and under the guidance of the DOE. It was done in close collaboration with key stakeholders from priority sectors in a nationally determined way to ensure that NDC drafts reflect national context and circumstances.

The Partnership also worked directly with the Ministry of Finance, Corporate Governance and Partnerships (MOF). The NDC Partnership has adopted this approach to create a better linkage between climate action, economic development and planning. By working along with the Partnership, the Department has been successful in securing technical assistance and finance to further the development and implementation of its NDCs.

Partnership Action Fund

In 2022, Antigua and Barbuda indicated its intent to participate in the newly launched Partnership Action Fund (PAF), which is designed to provide flexible support where needed. The Department has communicated a desire for the PAF to:

- Determine the feasibility for a gender-responsive blended financing window under the Sustainable Island Resources Framework Fund (SIRF Fund), to support NDC implementation through building climate resilience locally;
- Support the development of a NDC Financing Strategy and Action Plan detailing an investment roadmap;
- Support the development of a Private Sector Engagement Strategy for NDC implementation, which will complement work through the Department's Green Climate Fund's Multi-Year Strategic Readiness Project, which focuses on "Supporting NDC implementation towards a transformation to Climate Resilient and Low-Emission Development Pathway by 2030"

The PAF will also support the MOF's co-national Designated Authority to:

- Build on prior technical assistance provided to the MOF-Project Management Unit in order to further strengthen the technical capacity of the Unit and bolster the national enabling environment for the achievement of the NDC targets;
- Strengthen the capacity of the Ministry to execute its role as co-NDA to the GCF at the national level, including sustainable

procurement, climate finance, monitoring and evaluation, oversight (including risk) and investment; and
- develop a Technical Manual for the MOF-PMU that will detail the Unit's technical processes and methodologies throughout the project cycle.

NDC Partnership's Adaptation Pipeline Accelerator

Antigua and Barbuda will also be participating in the Adaptation Pipeline Accelerator (APA) to mobilize financial support for adaptation. Though at an early stage in the process, Department staff has engaged with consultants to contribute to the preparation of initial assessments and engaged in roundtable conversations with financiers and core partners of the APA (GCF, UNDP, and NDC Partnership to identify entry points for support. While discussions for how to frame the work in 2023 are still taking place, the Department is working with the NDC Partnership to identify adaptation priorities, develop investment plans, and address requests to support adaptation implementation on the ground.

IRENA & Abu Dhabi Fund for Development:

IRENA's SIDS Lighthouse Initiative

Technical assistance was also provided through IRENA's SIDS Lighthouse Initiative for the development of a Renewable Energy Roadmap for the decarbonization of the power sector and road transport through electromobility. This report helped to inform the development of NDC targets.

Technology Infrastructure Plans

The Government received support from IRENA for the development of Technology Infrastructure Plans for the electricity and transport sectors. These infrastructure plans will support the expansion of investment into renewable energy, and create an enabling environment for the energy sector transition, thus contributing to the country's climate response goals. These plans build on the Renewable Energy Roadmap developed by IRENA and complement active and new projects.

Technical Assistance for Renewable Energy Installations

Through the Abu Dhabi Fund for Development (ADFD) a US$15 million Concessional Loan was secured by the MOF on behalf of the SIRF Fund and repayment will be the responsibility of the SIRFF. The concessional loan will be applied to Component 3 of the GEF funded SPPARE project. In the first phase of this project, this component invested the ADFD funds directly into an initial 4MWh of electricity of a total of 10MW. This second phase will invest Phase 2 of the ADFD into an additional 6 MWH of wind and solar installations of an overall MW of additional Renewable Energy Technology. This loan is needed co-finance for the GEF 7 e-mobility and the GCF buildings project. The total allocation from the GEF to date is US$2.7 million (for mitigation in the transportation sector).

Table 7.5: Other Technical Assistance with IRENA for Climate Action

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support	Beneficiaries
Technical Assistance	2021-2022	IRENA	Fleet Electrification Feasibility Study	Completion of the following: Fleet Electrification Feasibility Study Fleet Electrification Workshop	Antigua & Barbuda
Technical Assistance	2022 - 2023	IRENA	Socio-economic analysis of fleet electrification	Goal: To complete the Socio-economic analysis of fleet electrification under the Sustainable Low-Emission Mobility (SLIM) project	Antigua & Barbuda

The UNDP's Climate Promise Initiative

The UNDP's Climate Promise Initiative serves as a framework for NDC enhancement and implementation. The Initiative was a response to an urgent call for countries to develop robust and ambitious NDCs for submission in 2020. Like its counterparts in the Eastern Caribbean, which participated Antigua and Barbuda benefitted from access to the UNDP's expertise across areas such as energy, finance, gender equality, agriculture, youth empowerment, and governance in the revision and enhancement of its NDCs.

Through Climate Promise, the UNDP is supporting Antigua and Barbuda's goal of achieving its established NDC targets. The programme has supported the development of:

(i) An institutional capacity assessment at the national level to identify critical skill and knowledge gaps for NDC Implementation focusing on the country's energy, water, and agriculture sectors.

(ii) An insurance prospective for farmers and fishers in Antigua and Barbuda. The report resulted from a baseline assessment of the insurance availability for farmers and fishers in Antigua and Barbuda followed by the study of their willingness to pay for insurance.

(iii) Socio-economic and gender indicators to support socio-economic monitoring of NDC development in Antigua and Barbuda

(iv) Communication videos to promote awareness of the NDCs and Climate Promise

As the first phase of the Climate Promise in the Eastern Caribbean ended, a subregional event was held to showcase the achievements of the implementation of the Promise. The event was held to:

- Showcase the work of the Climate Promise in Antigua and Barbuda, the

Commonwealth of Dominica, Grenada, and St. Vincent and the Grenadines with specific focus on country priority areas

- Share lessons learned during the NDC revision process and preparations for the next phase of NDC implementation from Caribbean Countries
- Facilitate interactive dialogue on Caribbean tools and resources necessary for implementing their NDCs
- Introduce UNDPs Climate Promise Phase 2, partner initiatives that countries can access to facilitate implementation of their NDCs and proposed plans to support increased regional adaptation and mitigation efforts.

The event brought together regional experts on climate change, and environmental sustainability who participated in dialogue on advancements in the region's adaptation and mitigation efforts.

Building Relationships for The Just Transition - ILO

Labour Assessments

In recognition of equity issues related to energy transitions, the Government committed to ensuring a just transition with a strong focus on the International Labour Organization's (ILO) principles of decent work, green jobs, and sustainable development. As part of this effort to frame Antigua and Barbuda's just transition approach, the ILO collaborated with UNDP through its Climate Promise Initiative.

The ILO project supported Antigua and Barbuda in the realization of its NDC target to transition to low-carbon and more climate-resilient development equitably and inclusively. The information provided by the project will allow climate change and labour policies to integrate measures to promote a just transition and green job creation. These policies and measures will increase resilience, and reduce vulnerability of business and jobs overall in the country while identifying options for investments in low-carbon and environmentally friendly sectors, including low-carbon transportation and renewable energy supply sources.

The ILO project provided support in five specific areas:

1. Just transition and NDC labour impact assessment
2. Gender awareness on just transition assessment over the workforce
3. Skills and capacity building needs for just transition
4. Just transition communication needs (with specific focus on world of work actors)
5. Social dialogues with workers representatives, Ministry of Legal Affairs, Public Safety and Labour and workers and other key organisations to inform the development of a structure for the just transition of the workforce. The social dialogue process discussed labour-related issues and climate change in Antigua and Barbuda.

The technical assistance from the ILO leads to the elaboration of a Just Transition Action Plan that will allow labour impact assessments linked to NDC and more generally, linked to

low carbon and a climate resilience economy and society for the country. The ILO project is intended to contribute to Sustainable Development Goals (SDG) 8, SDG 13, SDG 4 and SDG 5.

Strengthening Ties with Academia and Training Institutions

The DOE will soon formalize a new phase of cooperation between the country's lone Technical and Vocational Education and Training (TVET) institution and the University of the West Indies Five Islands Campus. The DOE prioritizes partnerships centered on knowledge. It is working along with these institutions, along with other universities, international organizations, and government actors in this effort.

The partnership agreement lays the groundwork for joint research, shares demonstration technologies in renewable energy, makes valuable use of expertise, informs projects and policies, and fosters a culture of sharing lessons learned. Along with academia, TVET will be a central part of the countrys energy and just transition approach, which will require changes to education systems and labor markets.

The DOE is establishing strategic partnerships with the Antigua and Barbuda Institute for Continuing Education (ABICE) and the University of the West Indies-Five Islands Campus (UWI – Five Islands) to advance the energy transition and just transition, in order to facilitate human, technical, and institutional capacity building, by:

- Coordinating the development and implementation of the just transition initiatives across agencies;
- Collaborating with appropriate authorities to establish certified training opportunities for students and faculty;
- Collaborating with local, regional, and international agencies on clean energy workforce development;
- Coordinate the re-design, development, and implementation of curricula to align with the needs of the energy transition;
- collaborate on renewable energy projects to advance the energy transition;
- Create re-skilling opportunities for students and faculty in the construction, electrical, plumbing, Heating, ventilation, and air conditioning (HVAC) and automotive courses; and
- Collaborate on gathering, analyzing, publishing, and disseminating relevant data and information.

It is expected that these partnerships will support the Government in initiating an energy transition to renewable energy to reduce its dependence on fossil fuels and advance its efforts to achieve its long-term mitigation target: 86 percent RE generation from local resources in the electricity sector by 2030. The activities under the arrangement will represent in part Antigua and Barbuda's response to the adverse impacts of climate change on the country's energy, building, and transportation sectors as well as on its national workforce. The collaboration also affirms the GoAB's commitment to ensuring a just transition alongside the energy transition:

i) For those workers employed in affected fossil fuel-dependent industries (such as

energy, building and construction, and transportation)

ii) To enhance the development of the country's workforce to support new industries in appropriate sectors that would be underpinned by appropriate policies and activities.

The Just Transition to Electric Mobility

The Just Transition of the West Indies Oil Company Limited

The DOE has entered a MOU with the West Indies Oil Company Limited (WIOC) for 2021-2025. The goal of the memorandum is to build capacity within the WIOC to manage and develop Antigua and Barbuda's electric vehicle charging infrastructure. This collaboration will result in the assessment of the economic, technical, environmental, and social viability of a just transition of the transport sector from fossil fuel energy generation and storage to renewable energy and storage as a means of emissions reductions in line with the UNFCCC Paris Agreement 2015 pursuant to a Cabinet Decision dated 27th November 2019.

The partnership will address the just transition of WIOC, its operations, and workforce, as a part of the Antigua and Barbuda's just transition to a low GHG emissions, climate-resilient economy as specified in its NDC to the global response to climate change with a view of achieving the goals of the Paris Agreement 2015. The intent is to build the capacity and skills of staff to implement the projects/work required to achieve the scope and objectives of the MOU; and develop the renewable energy business portfolio of WIOC including via the development and implementation of climate change mitigation and adaptation projects and programmes. This includes projects and programmes focussed on, *inter alia*: renewable energy technology installation, maintenance, and management; etc.; identifying technologies and best practices for the development for electric mobility and the renewable energy sector in Antigua and Barbuda; and enhancing collaboration and data sharing between the DOE and WIOC to accelerate the uptake of electric vehicles within Antigua and Barbuda in line with the country's NDC.

Electric Mobility Transition and The National Solid Waste Management Authority

As Antigua and Barbuda is implementing policy frameworks and building capacity to ensure the long-term sustainability of electric mobility, the Department is working with the National Solid Waste Management Authority on providing training in reusing, recycling, and disposing of used vehicles (conventional and electric) and electric vehicle batteries. The support is valued at USD450,000.

Partnering with RELAC/NREL to Accelerate Transition to Low Emission Advanced Energy Systems

In 2022, Antigua and Barbuda joined the Local2030 Islands Network, Renewables in Latin America and the Caribbean (RELAC). The Local2030 Islands Network and RELAC will assist Antigua and Barbuda in investing its capacities and resources into building and leading regional and global partnerships with other island champions. The Local2030 Islands Network has the potential to be a historic partnership among islands, both developed and developing, this form of engagement.

Antigua and Barbuda welcomed the support of the National Oceanic and Atmospheric Administration (NOAA) and National Renewable Energy Laboratory (NREL), supporting communities of practice, providing training and technical assistance in partnership with Local 2030 Islands Network. The technical knowledge sharing this partnership facilitates in helping the country to meet its own energy goals.

Antigua and Barbuda's top priorities of collaboration with the Local2030 Islands Network are climate change, training and capacity building, and the blue economy. As a SID, Antigua and Barbuda is positioned to build partnerships, and understands the value of communal partnerships and collaboration for shared goals. In this vein, opportunities like Local2030 Islands Network and RELAC provide easy access to global forums for SIDS and other island nations as a space for candid dialogue and concrete action.

Over the years, stakeholders in Antigua and Barbuda have collaborated to support the energy transition. The partnership builds on NREL's extensive experience partnering with islanders in the Pacific and Caribbean. NREL has collaborated with Antigua and Barbuda in:

1. A procurement of grid-interactive solar photovoltaics with battery energy storage systems and accessories for schools and clinics;
2. A workforce development strategy for priority energy sectors in Antigua;
3. Development of a community solar program and tariff design;
4. Deployment of electric buses; and
5. An analysis of US$5.6 million solar and energy storage system in Barbuda to support rebuilding efforts following Hurricane Irma.

Going forward, with the sponsorship of the U.S. State Department and the U.S. Department of Energy, NREL is working with the GoAB and the Local 2030 Network to facilitate long-term local capacity building and to provide direct support for increasing energy efficiency, resiliency, and the deployment of solar, wind, storage and electric mobility technologies in the country. Lessons learned and materials from this technical assistance will be disseminated through the Local 2030 and the Global Climate Action Partnership (GCAP) network.

Furthermore, NREL is continuing to support Antigua and Barbuda through technical support to:

1. Assess the installation of renewable energy technologies appropriate with resiliency practices related to hurricane issues (e.g., support the procurement of solar carports, installation of 15 wind turbines);
2. Develop a trained workforce in Antigua and Barbuda that supports the installation and maintenance of sustainable energy technologies such as: photovoltaics and Battery Energy Storage Systems (BESS), hurricane-resistant wind turbines, EV charging stations, and energy efficiency improvements or retrofits in buildings;
3. Develop a training hub model for the installation and maintenance of sustainable energy technologies to support greater workforce development; and
4. Leverage high-value partnerships to maximize the impact of investments in the region, through regional peer-to-peer learning, knowledge sharing, and training programs.

Inclusive Climate Action: Youth, Gender, Women and Vulnerable Groups

Youth Engagement

Youth engagement is central to climate action. Antigua and Barbuda has demonstrated significant leadership in terms of youth engagement in areas related to climate action and environmental sustainability. As a result, the DOE welcomed support from UNICEF to contribute to Antigua and Barbuda's climate policy framework including its NDCs. As a commitment from Antigua and Barbuda's NDCs, revised in 2021, the agency supported the DOE in the design of a Youth Engagement Strategy on Climate Action and Environmental Sustainability (YES-CA) and an accompanying action plan.

The YES-CA was commissioned by the DOE, with support from UNICEF Office for the Eastern Caribbean. It will be implemented in collaboration with young people and be updated on a regular basis based on progress made and emerging needs. The strategy and action plan were formulated in line with the national adaptation priorities and the Action for Climate Empowerment (ACE) commitments, as defined in the Paris Agreement. The strategy will serve as the framework for youth engagement as part of the Department's Climate Change Programme and will primarily support the engagement of youth in adaptation and mitigation initiatives. The YES-CA incorporates intervention strategies to increase youth participation in climate action, research, and development of the NAP.

