

Challenges and Opportunities for the Energy Sector in the Eastern Caribbean

Antigua and Barbuda Energy Dossier

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Energy Division
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Abstract

This Energy Dossier is part of a series of publications produced by the Energy Division of the Infrastructure and Environment Department of the Inter-American Development Bank. It is designed to increase the knowledge base about the composition and organization of the energy sector of Latin American and Caribbean countries. Each dossier describes the energy matrix of the country under analysis and then dives deeply into the institutional organization and regulatory framework of the energy sector in that country. This series is an important contribution to the understanding of the energy sector of the Eastern Caribbean countries, as many projects providing comparable information have been carried out in this part of the hemisphere.

Keywords: Energy; electricity; energy matrix; Caribbean; Eastern Caribbean.

JEL Codes: Q40, Q43, Q48

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Acronyms

ABNEC	Antigua and Barbuda National Energy Council
APC	Antigua Power Company Limited
APUA	Antigua Public Utilities Authority
CR&W	Combustible Renewables and Waste
EA	Electricity Act
ECERA	Eastern Caribbean Energy Regulatory Authority
EIA	U.S. Energy Information Administration
GDP	Gross domestic product
GWh	Gigawatt hour
IPP	Independent power producer
Kboe/day	Thousand barrels of petroleum equivalent per day
kW	Kilowatt
kWh	Kilowatt hour
LPG	Liquefied petroleum gas
MW	Megawatt
MWh	Megawatt hour
NEP	National Energy Policy
PV	Photovoltaic
SEAP	Sustainable Energy Action Plan
SEU	Sustainable Energy Unit
TES	Total energy supply
WIOC	West Indies Oil Company

Country Overview: Antigua and Barbuda

Antigua and Barbuda is a two-island state consisting of these two islands and a number of smaller islands located in the Eastern Caribbean. It is the wealthiest of the Eastern Caribbean states and also has the highest per capita consumption of electricity. The two islands cover a land area of 443 square kilometers and are home to a population of 89,985 people. Antigua is home to 98 percent of the population, and almost 40 percent reside in the capital city of St. John's (World Bank, 2014).

Map 1 Antigua and Barbuda



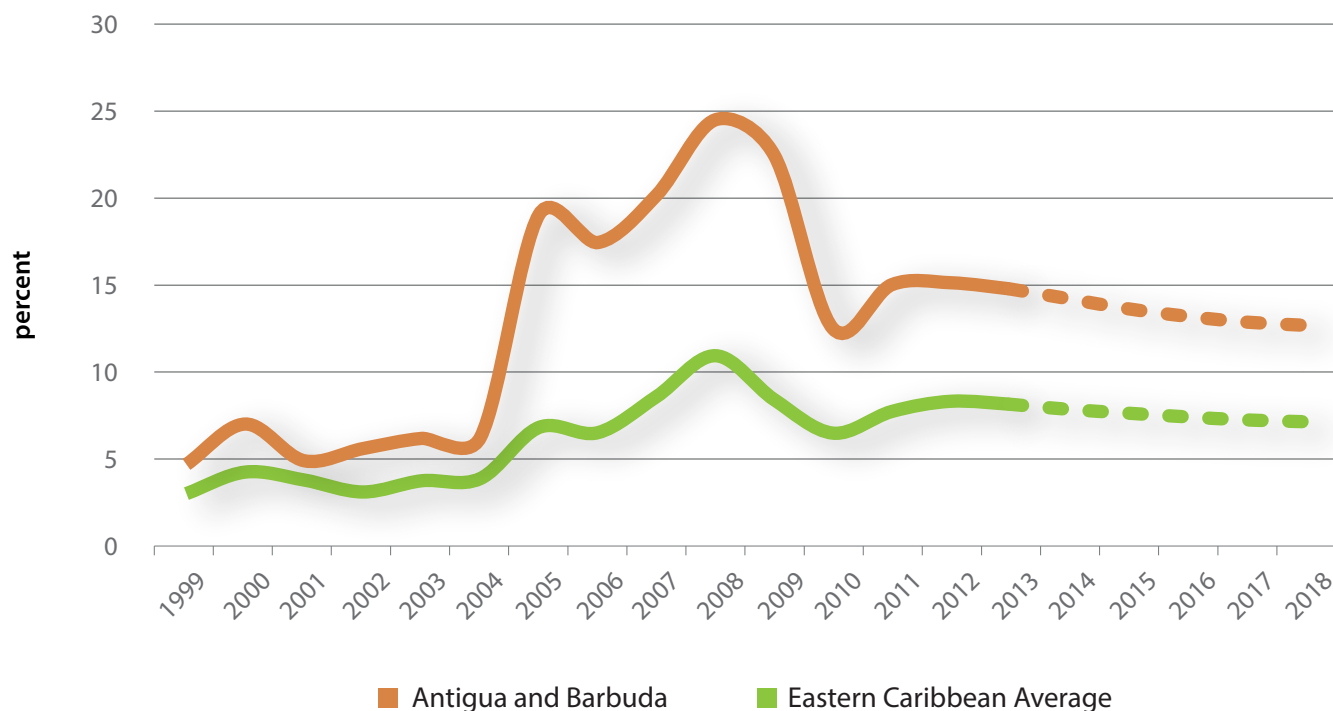
Source: Author's elaboration.