Climate Change Youth Negotiation Training

The Department recognizes that children and young adults are important voices that can influence climate action. As a result, it has engaged with bodies that provide capacity building to the youth and young negotiators to ensure their meaningful participation in climate change negotiations by equipping them with all the required skills required to actively participate in the decision-making process (Table 7.2).

Gender Responsive Programs

The Department has embarked on initiatives to identify multiple cases of vulnerability to climate change between men and women and to identify the differential adaptive capacity to climate change.

Gender-Responsive Disaster Recovery, Climate and Environmental Resilience

From 2020, the DOE joined forces with the UNDP's Enabling Gender-Responsive Disaster Recovery, Climate and Environmental Resilience in the Caribbean (EnGenDER) project. Based on that partnership the following key products were developed.

Gender Responsive Budgeted Sectoral Adaptation Strategies and Action Plans

Under the EnGenDER project, the DOE received support for the development of a Gender Responsive Budgeted Sectoral Adaptation Strategy and Action Plan and a Monitoring and Evaluation Framework for the Finance Sector.

Table 7.2: Climate Change Youth Training

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
Capacity Building	2019	European Capacity Building Initiative	Training for young negotiators to support the international climate change negotiations.	Improvement in knowledge of the UNFCCC decision-making process.
Partnership (in discussion)	2023	Climate Youth Negotiator Programme (CYNP)	Increase the number of climate change negotiators with the skills, knowledge, networks and resources to deliver transformative change.	- Developing young people's negotiation and leadership skills through a targeted training programme - Creation of a community of youth negotiators - Long term meaningful youth participation in decision-making

Behavior Change Communications

The EnGenDER project has as its ultimate outcome the improvement of climate and disaster resilience for women and girls, key vulnerable populations, and for future generations to come across the Caribbean region. Sustainable action is therefore critical and must be embedded in national and regional decision-making processes if this outcome is to be achieved.

Thus in 2022, the DOE kicked off efforts with UNDP's EnGender Project to develop a Communications for Behavioral Change Framework and Action Plan. This framework document is meant to act as a guidance tool in supporting the development of current and future behavioral change communication strategies and action plans.

Through aid from the Government of Canada and UK, the EnGenDER Project supported the integration of gender equality and human-rights based approaches into Disaster Risk Reduction (DRR), Climate Change (CC) adaptation and mitigation, environmental management frameworks and interventions in Antigua and Barbuda and eight other Caribbean countries (Belize, the Commonwealth of Dominica, Grenada, the Co-operative Republic of Guyana, Jamaica, Saint Lucia, Saint Vincent and the Grenadines and Suriname).

Engender Offer of Complimentary Funding to Governments

To this end, the EnGenDER Project issued an Offer of Complimentary Funding (OCF) to Governments of the beneficiary countries for US$100,000, to present proposals to assist in accelerating the closing of the existing climate financing gaps and to leverage sustainable and diverse sources of climate finance. The objective for the OCF to Governments is to improve countries'

capacity in leveraging climate financing, in compliance with the requirements of entities such as the Adaptation Fund (AF), the Climate Investment Fund, the Green Climate Fund (GCF), Special Climate Change Fund (SCCF) and other funding options.

Antigua and Barbuda is using the support under the EnGenDER Project-OCF to advance the development of (i) Environmental and Social Management Framework (ESMF) and a Gender Action Framework (GAF) for a parametric focused insurance Concept Note titled "Mainstreaming Gender Responsive Financial Resilience to Climate Change in Antigua and Barbuda" and (ii) to support the evaluation and further upscaling of the Department's Sustainable Island Resources Framework Fund (SIRFF) Revolving Loan Pilot Programme, which offers low-cost loans to vulnerable individuals, the private sector, civil society organizations and non-governmental organizations to allow them to manage the cost of sound environmental practices in their homes, businesses, and organizations to enhance their resilience to climate change.

Mainstreaming of Environmental Social Safeguard and Gender Standards

The Department values the environmental and social benefits generated through its projects and programs. It strives to avoid or reduce any negative impacts that could potentially arise through its work. Considering this, the DOE has established partnerships and has received as well as provided technical assistance, which has been instrumental in the mainstreaming of environmental social safeguards and gender standards in line with the Department's Environmental and Social Safeguard and Gender Policy, its Complaints and Grievance Mechanism and those policy requirements of its donors.

Table 7.3: Partnerships and Technical Assistance for Mainstreaming of Environmental Social Safeguard and Gender Standards

Type of Support	Year	Name Of Entity	Purpose of Support	Impact of Support
Capacity Building	2018	Community Development Division within the Ministry of Social Transformation, Directorate of Gender Affairs	To host a capacity building workshop with key stakeholders including government agencies and local NGOs on the mainstreaming of gender, climate change and disabilities along with other vulnerable groups in decision making, policy development and programme and project implementation.	The Community Development Division (CDD) within the Ministry of Social Transformation, Directorate of Gender Affairs hosted a capacity building workshop with key stakeholders, including government agencies and local NGOs on the mainstreaming of gender, climate change and disabilities along with other vulnerable groups in decision making, policy development and programme and project implementation. The partnership with the CDD and the Directorate of Gender Affairs was instrumental in building capacity on gender mainstreaming and the

Type of Support	Year	Name Of Entity	Purpose of Support	Impact of Support
				importance of climate change with government agencies and NGOS instrumental to the implementation of Antigua and Barbuda's climate change programme. The workshop resulted in a completed output under the AF's technical assistance grant with the DOE and solidified among DOE stakeholders the importance of mainstreaming gender and social inclusion.
Technical Assistance	2020	Ministry of Agriculture	To assist the DOE with conducting farmers interviews for the completion of the Baseline Gender Assessment of Antigua and Barbuda Climate Change Programme in Agriculture	The DOE along with the Ministry of Agriculture conducted farmers interviews for the completion of the Baseline Gender Assessment of Antigua and Barbuda Climate Change Programme in Agriculture. The support from the Ministry of Agriculture was critical in securing interviews with farmers for the completion of the report. The Ministry organized all interviews and provided transportation to facilitate interviews with farmers. The partnership with Ministry of

Type of Support	Year	Name Of Entity	Purpose of Support	Impact of Support
				Agriculture assisted the DOE in compiling and publishing Its baseline assessment of Antigua and Barbuda's climate change programme which resulted in specific targets in Antigua's updated NDC as well as required outputs under the GCF 4 Readiness Support project and the project titled "Preparation of the Fourth National Communication under UN Framework Convention on Climate Change".
Technical Assistance	2020	ABICE	To assist the DOE with conducting interviews with professionals in construction, plumbing, electricity, vehicular maintenance and water plumbing to assess the impacts of a just transition.	ABICE organized all interviews, provided essential documents. This data collection exercise was essential to inform targets for just transition in the NDCs required outputs under the GCF 4 Readiness project and the Fourth National Communication project.
Technical Assistance	2020	NDC Partnership: Global Green Growth Institute (GGGI) and Climate Analytics	To assess the DOE in conducting an assessment on the mainstreaming of gender and social inclusion in the NDC process.	The GGGI— implementing partners of NDC CAEP initiative, supported the DOE in conducting assessments on the mainstreaming of gender and social inclusion in the NDC

Type of Support	Year	Name Of Entity	Purpose of Support	Impact of Support
				process. The gender assessments were instrumental in developing the NDC targets on energy, gender and social inclusion strategies, an affordability and accessibility survey on access to renewable energy, and a study on just transition of the workforce for the electricity and road transport sectors.
Capacity Building	2022	OECS Commission and partners	The DOE partnered with the OECS Commission and other partners to conduct capacity building with the OECS and its partners on ESS and Gender risk assessment and the development of project complaints and grievance mechanisms.	The DOE's ESS and Gender team conducted a capacity building session on Risk Assessment and project complaints and grievance mechanism with the OECS Commission as well as executing entities in Grenada and Dominica under the GCF Enhanced Direct Access (EDA) project.

Climate Finance and Nationally Embedded Technical Assistance

The emergence of COVID-19 and the resulting pandemic represented a challenging time for Antigua and Barbuda and the DOE. The COVID-19 crisis increased pressure on the Government's systems and demonstrated the need for improved strategic planning and strengthening of project management within the public sector. The COVID-19 pandemic: (i) contracted Antigua and Barbuda's economy; (ii) led to a decline in tourist arrivals by air and sea resulting in a contraction of tourism revenue; (iii) impacted on the livelihoods of workers relying on the tourism industry for employment; and (iv) caused disruptions in imports at ports and threats to food security.

Efforts to address the impacts of climate change were compounded by the COVID-19 global pandemic. As a result, there was an opportunity to adapt the country's recovery plans to address both its economic and climate change objectives. For the Department, the restrictions introduced to manage the spread of the COVID-19 pandemic in the country resulted in project implementation delays and procurement delays. COVID-19 constrained the hiring of external consultants and restricted their ability to travel in country as well as conduct workshops, consultations, and other meetings.

To navigate the COVID-19 pandemic and drive recovery, the Government committed the DOE as the focal agency for the coordination of the NDCs, the Ministry of Finance and the NDC Partnership to collaborate in economic recovery planning for Antigua and Barbuda. Subsequently, the NDC Partnership collaborated with the World Bank and the UK Government to provide support in the form of embedded advisors to support the MOF for 12 months. As a result, the Ministry received an economic advisor to assist in recovery efforts, a climate finance advisor to support the development of a new Medium-Term Development Strategy (MTDS) (and a monitoring framework) that aligns with national priorities, Sustainable Development Goals and incorporates low-emission, climate-resilient development strategies and a project management consultant to set up and operationalize the ministry's Project Management Unit and prepare it for new projects.

Monitoring Climate Finance for Climate Action

Antigua and Barbuda has established an enabling environment for addressing climate change and accessing climate finance, and has seen achievements since 2015 including: (a) legislating a national environmental fund, the Sustainable Island Resources Framework Fund (SIRF Fund); becoming accredited to the Adaptation Fund (AF) and Green Climate Fund (GCF)—the first national entity in the region; and accessing now five successful readiness grants from the GCF. It has also agreed to a roadmap for engagement with the GCF that puts forward an ambitious project pipeline. The DOE has also secured a $20 million GCF project to assist Dominica and Grenada with climate finance readiness.

Assessing Climate Finance Flows

The country has accessed several sources of climate financing, including those from multilateral climate change funds, public and private, and bilateral sources. This has increased the country's need to improve government-wide coordination, monitoring, verifying, and reporting on climate finance. The UNFCCC Secretariat supported the

Government through its Needs Based Finance (NBF) Project, which was executed by the DOE, and the Ministry of Finance. The technical assistance under this project enabled the development of an initial methodology for assessing the relationship between public expenditure and climate finance. The GOAB is seeking to build on the outputs of this project to support the mainstreaming of climate change concerns in its budgeting process.

Commonwealth Climate Finance Advisor

The Commonwealth Secretariat has been assisting the Government, through the DOE, to strengthen its institutional capacity to mobilise and utilise climate finance to build its resilience to climate change and mitigate against greenhouse gas emissions. This support is delivered under the Commonwealth Climate Finance Access Hub, which aims to facilitate improved access by small and vulnerable countries to climate finance to meet their priority needs in securing sustainable development. To do this, the Hub has placed a long-term adviser to work along with the DOE to support national efforts to access and effectively use international climate finance. The focus is on building the necessary capacity to access climate finance through on-job training in developing project proposals and completing application procedures for relevant funds such as the GCF, and through promoting South-South cooperation, exchange, and mutual learning.

Development of Data Partnerships

The development Data Partnerships facilitates the use of data in research and to inform environmental management and project development. Through the Department's Data Management Programme Memorandum of Understanding, data sharing agreements were signed with entities to strengthen collaboration and lay the groundwork for expanding various initiatives.

Memorandum of Understanding with CEFAS

In November 2017, the DOE and the Centre of Environment, Fisheries and Aquaculture Science (Cefas) signed a Memorandum of Understanding (MoU) to facilitate collaboration between both organizations. To assist the long-term goals of enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change, the DOE of the GOAB aims to develop a National Adaptation Plan (NAP). A scope of works was developed between DOE and Cefas to outline areas of collaboration in support of this initiative. A GCF grant was secured by the DOE and following the devastating impact of hurricane Irma in Barbuda in September 2017, the UK Government Commonwealth Marine Economies Programme (CME Programme) provided additional resources to fast-track the work. This work involved:

a) establishing adaptation baselines through data collection, compilation, and comprehensive climate change risk mapping;

b) developing Vulnerability Risk Assessments and NAPs for up to three Government agencies, three communities/NGOs and three private sector entities using a 'learning by doing' capacity building approach;

c) developing the NAP; and

d) developing a sustainable financing strategy to facilitate NAP implementation in the Government, community, and the private sector.

Technical Assistance Provided by DOE's Data Management Unit

Table 7.4: Support provided by the Data management unit of the DOE

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support	Beneficiaries
Workshop: "Introduction to GIS" workshop for Public Sector, NGOs and CSOs in support of Monitoring and Assessment of MEA Implementation and Environmental Trends in Antigua and Barbuda.	2020	DOE	-To strengthen capacities for effective data management across various sectors. -To enhance the capacity of staff members and other relevant stakeholders through the development of their ability to utilize open-source GIS software. -Provide the knowledge and skill needed to improve the utility of the Environmental Information Management and Advisory System (EIMAS).	- Participants introduced to the principles of data management so they can start identifying the needs of their agencies/organizations. - Participants introduced to the concept of GIS as a tool for spatial data analysis and for information management. - Public sector agencies, local CSOs and NGOs introduced the necessary tools to create, organize, and view spatial environmental information. - Public sector agencies, local CSOs and NGOs	- Ministry of Works - National Parks Authority - Environmental Awareness Group - Ministry of Tourism - MEPA Trust - Ministry of Agriculture - Ministry of Agriculture Extension Division - Ministry of Agriculture Cotton Division - National Solid Waste

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support	Beneficiaries
			-To introduce members of the DMU's GIS team to colleagues and collaborators.	introduced to the necessary skills to create, organize, and view spatial environmental information.	Management Authority - Community Development Division - Fisheries Division - Statistics Division - GEF Small Grants Coordinator - Department of Analytical Services - Central Board of Health
Phantom 4 Pro UAS Training in support of Monitoring and Assessment of MEA Implementation and Environmental Trends in Antigua and Barbuda.	2020	DOE	-To enhance the capacity of the Environmental Awareness Group to use Unmanned Aircraft System (UAS) for field data collection.	- EAG staff familiarized with UAS protocols in Antigua and Barbuda. - EAG staff familiarized with care and operation of DJI Phantom 4 Pro drone. - EAG staff given opportunity to practice data capture with UAS in controlled environment.	Environmental Awareness Group

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support	Beneficiaries
KoBo Toolbox Training for public sector, NGOs and CSOs in support of Monitoring and Assessment of MEA Implementation and Environmental Trends in Antigua and Barbuda.	2021	DOE	- To strengthen capacities for effective data management across various sectors. - Enhance capacity by developing ability of stakeholders to utilize KoBo Toolbox software. - Encourage data collection. - Provide the necessary information to empower stakeholders to build and deploy adequate survey instruments using KoBo Toolbox.	- Public sector agencies, CSOs and NGOs provided with introduction to open-source data collection tool. - Public sector agencies, CSOs, and NGOs provided instruction and practice through all stages of the data collection cycle from problem identification to survey design to data collection. - Participants provided with instructional reference material for future guidance.	Substance-use Prevention Assessment and Rehabilitation Centre - Department of Social Policy, - Research, and Planning - Family and Social Services Division - Community Development Division - Friends of the Care Project - National Vocational and Rehabilitation Centre for Persons with Disabilities - Ministry of Social Transformation - National Office of Disaster Services - Statistics Division

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support	Beneficiaries
Capacity Building: SwellPro UAS Training in support of Monitoring and Assessment of MEA Implementation and Environmental Trends in Antigua and Barbuda	2021	DOE	To enhance the capacity of the Wallings Nature Reserve (WNR) to use UAS for field data collection	- WNR staff familiarized with UAS protocols in Antigua and Barbuda. - WNR staff familiarized with care and operation of SwellPro drone. - WNR staff given opportunity to practice data capture with UAS in controlled environment.	Wallings Nature Reserve

Enhancing Project Management and Procurement Procedures - Establishing Ties with the Canada-CARICOM Expert Deployment Mechanism

The DOE embarked on a new partnership with the Canada-CARICOM Expert Deployment Mechanism (CCEDM). This project is working across the Caribbean to address priority needs identified by national governments while supporting countries in their efforts to:

- Strengthen and diversify local economies
- Build strong, climate-resilient communities
- Reduce gender and economic inequalities

CCEDM's work with advisors from the Canadian Executive Service Organization (CESO) to provide technical assistance (strategic advice, coaching, training, workshops, networking, etc.) based on expressed government needs.

The Department has applied for support from the CCEDM to:

a) provide training and capacity building support for the Project Management Unit (PMU) for project development and implementation to support its mission and mandate and identify gaps and measures to close these capacity gaps.
b) Update its Procurement Manual and Policy, which was developed and approved in 2017.

Table 7.5: Partnerships and Technical Assistance Received for project Management

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
Capacity Building	2017	Inter-American Development Bank	Certificate in Project Management Techniques for Development Professionals	Improved project management capacity within the Department of Environment
Capacity Building	2021	Green Climate Fund	Impact evaluation design	GCF Accredited Entity and other agencies increased capacity in monitoring and evaluation. More than 10 people benefited.
Partnership	2019	OECS Commission	To enhance project knowledge and learning.	The Department as an Accredited Entity entered into a MOU with the OECS Commission M&E Unit, to provide external M&E services to independently

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
				evaluate project results (*Sub-component 1.4 Monitoring, evaluation, reporting and promoting learning*) for the Enhanced Direct Access project, which is funded by the Green Climate Fund.
Technical Assistance	2022	OECS Commission Commonwealth of Dominica Grenada	The Department is also providing technical assistance to support accreditation of three direct access entities in the Eastern Caribbean, including for on-lending accreditation to international environmental funds.	Support the direct access accreditation application process. This would involve identifying their capacity building needs and assisting in the development of any missing or necessary policies.

Table 7.6: Technical Assistance Received for Procurement

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
Technical Assistance	2021	Sustainable Public Procurement (SPP)	Certification Programme on SPP. Support valued at US$1940.03.	Certificate in SPP to enable integration of SPP into the procurement processes. Primary beneficiaries were two DOE officers.

Technical Assistance	2022/2023	Chartered Institute of Procurement and Supply (CIPS) and Caribbean Development Bank (CDB)	Provide professional certification in procurement and supply. Support valued at US$5,586.90.	To improve management of procurement

The Global Green Growth Institute (GGGI) for Project Development

The purpose of this MoU is to formalize a framework of cooperation and to facilitate collaboration between the Parties to promote development and implementation of projects and programs for the Green Climate Fund. The DOE and the GGI will cooperate in preparing project concept notes, implementing GCF project preparation grants and/or readiness proposals, and/or other applications, identifying consultants and technical assistance for the development and the eventual implementation of the projects.

Adaptation Planning

Antigua and Barbuda's national adaptation planning process focuses on the full integration of climate change adaptation into national development planning and budgeting and therefore seeks to facilitate the holistic adjustment of the public and private sectors to tackle challenging issues caused by the adverse effects of climate change. The Department has established a Memorandum of Understanding (MOU) with the Inland Revenue Department (IRD) concerning their collaboration in the provision of funding for the development of a sectoral adaptation plan (SAP) for financial sector and the overarching National Adaptation Plan (NAP). The objectives of the MOU are:

(a) To enhance the resilience of the financial sector to the adverse effects of climate change through the development of a Sectoral Adaptation Plan (SAP) for the Financial Sector and the overarching NAP;

(b) To promote the use of the climate lens in the development and implementation of existing and future strategies and plans of the Inland Revenue Department (IRD); and

(c) To integrate and enhance national decision-making databases including those of the IRD to support adaptation mainstreaming into national development processes.

Building Relationships to Address Biodiversity Issues

To develop and implement effective biodiversity conservation and management strategies, the Biodiversity, Ecosystem, Protected Areas Management (BEPAM) Unit has embarked on varying models of partnerships and technical assistance. Over the years, relationships have been formed with non-governmental organizations, government agencies, local communities, civil society groups, academia, and sector representatives. Partnerships as well as technical assistance provided to and by the Unit have been important in facilitating the monitoring of biodiversity issues.

Table 7.7: Technical Assistance Given by the DOE's BEPAM Unit

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
Risk Evaluation and Environment Impact Assessment (EIA)	2018	Energy Unit, Antigua Public Utilities Authority (APUA), Abu Dhabi Fund for Development, CARICOM Development Fund, New Zealand Ministry of Foreign Affairs and Trade	1. Provide an environmental review 2. Conduct an EIA	- Facilitated achieving development approval of project - Raised awareness of climate mitigation and adaptation - Reduced vulnerability of Barbuda population to climatic hazards - Contributed to national policy to build back better Beneficiaries include all residents of Barbuda, approximately 2000-2500 and visitors to Barbuda.
Lecture	2018	Gilberts Agricultural and Rural Development (GARD) Center	Presentation on climate change impacts	Raised awareness of participants. More than 30 people benefited.
Project proposal appraisal	2019-20	Inter-American Institute for Cooperation on Agriculture (IICA) The Caribbean Biodiversity Fund	Provide technical review and support for the development of proposal	Presented "Strengthening Coastal and Marine Climate Resilience through Upland and Coastal Ecosystem Based Adaptation and Community Engagement". Over 150-200 persons directly benefited.
Review and planning	2022	Bureau of Standards	Review and development of national quality assurance priority	Development of quality Infrastructure.

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
			area of agriculture.	
Review	2022	Department of Meteorological services, and the World Meteorological Organization		Development of a national strategic Plan for Weather. Water and Climate Services.
Review	2021	Department of Blue Economy and the Commonwealth Secretariat	Maritime Economy Plan.	Development of a national policy for the Blue Economy.
Review, Monitoring	2018	Department of Works, the Caribbean Development Bank, and the Department for International Development (DIFID)	Reviewed road rehabilitation study for environmental risk. Monitored construction of the Friars Hill Road.	- Ensured roads are climate resilient. - Minimized environmental impact.
Policy guidance	2022	Department of Blue Economy	Commonwealth Blue Charter: Ocean Action Reporting Form	- Provided information to the Department.
DCA – Environmental Risk Assessments and EIAs	2017-2022	Development Control Authority	Reviewed development applications to identify their environmental risks and if necessary, set Terms of Reference for EIAs and overall supervision of the EIA process nationally.	- Ensured large and significant developments are in line with national environmental laws and support sustainable development goals and objectives.

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
Policy support, monitoring and evaluation	2021	Ministry of Finance	Provided support for the development of the updated Medium-Term Development Strategy.	- Assisted the Ministry of Finance to prepare and update national achievement of SDGs.
Public consultation, project writing	2022	Ministry of Agriculture	Rehabilitation of water course.	- Ongoing activity to rehabilitate the East Country Pond into a safe public green space.
Technical Assistance	2022	Environmental Awareness Group	Environmental Conference	- Provided Technical Assistance in raising awareness of the Convention of Biological Diversity, Global Biodiversity Framework and how each Community Group can contribute to it.
Technical Assistance	2022	WOTA	Survey Development	- Provided technical assistance in developing a survey for distribution in Antigua on behalf of WOTA Japan to quantify water usage on Island and assess the feasibility of using WOTA's water recycling technology.
Technical Assistance	2022	Integrated Health Outreach (IHO)	Completed Survey	- Completed two surveys with IHO to highlight how the DoE works with Community groups and how easy the access is to Environmental

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
				Biodiversity Information.
Technical Assistance	2021	Freemans Ville Primary School	School Presentation	- Presented to the Primary School on Biodiversity.
Technical Assistance	2019 - 2022	OECS	Biodiversity and Ecosystems Management Committee	- Provides technical advice to the OECS as to the needs of Antigua and Barbuda with respect to Biodiversity Conservation and Sustainable Unit.
Technical Assistance	2016 –2018 and 2022	Plant Protection Board (PPB)	Represented the DoE on the PPB	- Provides technical assistance with respect to the implementation of the Plant Protection legislation with respect to the role of the PPB from the perspective of the DoE.
GEF – Path to 2020 Project				
Technical Assistance	2021/ 22	Wallings Nature Reserve Inc.	Reforestation Efforts	Assisted the NPO in their reforestation efforts of Signal Hill through the removal of the Invasive Lemongrass and the planting of fruit trees.
GEF – Cost of Invasive Alien Species in the Eastern Caribbean Countries and Barbados Project				
Technical Assistance		Primary and secondary schools	Preparation for their internal and regional examinations on pathway of invasive alien species	- Public education and awareness of early detection, control, prevention and eradication of invasive alien species.

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
Technical Assistance		Antigua and Barbuda Chamber of Commerce	General knowledge of Invasive alien species in Antigua and Barbuda	- General education and awareness of Invasive alien species.

Table 7.8: Technical Assistance provided to the DOE's BEPAM Unit

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
Capacity Building	2017	World Bank	Post Irma Disaster Assessment	Assisted in developing the impact assessment of the damage experienced by the passage of hurricane Irma. More than 50 people benefited.
Capacity building	2020	National Office of Disaster Services (NODS), and the United States Southern Command (USSOUTHCOM)	Organization and Operation of Emergency Operations Centers	Increased human resources capable of taking command in an emergency event. Two staffers from the DOE trained.
Capacity building	2019	NODS, World Bank	Post Disaster Needs Assessment	Increased national capacity to conduct Disaster Needs Assessment.
Capacity building		Government of China	Coastal spatial modelling	Increase capacity in use and interpretation of climate model impacts on coastline.
Capacity building	2022	UWI, Caribbean Agricultural Research and Development Institute (CARDI), Caribbean Catastrophe Risk	Regional Climate Resilience Workshop	Increased awareness in climate resilience. More than 40 people trained.

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
		Insurance Facility (CCRIF), Climate Investment Funds (CIF), International Development Bank (IDB)		
Capacity building	2022	Smith and Warner International	Coastal Engineering 101- The Caribbean Context.	Improved regional knowledge of coastal engineering and times to use it. More than 30 people trained.
Capacity building and technical review	2017	Centre for Environment, Fisheries and Aquaculture Science CEFAS	- Training in EIA - Assisted in a coastal review as part of the DCA application process.	More than 20 people trained in EIA.
Capacity building	2021	GARD Centre	- Climate smart capacity building	Certification in Sustainable Agriculture.
GEF – Path to 2020 Project				
Equipment Donations	2021	Lifeplan	Path to 2020 Biodiversity Data Collection. Support valued at 718.78USD.	This project seeks to DNA barcode the biodiversity found in Wallings Forests and the Botanical Gardens.
GEF – Cost of Invasive Alien Species in the Eastern Caribbean Countries and Barbados Project				
Technical Assistance	2020/2021	National Archives of Antigua and Barbuda	Gap analysis of legislation on invasive alien species from 1683 - 1950	Assisted in the written account of the (1) critical situation analysis,

Type of Support	Year	Name of Entity	Purpose of Support	Impact of Support
				(2) national Invasive species strategy and action plan and (3) draft legislation for invasive alien species.
Technical Assistance	2021 / 2022	West Indies Oil Company	(1) Biosecurity and bio safety protocols for Ballast water in oil tankers to Antigua and Barbuda (2) Templates for risk assessment for marine environment	Assisted in the written account of the (1) critical situation analysis, (2) National Invasive species Strategy and action plan, (3) preparation of oral presentations to TAC and the general public. Beneficiaries of this support were school children and the general public.
Technical Assistance	2020/2021	Department of Geography and Geology, UWI, MONA	Templates for risk assessment for marine environment	Assisted project coordinator for the IAS Project in preparation of a risk assessment report with threat prioritized and recommendations for prevention; preparation of oral presentations to Technical Advisory Committee and the general public.

SUMMARY

Antigua and Barbuda will continue to partake in any program that provides technical assistance. Due to its limited capacity, the country remains open to technical assistance that will allow it to transition while mitigating transitional risks. The technical assistance in the next phase will continue to focus on the priorities in this chapter and to further monitor and evaluate the same.

CHAPTER 8

NEXT STEPS FOR THE NATIONAL COMMUNICATION PROCESS, THE INTEGRATION INTO THE CLIMATE ACTION IMPLEMENTATION AND COMMUNICATION AND AWARENESS OF THE CLIMATE ACTION

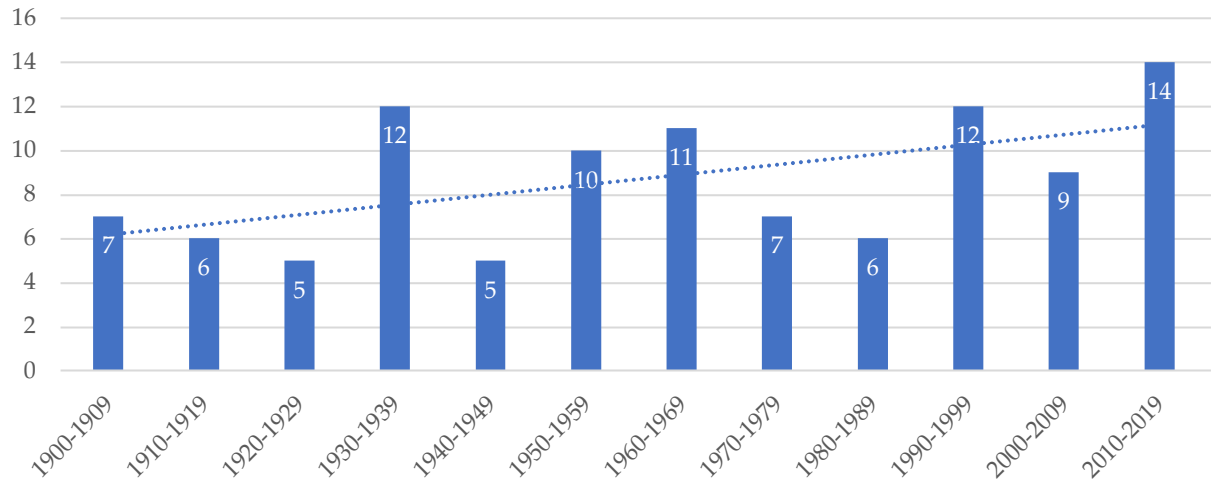
Climate Vulnerability of Antigua and Barbuda and Capacity and Institutional Requirements

The islands of Antigua and Barbuda are exposed economically, environmentally and socially to projected climate change impacts, which will result in a greater intensity of hurricanes, more frequent droughts, high temperatures and sea-level rise [258]. The country is basically in Hurricane alley and is subjected to extensive droughts, heat and sea level rise. When there is a hurricane or a drought the entire country and the entire population is impacted.