Antigua and Barbuda has a high level of development with a score of 0.774, ranking 61st out of 187 countries on the 2013 Human Development Index (UNDP, 2014a). In 2013, it recorded a national gross domestic product (GDP) of US\$1.201bn and its per capita GDP stood at US\$13,733 (IMF, 2015).

The national economy is dominated by the tourism industry, which accounts for nearly 60 percent of GDP, 40 percent of investments, and one-third of foreign exchange (CIA, 2015). Banking and financial services also play a significant role. The industrial sector is minimal with limited manufacturing capacity focused on producing goods for the export market. Agricultural production is focused on the domestic market and accounts for about 4 percent of GDP (Gore-Francis, 2013; Government of Antigua and Barbuda, 2011; OAS, 2010).

Like many island states, Antigua and Barbuda is highly reliant on imported fossil fuels to meet its energy needs. With no domestic production of primary energy in 2012, its fuel import costs as a share of GDP are among the highest in the Caribbean and worldwide. In 2012, oil import costs accounted for 15.1 percent of its GDP, well above the Eastern Caribbean average of 8.6 percent, but down from its peak of 24.5 percent in 2008 (IMF, 2013).

Figure 1 Oil Import Costs as Share of GDP



Source: IMF (2013).

Notes: Eastern Caribbean average includes Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines.