Also, it was observed that the moving average from 1990 showed a gradual increase in the average wind speed of these systems. This might have been mainly due to the influence of one category 4 and two category 5 hurricanes. Category 4 and 5 hurricanes have also been on the increase.

Antigua and Barbuda has developed an climate strategy in response to the climate emergency. This is summarized in Table 4.

Figure 8.1: Linear Forecast of Tropical Systems, 1900-2019



[258] GoAB. 2020. Antigua and Barbuda's First Biennial Update Report.

Figure 8.2: Average wind speed of storms from 1900-2019

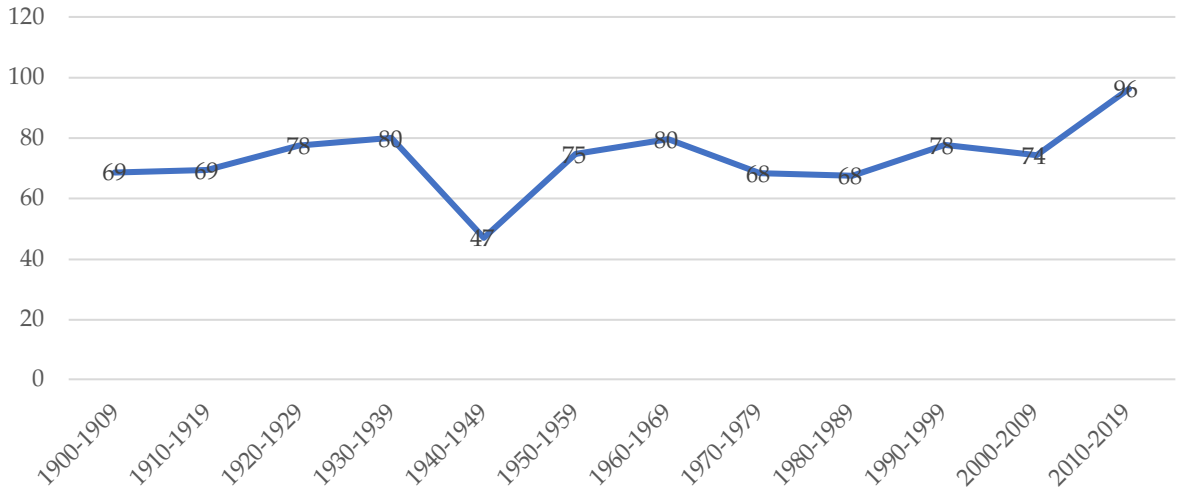


Table 8.1: Climate Variables and Impacts in the Context of Antigua and Barbuda and the Approaches of the National Communication Process.

Climate Variables	Climate Variability	Climate Impacts	Affected Sectors	Example of Investment/Actions
Temperature	More hot and dry days	Increased incidence of serious illness among elderly, children, and the poor Increased heat stress in livestock Increased energy demand and reduced energy supply reliability	Agriculture (Crops), Infrastructure, Livelihoods	Raise awareness Provision of potable water Provide RE AC systems to increase cooling while reducing the increase of emissions Improve efficiency of homes as well as indoor air quality Improve building codes
Precipitation	Change in rainfall patterns; Drier period and frequent droughts; More intense rainfall episodes leading to flooding	Drought leads to reduced income for farmers, reduced yield; In addition, illness, reduction of drinking water sources, migration and loss of livestock	Agriculture (Crops, Livestock), Water, Energy, Livelihoods, Health, and Infrastructure	Move desalination from 40% to 100% by 2030 Improved irrigation and water management Use resistant crops, improvement in cropping systems

		Increased chances of local flood; Increased soil erosion		Fund community rainwater harvesting projects Upgrade existing water supply infrastructure to minimise leakages Develop new drainage code Improve drainage according to code Provide RE systems to farmers to support the increased use in electricity due to more frequent droughts Provide innovation support for new technologies in water management and generation for farms and regular businesses
Wind Events	Increase intensity of Tropical Cyclones (not necessarily frequency)	Wind related damages	Housing, Livelihoods, Health, Agriculture (Crops, Livestock), Infrastructure, Energy, Livelihoods	Improve and revised building codes by 2025 Develop an improved methodology for acquiring meteorological and hydrological data and establish a knowledge and data sharing platform Provide farmers with the ability to have resilient food production systems Raise roads, burying utility lines Improve drainage codes and systems using ecosystems-based approaches Increase all buildings in the country to improve the resilience of the homes from Category 3 - Category 5 Make insurance coverage for Cat. 4 and 5 hurricanes mandatory for

				all buildings, farms and fishers by 2030 100% RE back-up energy systems in key sectors, including the homes of first responders
Sea Level Rise	Salinity intrusion and coastal erosion	Destruction of coastal structures and coastline	Agriculture (crops), water, livelihoods, health, infrastructure, housing, tourism	Revise land use plans to improve setbacks from the coastlines Other actions are being developed as part of the NAPS

Source: Watson C, Robertson M, Ramdin A and Bailey C. 'Assessment and Overview of Climate Finance Flows: Antigua and Barbuda 2014–2017' (2020)

Economy, and COVID-19 Impacts on the Preparation of the 4NC

Due to its dependence on tourism, Antigua and Barbuda is also sensitive to changes in the global economy [259]. The recent COVID-19 pandemic has resulted in major disruptions to the tourism industry, halting most tourism activities. It is projected to have a final impact of GDP contraction by at least 20 percent with Government revenues declining by over 40 percent[260]. These disruptions combined with high debt are expected to have major financial and economic consequences for Antigua and Barbuda's development in the future and its ability to funds its adaptation program. This financial impact will have long term impact on the ability of the Government to maintain the capacity to implement the 4NC and other reports to the UNFCCC.

Institutions and Organizational Systems to prepare the National Communication

The country's climate action and reporting systems involve a number of key stakeholders (e.g., Focal Point agencies, Government agencies, NDA, DAE, and Private Sector & NGOs). The reporting structure and the Governance system for the implementation of projects and programs are the same. This approach allows for the synergies between processes and to benefit from recent and updated lessons learnt from projects and program implementation.

Over the past five years, their capacities for climate action have grown significantly. However, the Government's Climate ambitions, and transitional targets requires a wider variety of human and technical capacity for its policy project pipeline baseline work, coordination, and implementation to include tracking climate finance flows, assessment of fiscal and monetary policy in line with Article 2(1)(c) of the Paris Agreement, strategic impact assessments on the proposed actions, and stakeholder engagements.

The capacity building although strong will still need building to implement and report. This clear need for capacity building and support is best achieved through a mixed approach of *in*

[259] Caribbean Development Bank. 2018. Antigua and Barbuda: Country Economic Review. Available at: https://www.caribank.org/publications-and-resources/resource-library/economic-reviews/country-economic-review-2018-antigua-and-barbuda.

[260] Informal Figures from the Ministry of Finance. Assessments are still ongoing.

situ technical assistance, expert consultancies, and training.

The Department of the Environment

The Delivery Partner for this Readiness Proposal is the Department of Environment of Antigua and Barbuda (DOE). The DOE is a direct access Accredited Entity to the Green Climate Fund (GCF) (as well as a National Implementing Entity to the Adaptation Fund), the national focal point for climate change, and is responsible for coordinating climate financing initiatives as well as developing and implementing projects and programs to advance the UNFCCC in Antigua and Barbuda and further national policies, goals and strategies.

Within this portfolio of priorities, the DOE has experience in the development of the 2nd NC, 3NC and the 4NC. The DOE is well experienced in the project design and implementation and have been recognized for its outcomes. The Department was responsible for implementation of the 4NC and undertook the necessary fiduciary and financial management, procurement of goods and services, monitoring and reporting activities under this proposal in compliance with the DOE policies and procedures and with the oversight and support from the UNEP as the implementing agency.

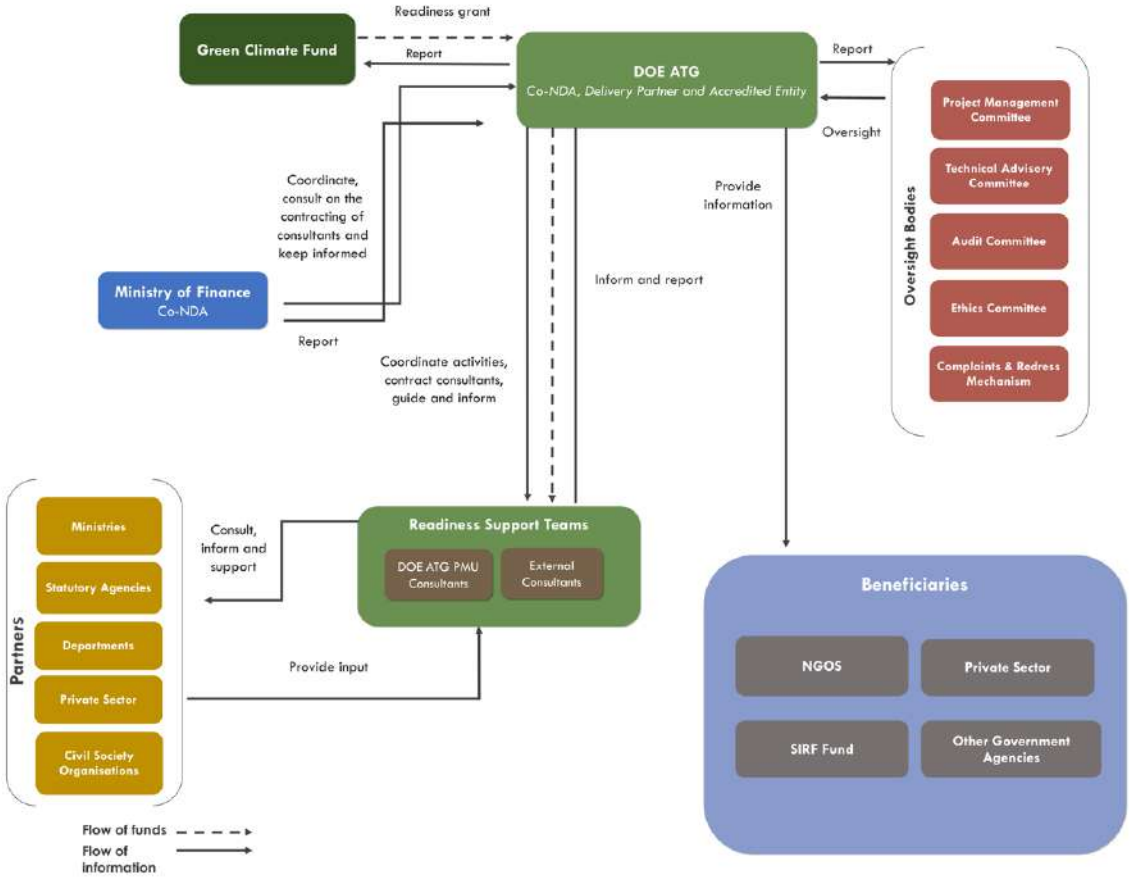
Project Management Unit – The DOE has a Project Management Unit (PMU) to manage day-to-day project activities. The PMU of the DOE is designed to achieve efficiency and coordination in the management of projects from a variety of contributors, including government co-financing projects. The PMU promotes effective coordination when there are project activities that are inter-dependent for execution, such as in this case co-financing or in-kind support for project development. The unit consists of regional and national project coordinators and consultants and is structured to draw on expertise from the public sector (through civil servant secondment) and the private sector (contracted long- or short-term consultants) in accordance with its Operational and HR procedures.

The PMU is assisted in its climate coordination work by the consultative body of a Technical Advisory Committee (TAC). The TAC currently consists of over 15 members from government, as well as several NGO and the private sector representatives. The TAC provides technical advice on projects, technical assessments of bid documents, ESS and gender oversight and provides financial oversight from a technical perspective through its representative on the Audit Committee.

The Project Management Committee (PMC) is an oversight committee within the DOE that is appointed by the Cabinet of Antigua and Barbuda. This committee was primarily established to provide financial, policy and administrative oversight. The PMC is also the body that can resolve any project conflicts that may occur between agencies during implementation.

The SIRF Fund - The Sustainable Island Resource Framework (SIRF) Fund is an entity that is part of the DOE and was formed via the Environmental Protection and Management Act, 2019 (EMPA 2019). The SIRF Fund is the designated national fund for climate change and is the mechanism through which international climate finance catalyses sustainable interventions and leverage national sources of financing to achieve transformational outcomes for the country. It is an important channel for environmental, climate mitigation and adaptation projects.

Figure 8.3: Implementation Arrangements for the 4NC in Collaboration with other Processes



Monitoring, Evaluation and Learning of the 4NC

Monitoring of the MYR Program will be in line with DOE regulation and policies and the terms of its agreement with UNEP. The M&E Plan for the national communication includes the establishment of indicators and milestones as part of other processes such as the NDC and project implementation rather that for the national communication.

The Monitoring, Evaluation and Data Management Unit (DMU) within the DOE has primary responsibility for monitoring the implementation of all agreements and processes. The DMU will conduct routine monitoring, provide support for data collection, analysis of data and preparation of key reports. The national communication process calls for diverse experts requiring the procurement of experts specializing in key areas.

Biannual and/or annual surveys will be conducted to track changes as climate action is being implementation. These are normally done with the use of interns and apprentices and with a strong link to TA assistance from regional and international agencies. Capacity scorecards will be used as a data collection tool to assess changes in the capacity of project development staff and note changes before and after exposure to any interventions. These assessment tools will be tested and reviewed with the support of

members of the Technical Advisory Committee and other key stakeholders.

The scorecards will also be provided to the DOE's oversight body, the PMC, for approval. The data collected will be used to inform evaluations. The salaries of relevant staff who will perform M&E activities will cover the work required for the necessary assessments, and stakeholder interviews required to inform project evaluations. Regarding ESS and Gender, a Monitoring Officer(s) and Gender Officer(s) are employed by the DOE to oversee and monitoring the application of gender-disaggregated indicators.

4NC Process and the Private sector and NGOs

Provision of data for reporting on climate finance and climate actions by the country's private sector and NGOs is the major area requiring institutional capacity building. The DOE and partners conducted extensive consultations and needs assessments with potential agencies to provide data and information for reporting. It is evident that government will play a catalytic role in transitioning to a low emission, climate resilient economy in order to mobilize downstream private sector and NGO actions.

Moreover, the Government is committed to involving the private sector in environmental decision-making when it enacted the *Environmental Protection and Management Act 2019* and ratified the *Escazu Agreement on Access to Information, Public Participation and Justice in Environmental Matters*. These two instruments create a legal mandate on the government to actively engage with the private sector when developing and implementing its climate actions. Furthermore, there is need for enhanced operational readiness of the private sector interest groups and NGOs to program climate finance in line with GCF's fiduciary standards on prohibited practices, ESS and Gender, procurement, and monitoring and evaluation, etc. NGOs and private sector interest groups in Antigua and Barbuda currently have no experience with GCF policies and processes, which limits their ability to engage in programming and implementing GCF funded activities.

This Government sought to address these gaps during the 4NC process by providing NGOs and private sector interest groups with technical assistance support, training to improve their standing with their respective regulatory bodies and compliance with corporate and financial requirements, and support in updating legal and regulatory frameworks in line with the Paris Agreement regulations on these standards.

Policy Environment to Support 4NC Preparation:

The 4NC was developed in tandem with several other policies mentioned throughout this report. The 4NC is therefore longer and contains more details on important areas of interest than the 3NC. As it relates to current work on this matter, there are a number of ongoing policy-related initiatives which will feed into the 4NC. These include, inter alia:

- Preliminary thematic analysis for these 2021 NDC targets under the NDC Partnership's Climate Action Enhancement Package;

- Support for the NDC revision process under UNDP Climate Promise initiative;
- Baseline and downscaled adaptation data collection and analysis, climate change risk modelling and mapping, sectoral adaptation planning with corresponding strategic impact assessments, and adaptation enabling environment development under the GCF Readiness Project; and
- Reporting on national measures responding to climate through the 4th National Communication to the UNFCCC under the GEF-funded enabling activity project.
- Report of the National communication to the UNFCCC;

There is still a need to build on the progress of these initiatives and take a deeper and more focused dive into the gaps, barriers and needs from a policy, regulatory, and market point of view. Based on the Government's current capacity, there is a need for human and technical capacity to analyze and assess the policy, regulatory, technological and market barriers within Antigua and Barbuda for progressing the proposed project pipeline on the following thematic area, inter alia:

- Electricity sector transition and corresponding sector coupling approaches
- Transportation sector transition and corresponding sector coupling approaches
- Back-up energy transition
- Electricity grid transition
- Finance resilience of vulnerable sectors through de-risking solutions from financial sector
- Finance resilience of the country through fiscal spacy creation from debt-for-climate swap
- Road infrastructure transition
- Just transition of the workforce in light of proposed climate actions.

Recognizing that in-depth analysis is a necessary pre-cursor to strengthening the policy regulatory and market environment, the 4NC team were instrumental in undertaking analysis of these policies and the implementation of climate agreements.

Information, Data and Knowledge

On the matter of information, data and knowledge needed for climate action, Antigua and Barbuda continues to make strides towards enhancing its repository and institutional systems through initiatives such as the NDC CAEP, NAP, and 4NC.

BUR1, however, noted that '*unfortunately, as a SIDS, Antigua and Barbuda is challenged in providing data due to limited human, technical, and infrastructural resources dedicated to the process of data collection and managemen*t.'

Under the UNFCCC NBF Project and GCF Readiness 4, there was also the development and trial of a fit-for-purpose methodology for tracking domestic and international climate actions in Antigua and Barbuda. The efforts at national climate finance tracking were constrained with human and technical capacity issues and the Assessment and Overview sections noted that, inter alia: there is a lack of dataset on private sector climate finance flows; and the method for assessing climate-related budget expenditure could be developed

further including identification of off-budget SOE flows, and brown finance flows.

As it pertains to MRV for the proposed climate actions there is a need for the development of preliminary performance metrics and associated indicators for the proposed actions and targets.

Sharing of Experiences

Over the years of the development of the 4NC, there has been a need for constant sharing of experiences in the following areas:

- Reporting to the UNFCCC;
- Experiences as a Direct Access Entity;
- Strategies for accessing climate finance and;
- Pipeline development lessons learned and best practices both regionally and amongst other small island developing States ('SIDS');
- Building awareness on the outcomes of the country's Readiness Support, and;
- Antigua and Barbuda climate action development and implementation.

Experience sharing is envisioned to be done via Antigua and Barbuda's membership in regional groups such as the OECS Climate Change Committee and Caribbean Community (CARICOM). This was also accomplished during Antigua and Barbuda's 2021-2022 Chairmanship of Alliance of Small Island States (AOSIS) which provided a unique opportunity and platform for dissemination of best practices with its particularly vulnerable SIDS membership.

Other processes and Reporting undertaken by the DOE and the Government while preparing the 4NC

While preparing the 4NC the DOE was also preparing the reports in Table 5. The DOE is an accredited entity to the Adaptation Fund and the Green Climate Fund (GCF).

Table 8.2: Previous and ongoing GCF Readiness Support and Synergies with the 4NC

Document Title	Objective	Current Status	Synergies with 4NC
ATG-RS-001 NDA Strengthening and Country Programming (2015)	This RS focused on supporting the NDA with the hiring of consultants and procurement of services to build the capacity of the Department of Environment and the Debt Management Unit which will has responsibility for coordinating with	Completed	4NC builds on economic and social information collected in RS 1.

Document Title	Objective	Current Status	Synergies with 4NC
	other ministries on GCF matters.		
ATG-RS-002 Realizing direct access climate financing in Antigua and Barbuda and the Eastern Caribbean (2016)	This RS focused on supporting the accreditation of a national direct access entity through the accreditation of the Department of Environment as well as supporting the further development and submission of the Enhanced Direct Access (EDA) funding proposal.	Completed	4NC builds on RS 2 in relation to RS Objectives 1, 4 and 5 by focusing on capacity building for accessing financing and M&E via the reaccreditation and a possible accreditation upgrade for the DOE in its capacity as a DAE as well as knowledge sharing amongst the region as well as SIDS on lessons learned.
ATG-RS-003 National Adaptation Planning in Antigua and Barbuda (2018 - 2024)	This RS focuses on conducting a national adaptation planning process that includes downscaled and GIS-based baseline data collection and climate risk assessment activities for adaptation action; evidence-based and consultative sectoral and local areas planning; and development of a corresponding enabling environment via policies, legislation and financial incentives necessary for the implementation of	Ongoing	4NC builds on R3 through its use of the work done under the NAP to enhance the development and implementation of the adaptation actions under the 2021 NDCs.

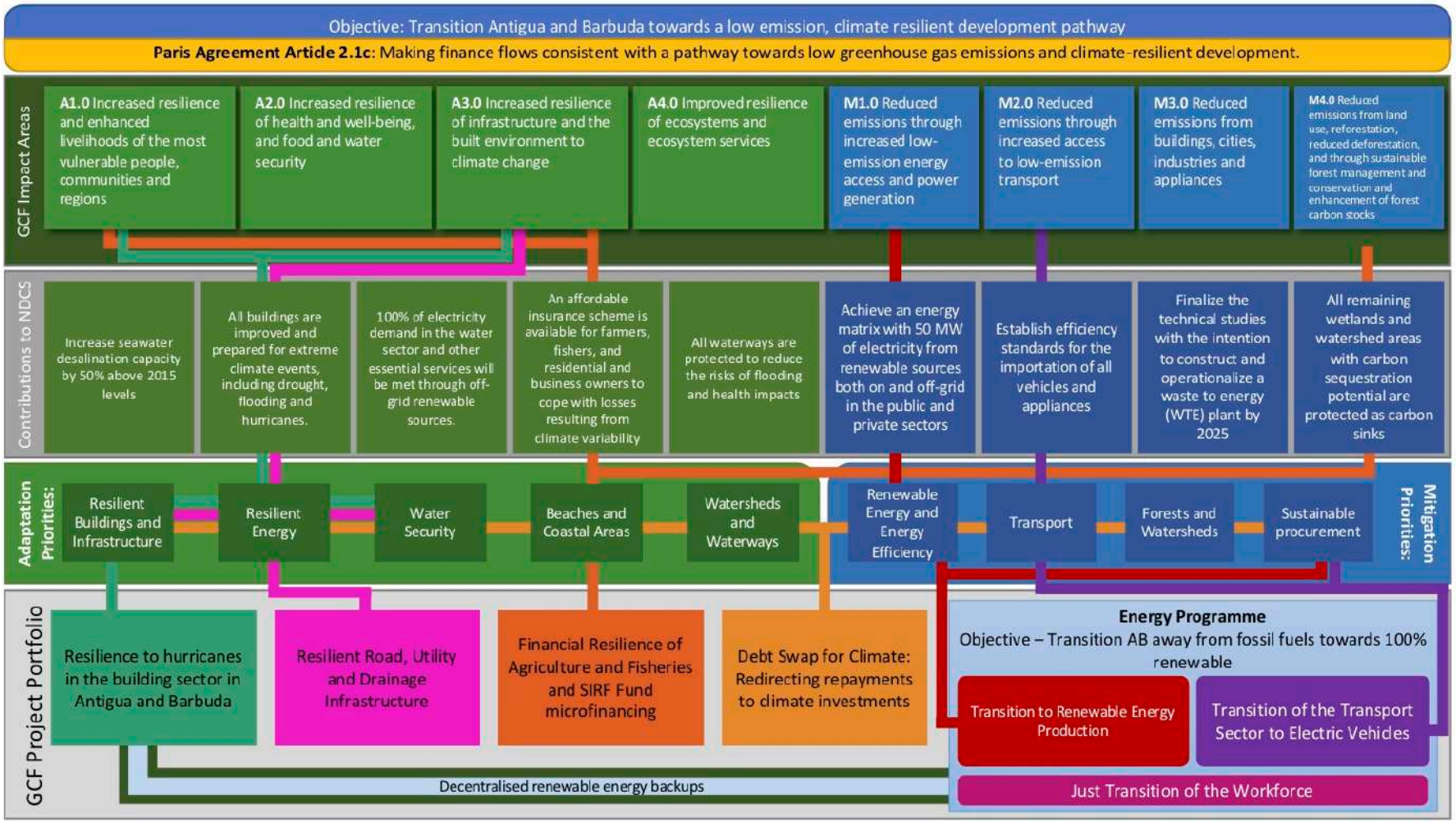
Document Title	Objective	Current Status	Synergies with 4NC
	the selected adaptation actions.		
ATG-RS-004 Accelerating a transformational pipeline of Direct Access climate adaptation and mitigation projects in Antigua and Barbuda (2019)	This RS focuses on accelerating ambition to implement the goals of the Paris Agreement 2015 by preparing for transformational impact in a small state.	Ongoing	On the three areas of complementary between RS 4 and the proposed RS 5, DOE ATG acknowledges that there is a clear connection as indicated in the CP Strategy. Further, RS5 shares complementarity with RS4 through the following activities: • A1.2.1: The institutional framework has now been established for the MRV system. An initial methodology for assessing the relationship between public expenditure and climate finance was developed under RS 4. Under the RS 5, a separate tracking system will be developed and integrated into the government system based on work conducted by UNFCCC NBF Project in RS 4. • A2.2.1 A baseline gender assessment was conducted to identify multiple cases of vulnerability to climate change among men and women well as identify the differential adaptive capacity to climate change. Baseline data collection was done on farmers and baseline data collected on social inclusive investment for private sector climate action completed to guide transformational gender interventions in A&B's Country Program. In RS 5, additional gender analyses will be conducted to integrate the baseline data into each CN. • A2.4.1 The Draft CNs were developed in RS 4 for the electricity grid, back-up energy, e-mobility, debt-for-climate swap, just transition, food security and financial resilience NDC thematic areas. RS 5

Document Title	Objective	Current Status	Synergies with 4NC
			builds on RS 4 through its enhancement and further inclusion of technical inputs to draft CNs developed under RS 4. • A2.3.2: Under RS 4, Technical Needs Assessment ('TNA') for climate action conducted in the following sectors: waste, energy including back up energy, resilient roads and finance. However, the technology prioritization done was only cursory and further research is needed. R5 will seek to close the gaps that remain at the completion of Readiness 4 and build the capacity of the DOE ATG and its co-NDA the MOF.
GCF -MYR 2022			The 4NC builds on the GCF readiness 5 or more accurately the reverse. It highlights areas such as just transition, debt restructuring and transitional risks.

Technical Partners

The DOE has formed collaboration with several agencies to assist the country in the implementation of its overall climate actions and from NREL and the OECS Commission. Each of these partners have invested significant time and resources into advising and studying all areas of climate action that was important to Antigua and Barbuda. The 4NC will allow for the DOE to continue to benefit from further external assistance which will allow for access to new and emerging technologies and knowledge to develop quality projects and quality climate actions.

Figure 8.4: Project Portfolio's Linkages with Antigua and Barbuda's 4NC, INDC, NDC, and GCF Readiness



NEXT STEPS, PUBLIC AWARENESS AND COMMUNICATION

The Government of Antigua and Barbuda is looking ahead towards the 5th national Communication and will need to plan its capacity building to meet the challenges of the UNFCCC as the countries are in full implementation mode. The following is a summary of the context of the main thematic areas for the 5th National Communication:

i. Energy Transition as a Means to Fund Adaptation
ii. Energy Resilience and Extreme Climate Events
iii. Energy Transition and Energy Resilience Road Map
iv. Strategic Approach to Alleviate Debt in the Public and Private Sectors
v. Achieving Article 2(1)(c) of the Paris Agreement
vi. Transitional Risk Management
vii. Just Transition of the Workforce
viii. Social Inclusion and Investment

Rational for 5NC approach

The GoAB understands and accepts that the negative impacts of climate change is a reality and is here to stay. The increased frequency and intensity of Category 5 hurricanes that affected Antigua and Barbuda in 2017, the Bahamas in 2019, Central America in 2020 and Grenada. It has become clear that these are not just climate aberrations but the new reality of the country and our region. Assessments done during the 4NC and NDC process have shown that the cost of Antigua and Barbuda adapting to a Category 5 hurricane is beyond the ability of over 70 percent of the population (initial costings under development for new draft Building Code). The GoAB is undertaking actions that are designed to: (1) result in cost reduction in business as usual i.e., emission reduction that saves on the importation of fossil fuel allowing for these savings to fund adaptation via economic growth and (2) to reduce the cost of adaptation and mitigation via sector coupling.

The transition to a low-carbon, sustainable future will involve strong planning and sector coordination. To respond to expected systematic shifts, technologies and strategies for Antigua and Barbuda have been prioritized and based on several detailed studies conducted for the NDC targets. Projects will be designed for the electricity grid, back-up energy, e-mobility, debt-for-climate swap, just transition, food security and financial resilience NDC thematic areas.

DOE has sought to advance its climate actions by implementing the Internship and Apprentice Program with GCF Readiness support. The internship component of the program is primarily executed during the summer months over a three-month period. An Intern working with the DOE to gain work experience are secondary or tertiary level students currently undertaking their studies. The length of an internship is normally for 3 months during the summer months when the students are on break. Interns can be potentially offered a position as an apprentice once they have completed their studies and based on their performance and their skill set. Qualified, skilled students and recent graduates are recruited and are involved in inter alia proposal development and management; M&E of projects and programs;

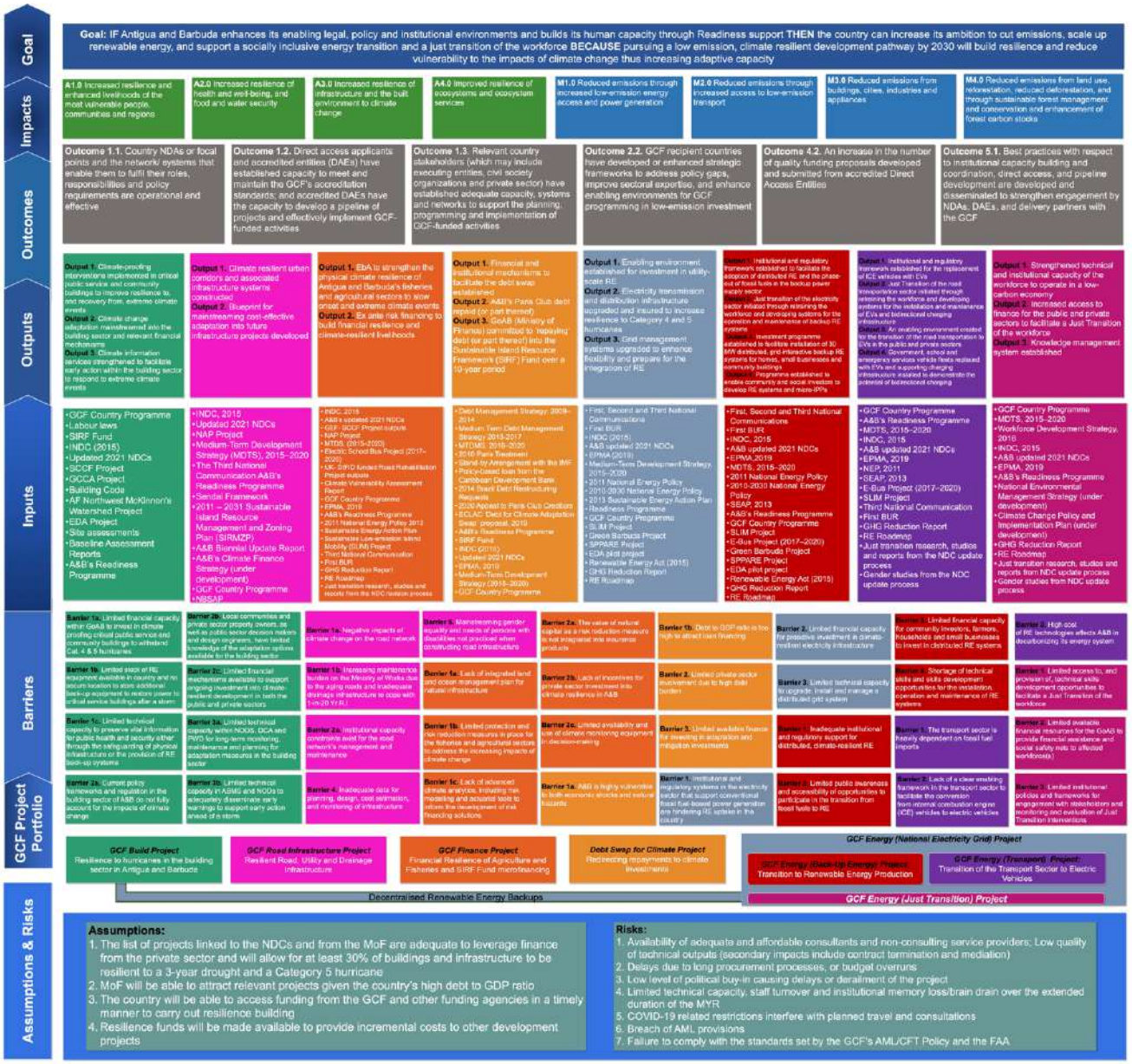
climate action MRV; geographic information systems; environmental assessment and monitoring; socio-economic assessment and stakeholder outreach; ecosystem valuation – data collection and analysis, economics, biodiversity, renewable energy, and ESS and gender.

Internships offered to students and graduates have equipped them with practical work experience that can enhance their employability as well as increase their awareness of job and career opportunities in the environmental sector. Former interns who perform well during their internship may graduate to become apprentices and undertake an initial six-month stint at the department. The Internship and Apprentice Program has proven effective in creating a pipeline of future full-time employees for DOE in order to meet its strategic staffing needs and to support projects and programs. Apprentices are persons with either a completed professional/vocational qualification, first degree or graduate who is working with the DOE in order to gain work experience in their relevant area of study/interest. The length of an apprenticeship is normally for 6 months.

The Internship and Apprentice Program was introduced as a means of taking a programmatic approach to hiring and training new employees thus preventing the gaps in capacity between one NC and the next. Recruiting and training these interns and apprentices proved beneficial in reducing costs and gaining access to talented individuals with the appropriate skillset.

This approach is designed to continue the systematic approach to supporting the enabling environment and capacity built from one NC to the next.

Figure 8.5: Theory of Change Diagram for the future GCF Readiness and the next national communication (5th NC).



Communication of Climate Action

Public awareness and education are essential for fostering a climate-resilient society. The DOE, in collaboration with educational institutions and media organizations, implements various public awareness campaigns and educational programs. These initiatives aim to inform the public about the impacts of climate change, the importance of adaptation, and the actions individuals and communities can take to enhance resilience.

Educational programs targeting schools and youth organizations are particularly important. The Communication and Awareness drive was implemented with several regional agencies, and other processes and targeted the introduction of new technology. Much of this work was discussed in earlier chapters and will not go into detail here. These chapters outline the integration and communication strategies employed by Antigua and Barbuda, highlighting the progress made, challenges encountered, and future directions for enhancing climate resilience.

Communication Tools and Platforms

A variety of communication tools and platforms are used to disseminate climate information and engage stakeholders. These include traditional media (television, radio, and print), digital media (websites, social media, and online portals), and community outreach programs. The DOE's website and social media channels provide regular updates on climate projects, upcoming events, and new research findings.

The use of visual aids such as infographics, videos, and interactive maps helps convey complex climate information in an accessible and engaging manner. Public service announcements and informational brochures are also distributed to reach a broader audience.

Challenges and Opportunities

While significant progress has been made, several challenges remain in the communication of climate change adaptation. These include the sheer number of media that is grabbing the attention of the public. The DOE therefore deployed a raffle to an EV, offered reduced prices for AC units etc. as a way to communicate climate action and the need for the same.

Despite these challenges, there are numerous opportunities to enhance communication efforts. Leveraging new technologies, fostering partnerships with media organizations, and engaging local communities in communication initiatives can significantly improve the reach and effectiveness of climate communication.

CONCLUSION

Effective communication is essential for the successful implementation of climate change adaptation strategies in Antigua and Barbuda. By enhancing stakeholder engagement, increasing public awareness, and utilizing diverse communication tools, the country can build a more resilient society. Continued efforts to address communication challenges and leverage new opportunities will be crucial for achieving long-term climate resilience and to get the public on board.

CHAPTER 9

INTEGRATION FOR THE NATIONAL COMMUNICATION FOR ANTIGUA AND BARBUDA POLICIES, PROGRAMS AND PROJECTS, INCLUDING THE PRIVATE SECTOR

Context:

Integration of climate change adaptation into national development planning is crucial for enhancing the resilience of Antigua and Barbuda. This chapter discusses the strategies and measures undertaken to integrate climate change considerations into national policies, plans, and sectoral activities. The goal is to ensure a coordinated approach to adaptation that aligns with international frameworks and supports sustainable development.

National Adaptation Coordination Structure

The Government of Antigua and Barbuda has emphasized the need to strengthen and reform national policies and institutional structures to effectively address climate change impacts. The Department of Environment (DOE), under the Ministry of Health, Wellness, and the Environment, plays a pivotal role in coordinating climate change adaptation activities. Established by the Environmental Protection and Management Act in 2015, the DOE transitioned from a division to a department, enhancing its mandate to include the Sustainable Island Resource Framework (SIRF) Fund. This act conferred authority to the DOE to coordinate multi-lateral environmental agreements and administer a sustainable financing mechanism for environmental management

The DOE's Climate Change Work Programme includes key functions such as Monitoring and Evaluation, Measuring, Reporting and Verification, Fiduciary Functions, and Database Structures. The DOE reports to Parliament through the Minister responsible for the environment and collaborates with other governmental and non-governmental agencies to implement adaptation activities. A Technical Advisory Committee (TAC) comprising representatives from various government agencies, NGOs, and private sector coalitions, provides technical guidance and policy recommendations, facilitating stakeholder communication and cooperation

Integrating Climate Change Adaptation into National Systems

Antigua and Barbuda have made significant strides in integrating climate change adaptation into national systems and processes through overarching policy frameworks such as the Medium-Term Development Plan, the 2021 Medium-Term Development Strategy, and the 2020 Economic Recovery Plan. These frameworks create an enabling environment for public and private sectors, as well as civil society organizations (CSOs), to prioritize climate change adaptation and mitigation.

Key sectors such as youth, tourism, blue economy, and social transformation have begun incorporating climate change considerations into their planning processes. For instance, the 2021 National Youth Policy outlines strategies for youth engagement in climate resilience, while the Ministry of Social Transformation and the Blue Economy has collaborated with the DOE to ensure gender responsiveness in their processes

Sectoral Integration of Climate Change Adaptation

Several sectors have embarked on integrating climate change adaptation into their systems and processes. The finance sector, through the NAP project, has developed sectoral adaptation guidelines and conducted capacity needs assessments. These efforts are aimed at building resilience by incorporating climate risk management practices, developing gender-disaggregated adaptation metrics, and promoting adaptation investment opportunities.

The fisheries sector, vulnerable to climate impacts, has also integrated adaptation measures. Projects such as the Climate Change Adaptation of the Eastern Caribbean Fisheries Sector (CC4FISH) aim to blend traditional knowledge with modern technology to enhance resilience.

Challenges and Gaps

Despite progress, several challenges and gaps hinder the effective integration of climate change adaptation. These include limited financial resources, inadequate access to climate data and information, and insufficient capacity for implementation and monitoring. Socio-political challenges, such as limited public awareness and engagement, also pose significant barriers .

CONCLUSION

Antigua and Barbuda's efforts to integrate climate change adaptation into national planning are critical for building resilience and achieving sustainable development. Continued strengthening of institutional frameworks, enhanced stakeholder engagement, and increased financial and technical support are essential to address the remaining challenges and gaps. The integration of adaptation measures across sectors will ensure a holistic approach to climate resilience, aligning with national and international goals.

CHAPTER 10

COMMUNICATION FOR THE 4TH NATIONAL COMMUNICATION FOR ANTIGUA AND BARBUDA

Introduction

Effective communication is vital for the successful implementation of climate change adaptation strategies. This chapter outlines the communication strategies and practices employed by Antigua and Barbuda to disseminate climate information, engage stakeholders, and enhance public awareness about climate change impacts and adaptation measures.

Communication Framework at the National and Regional level

The Department of Environment (DOE) leads the communication efforts related to climate change adaptation in Antigua and Barbuda. The DOE collaborates with the Government Information Service Unit and other relevant agencies to ensure the dissemination of accurate and timely climate information. The Freedom of Information Act No. 19 of 2004 underpins the legislative framework for access to information, promoting maximum disclosure in the public interest.

Stakeholder Engagement

Stakeholder engagement is a critical component of the communication strategy. The DOE conducts regular consultations with various stakeholders, including government agencies, NGOs, private sector entities, and community groups. These consultations provide a platform for stakeholders to share knowledge, discuss challenges, and contribute to the development and implementation of adaptation strategies.

The Technical Advisory Committee (TAC), comprising representatives from key government agencies and other stakeholders, plays a significant role in facilitating communication and cooperation. The TAC meets monthly to discuss ongoing projects, share updates, and provide technical guidance on adaptation activities.

Public Awareness and Education

Public awareness and education are essential for fostering a climate-resilient society. The DOE, in collaboration with educational institutions and media organizations, implements various public awareness campaigns and educational programs. These initiatives aim to inform the public about the impacts of climate change, the importance of adaptation, and the actions individuals and communities can take to enhance resilience.

Educational programs targeting schools and youth organizations are particularly important. The 2021 National Youth Policy emphasizes the role of youth in climate action and includes specific strategies for raising awareness and building capacity among young people.

Communication Tools and Platforms

A variety of communication tools and platforms are used to disseminate climate information and engage stakeholders. These include traditional media (television, radio, and print), digital media (websites, social media, and online portals), and community outreach programs. The DOE's website and social media channels provide regular updates on climate projects, upcoming events, and new research findings.

The use of visual aids such as infographics, videos, and interactive maps helps convey complex climate information in an accessible and engaging manner. Public service announcements and informational brochures are also distributed to reach a broader audience.

Challenges and Opportunities

While significant progress has been made, several challenges remain in the communication of climate change adaptation. These include limited financial resources for communication activities, the need for improved data management systems, and the challenge of reaching remote and vulnerable communities. Addressing these challenges requires continued investment in communication infrastructure, capacity building, and the development of innovative communication strategies .

Despite these challenges, there are numerous opportunities to enhance communication efforts. Leveraging new technologies, fostering partnerships with media organizations, and engaging local communities in communication initiatives can significantly improve the reach and effectiveness of climate communication

CONCLUSION

Effective communication is essential for the successful implementation of climate change adaptation strategies in Antigua and Barbuda. By enhancing stakeholder engagement, increasing public awareness, and utilizing diverse communication tools, the country can build a more resilient society. Continued efforts to address communication challenges and leverage new opportunities will be crucial for achieving long-term climate resilience.

These chapters outline the integration and communication strategies employed by Antigua and Barbuda, highlighting the progress made, challenges encountered, and future directions for enhancing climate resilience.

Annex 1 - Summary Mitigation Actions for Antigua and Barbuda and Other important Climate Data

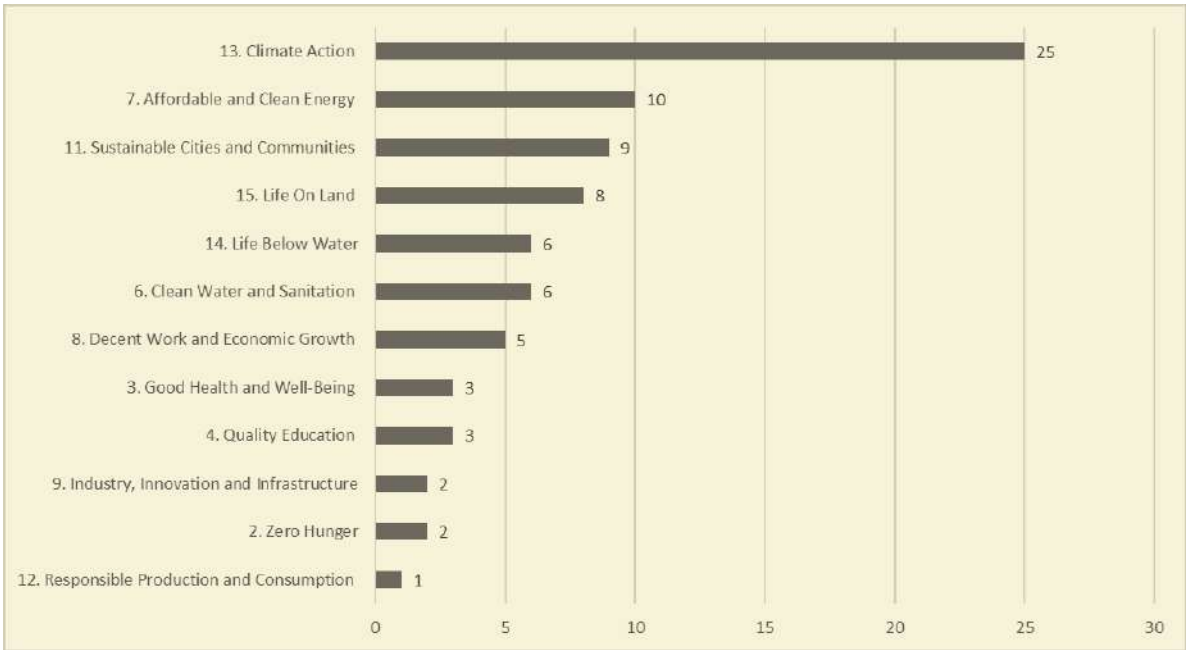
Table A1: Mitigation Actions for Antigua and Barbuda

No	Sector	Mitigation Action/Strategy	Completion Year	Modelled
1	Energy	Establish efficiency standards for the importation of all appliances	2020	Yes
2	Energy	100% Sodium Street lights replaced by LED lighting	2021	Yes
3	Energy	Overall Target: 86% renewable energy generation in the electricity sector.	2030	Yes
4	Energy	4.125 MW of wind turbines procured and installed	2021	Yes
5	Energy	Modular hybrid power plant installed in Barbuda	2021	Yes
6	Energy - Transport	Ban on importation of new ICE vehicles	2028	Yes
7	Agriculture, Forestry, Other Land Use	100% Remaining wetlands, watershed areas, and seagrass bed areas with carbon sequestration potential are protected as carbon sinks: Approx. 43216 tCO2 potential carbon sequestration per year	2030	No
8	Agriculture, Forestry, Other Land Use	20,000 Trees planted to restore degraded land and increase CO2 sequestration	2021	Yes
9	Energy	100 MW of renewable energy generation capacity available to the grid.	2030	Yes
10	Energy	50 MW of renewable energy generation capacity owned by farmers who can sell electricity to off-takers	2030	Yes
11	Energy	100 MW of renewable energy generation capacity owned by social investment entities	2030	Yes
12	Energy	20MW of wind-powered energy generation for a new zero greenhouse gas emission energy generation technology	2030	Yes

No	Sector	Mitigation Action/Strategy	Completion Year	Modelled
13	Energy	100% renewable energy generation for all government operations	2030	Yes
14	Energy	100% of fixtures and appliances in government buildings will be energy efficient	2030	Yes
15	Energy - Transport	Change in fiscal policies on fossil fuel to enable the transition to 100% renewable energy sources for the transport sector	2025	No
16	Energy Transport	100% of Government vehicles are electric vehicles	2035	Yes
17	Energy Transport	Establish efficiency standards for all vehicle importation.	2020	Yes
18	Energy	Building Code updated and passed into law in line with a climate-resilient development pathway including, inter alia, a requirement that all new homes built after 2025 have backup renewable energy generation and storage systems	2025	Yes
19	Energy	Enhance the established enabling legal, policy and institutional environment for a low carbon emission development pathway to achieve poverty reduction and sustainable development.	None	No
20	Energy	Elimination of the fuel surcharge tax on electricity bills	2030	No
21	Energy	Finalize the technical studies with the intention to construct and operationalize a waste to energy (WTE) plant targeting 20,000 homes.	2025	No
22	Energy	100% of female-headed households have all barriers removed to access backup renewable energy generation and storage systems	2030	No
23	Energy	20% increase in the number of women-led businesses implementing renewable energy and adaptation interventions	2030	No
24	Energy	100% of Water supply infrastructure powered by own grid-interactive renewable energy sources	2030	No

No	Sector	Mitigation Action/Strategy	Completion Year	Modelled
25	Energy	30,000 or 50% of pre-2020 homes to have backup RE systems for at least 4-6 hours of energy	2030	No
26	Energy	Education, health, food supply and/or storage, and energy shelter facilities powered by own grid-interactive RE sources; GISS: Grid-Interactive Solar PV Systems for Schools and Clinics; Sustainability Energy Facility / Caribbean Development Bank (SEF/CDB) project	2030	No
27	Agriculture, Forestry, Other Land Use	100% of Waterways are protected to reduce risks of flooding and health impacts	2030	No
28	Agriculture, Forestry, Other Land Use	Expansion of protection and sustainable use of globally significant biodiversity in protected areas and surrounding communities by 3035 hectares	2021	No
29	Finance	Establish dedicated technical and other support for de-risking GHG reduction investments by MSMEs in Antigua & Barbuda	2030	No
30	Finance	50 % increase in the number of MSMEs that provide energy services aligned with the objective of the Paris Agreement [SIRF Fund; Entrepreneurial Development Program Fund	2030	No

Figure A1: Number of Climate Actions Which Contribute to the Fulfilment of the Sustainable Development Goals



Source: OECS Climate Trends and Projections 2020

Figure A2: Short- and Long-Term Drought Impact Potential in the OECS

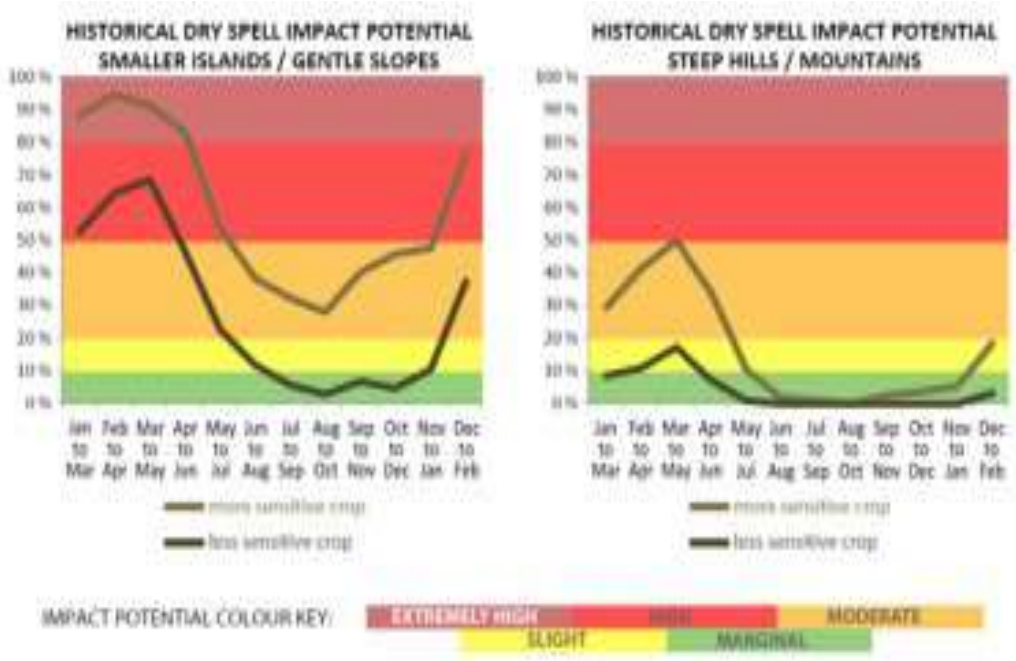


Figure A3: Total Aggregate GHG Emissions and Removals by Year and Gas

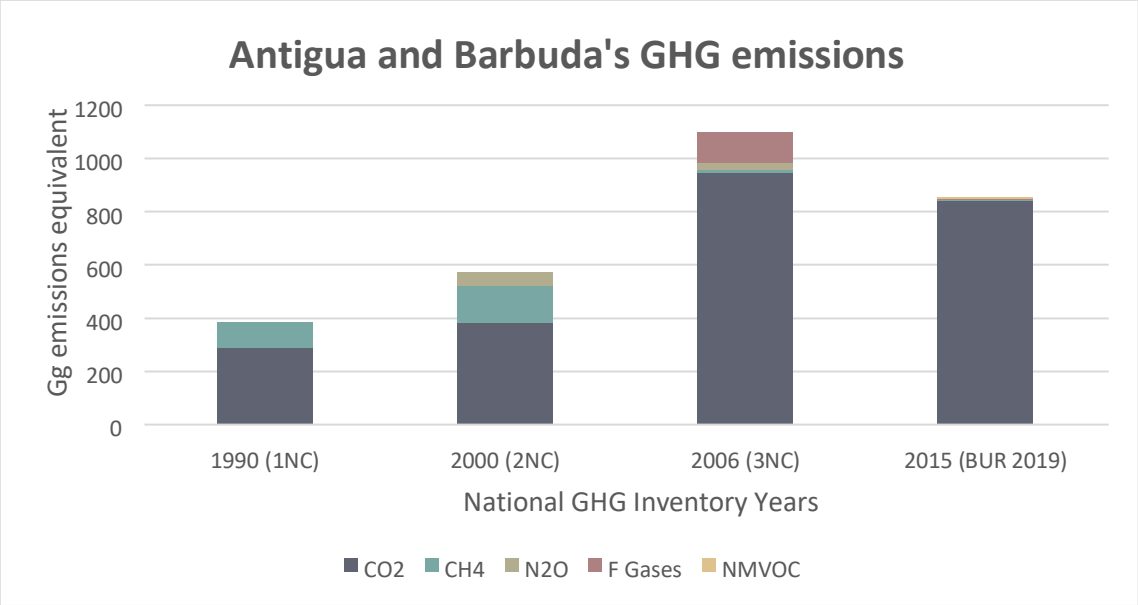


Figure A4: GHG Emissions and Removals by Year and Sector

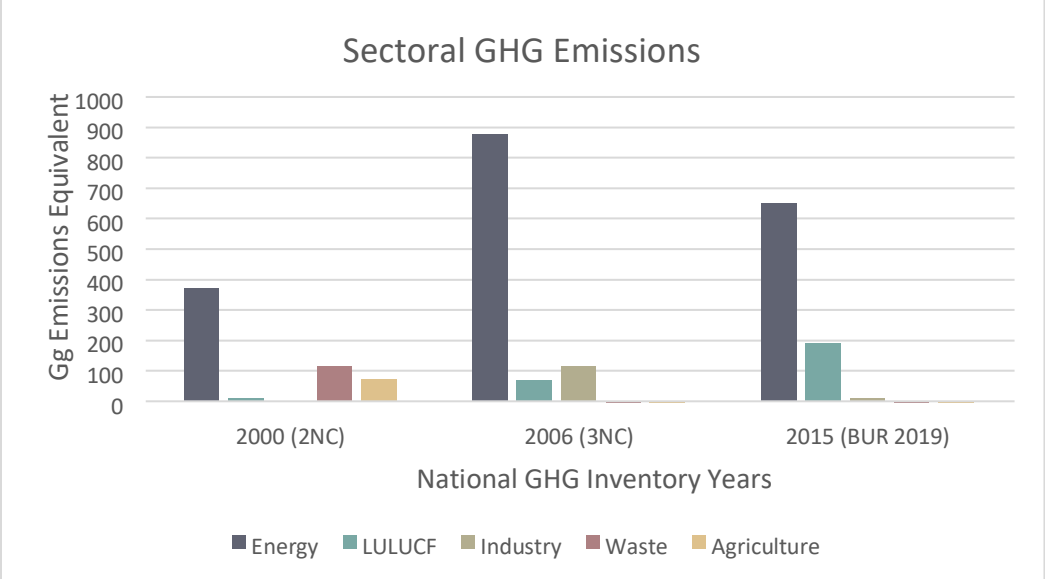
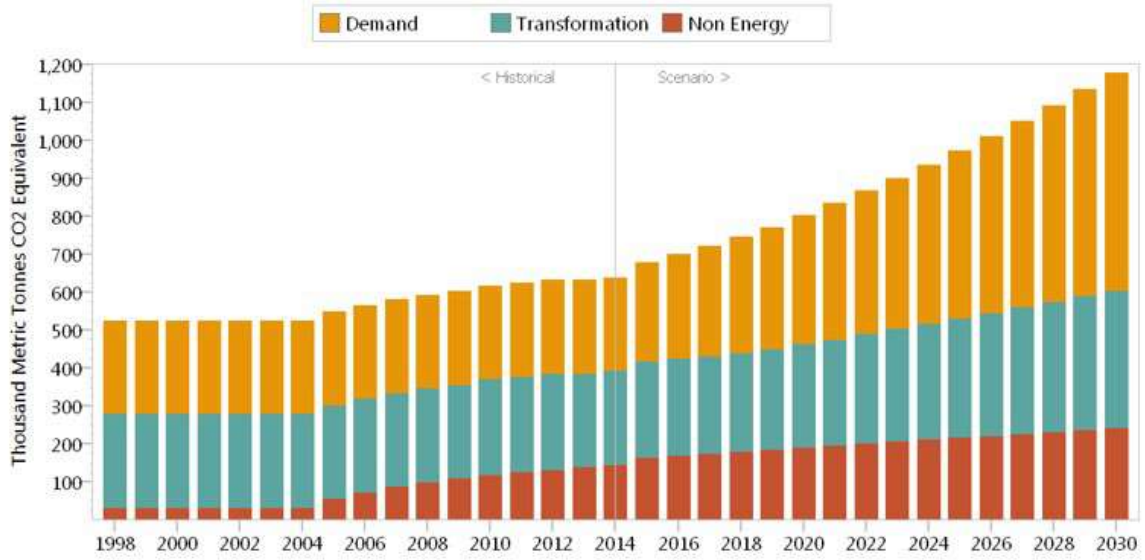
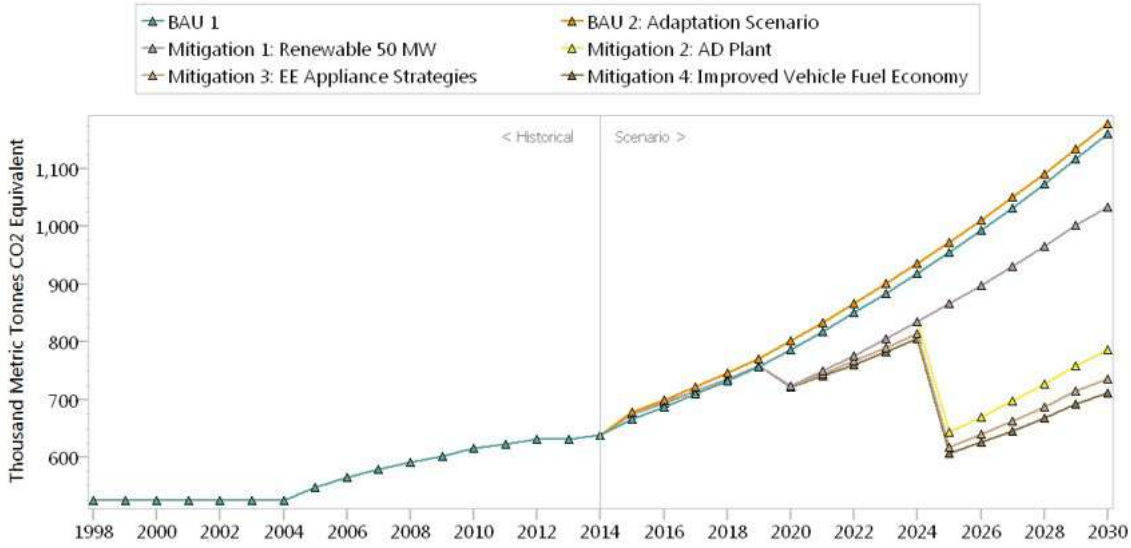


Figure A5: CESC Emissions Projections to 2030 by Sector



Note: Emissions totals for historic years do not match inventory data used for the Third National Communication (2015) reported to the UNFCCC and the latest GHG inventory produced for this BUR report, projections should be viewed as indicative of an increasing trend.

Figure A6: CESC Emissions Projections to 2030 by Projection Scenario



Note: Emissions totals for historic years do not match inventory data used for the Third National Communication (2015) reported to the UNFCCC and the latest GHG inventory produced for this BUR report, projections should be viewed as indicative of an increasing trend. Full information

on the assumptions and methodologies behind the scenarios can be found in section 9.2 Projections-there is no section 9.2 in this document.

Figure A7: Climate Actions by Sector and Responsible Institution

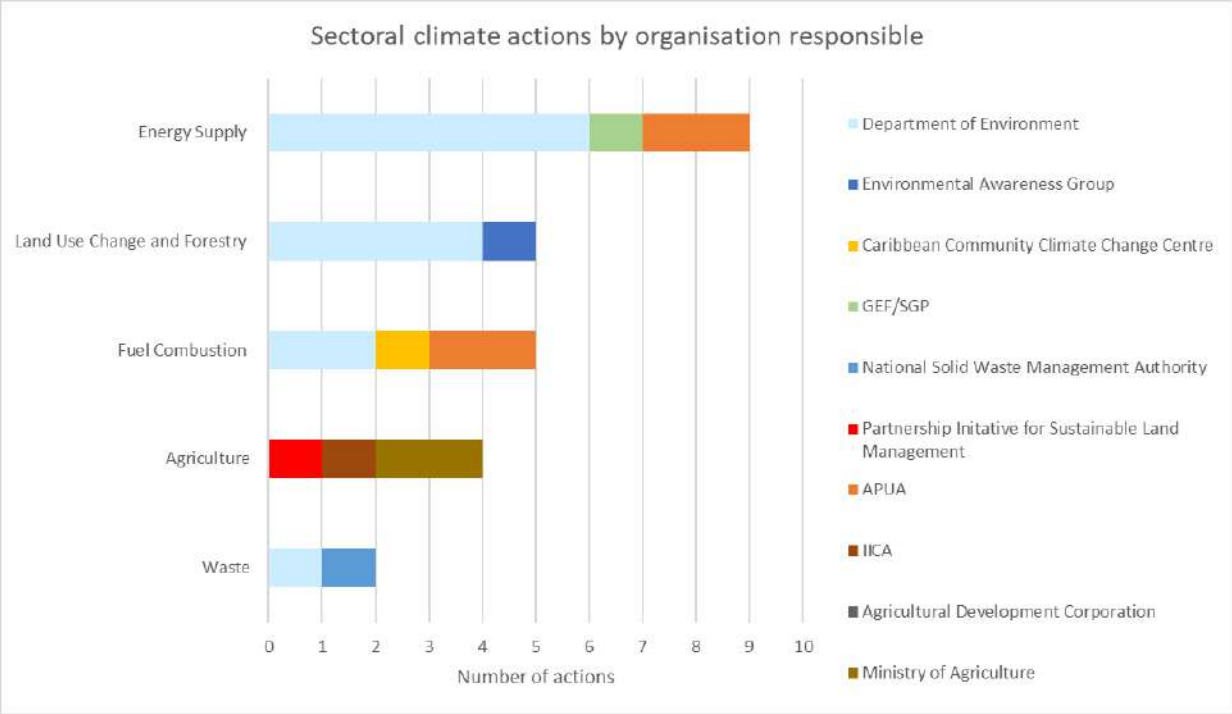


Figure A8: Number of Climate Actions Which Contribute to the Fulfilment of Sustainable Development Goals

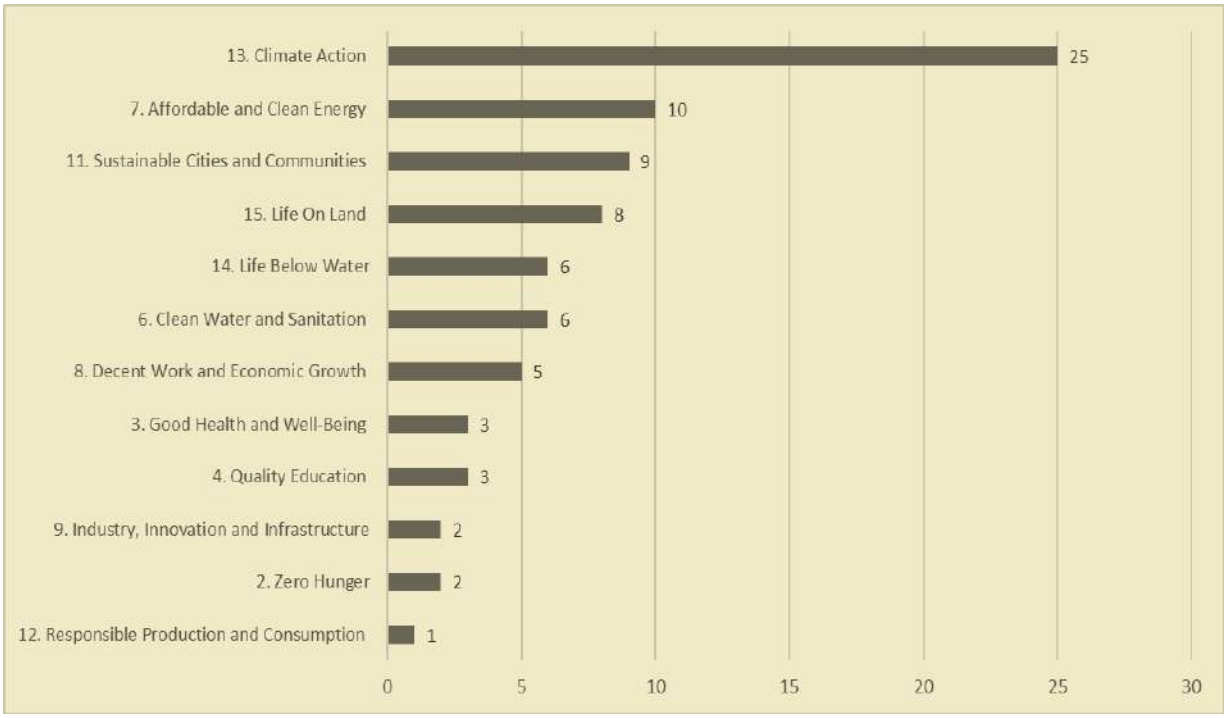


Figure A8 above shows that beyond Goal 13: Climate Action, the mitigation actions were linked most strongly to the SDGs detailed below.

Figure A9: Number of Climate Actions Which Contribute to the Fulfilment of Number of Climate Actions Which Contribute to Necessary Conditions

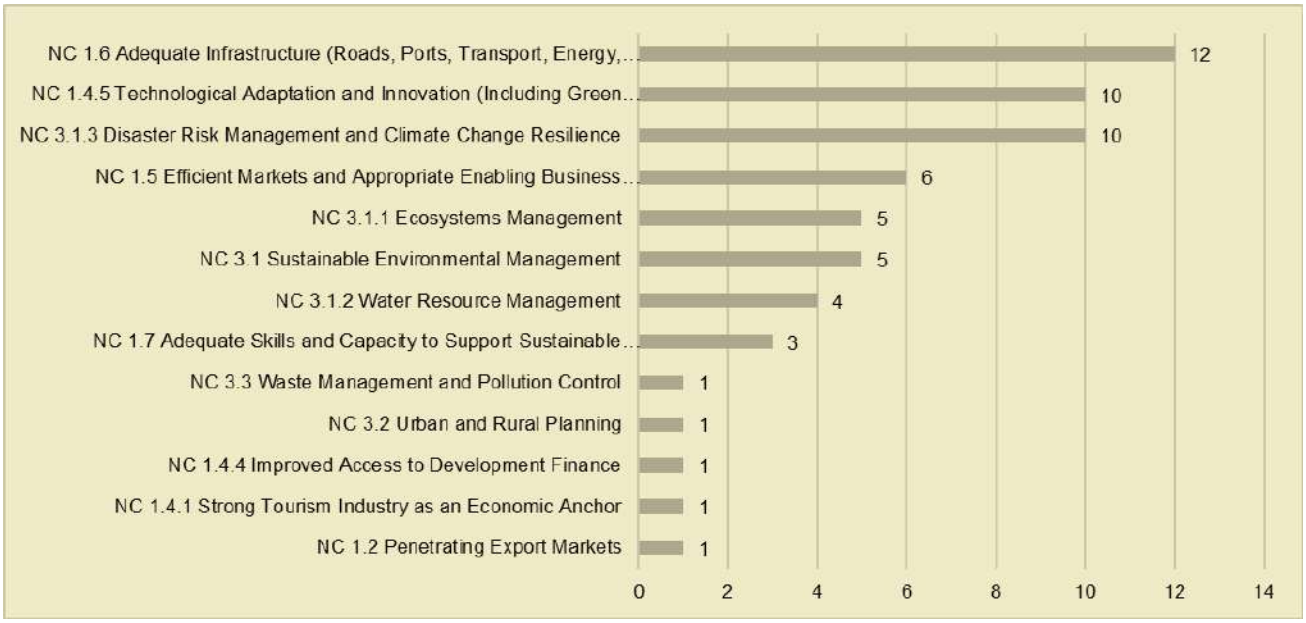
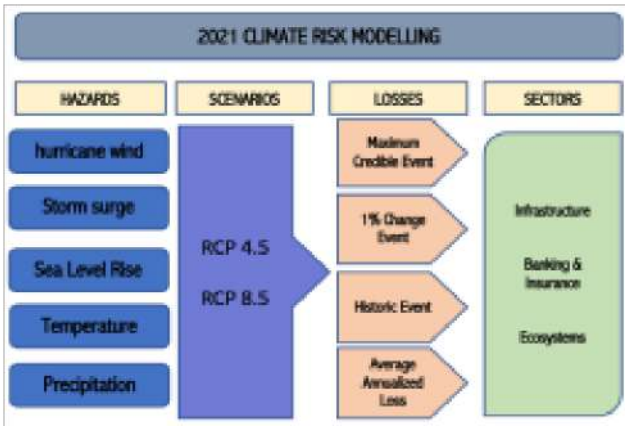
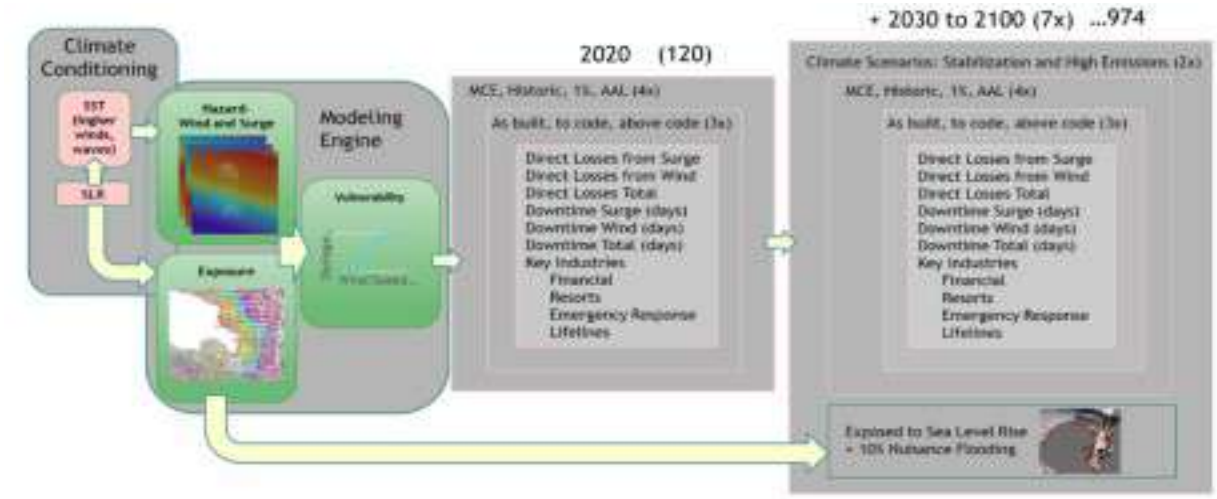


Figure A10: Risk Modelling Framework



Source: Risk Modelling Project Summary Report 2021

Figure A11: Scope of 2021 Climate Risk Modelling



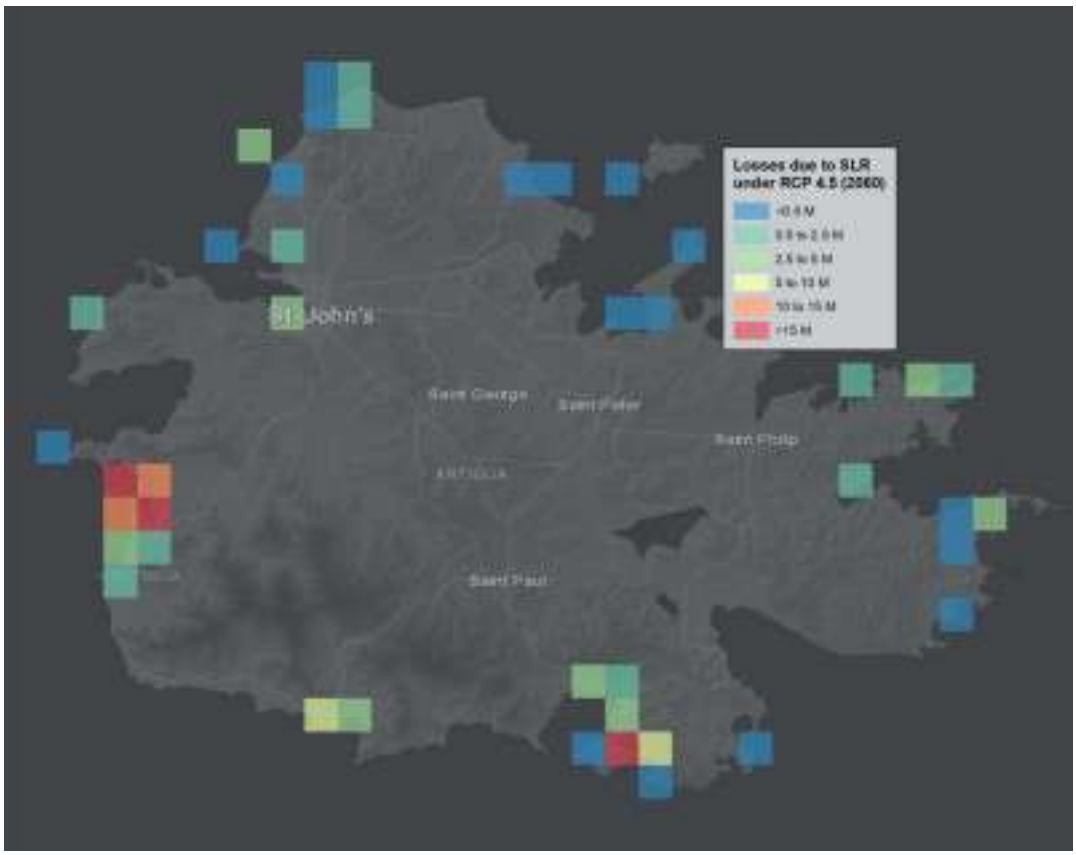
Annex 2: Projected Losses to Building Stock per Hurricane

Figure A12: Total Direct Losses USDM for General Building Stock

Event Type	RCP scenario	Hazard	Total Direct Building Losses per decade for RCP 8.5 (high) and RCP 4.5 scenarios (stabilization) $M USD								
			2020	2030	2040	2050	2060	2070	2080	2090	2100
Historic	RCP 8.5	Wind &	$473	$451	$516	$573	$710	$909	$1,160	$1,342	$1,626
	RCP 4.5	Surge	$473	$451	$483	$534	$563	$624	$628	$642	$663
1:100 year	RCP 8.5	Wind &	$3,801	$4,032	$4,490	$4,831	$5,366	$5,885	$6,420	$6,721	$7,082
	RCP 4.5	Surge	$3,801	$4,015	$4,269	$4,600	$4,783	$5,047	$5,084	$5,117	$5,059
MCE	RCP 8.5	Wind &	$9,368	$9,422	$9,626	$9,750	$9,936	$10,093	$10,182	$10,143	$10,122
	RCP 4.5	Surge	$9,368	$9,422	$9,534	$9,672	$9,728	$9,818	$9,790	$9,756	$9,703
AAL	RCP 8.5	Wind &	$138	$139	$160	$176	$206	$244	$291	$317	$365
	RCP 4.5	Surge	$138	$138	$149	$165	$174	$190	$190	$194	$194
Sea Level Rise	RCP 8.5	SLR &	$-	$108	$128	$184	$251	$320	$415	$561	$689
	RCP 4.5	frequent flooding	$-	$95	$108	$129	$165	$203	$262	$314	$366

Figure A13: Visualization Platform Output for AAL in 2050 under RCP 8.5

Figure A14: SLR for Antigua Multi-model RCP 4.5~ 20km^2 of Land Loss Projected



Source: Sectoral Adaptation Planning for Climate Resilience in Antigua and Barbuda-Risk Modelling Data and Adaptation Presentation

Figure A15: Direct Losses to Key Industries in Antigua and Barbuda