The Energy Matrix of Antigua and Barbuda

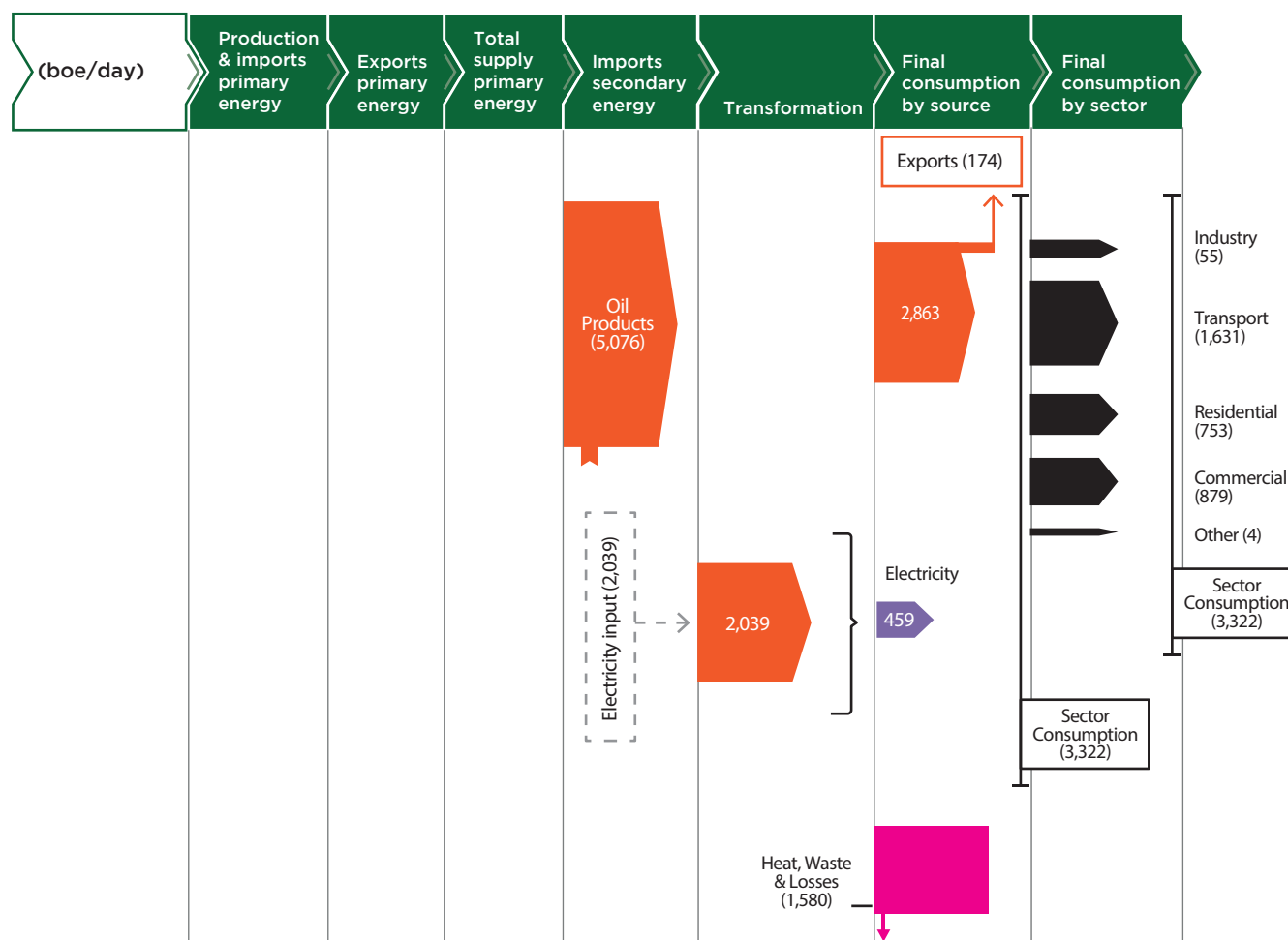
Antigua and Barbuda does not produce any primary energy and imports 100 percent of its energy. In 2012, Antigua and Barbuda imported 5076 barrels of oil equivalent per day (boe/day), of which 174 boe/day were subsequently exported. About 40 percent of oil products (2039 boe/day) were used to generate electricity. Losses during generation, distribution, and transmission total 1580 boe/day, leaving 459 boe/day of electricity for final consumption. In total, final consumption of Antigua and Barbuda stood at 3,322boe/

day, of which 2,863 boe/day were oil products and 459 boe/day were consumed in the form of electricity.

Consumption by sector is as follows: the transportation sector consumes 49 percent and 1,631 boe/day, followed by the commercial sector with 26 percent and 879 boe/day, and the residential sector with 23 percent and 753 boe/day. The industrial sector accounts for 2 percent and 55 boe/day.¹ Other consumption accounts for 0.15 percent and 4 boe/day.

¹ Estimates are based on CO2 emissions by sector.

Figure 2 Antigua and Barbuda Energy Matrix, 2012



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Infraestructure & Enviroment / Energy

Editor: Ramón Espinasa (INE/ENE).

Authors: Malte Humpert

Source: Own calculations based EIA, APUA, Government of Antigua & Barbuda, and Sanguinetti & Gomes.

Total Energy Supply

The total energy supply (TES) in Antigua and Barbuda reached 5,076 barrels of petroleum equivalent per day (boe/day) in 2012. Imported oil products made up 100 percent of TES (EIA, 2012; IRENA, 2012; NREL, 2015).

Antigua and Barbuda has achieved near universal access to energy and electricity for all its citizens. The abundant use of energy coupled with its exclusively reliance on imported fossil fuels, however, has created significant and increasing macroeconomic challenges. The combination of high dependence on imported oil, on one hand, and rapidly growing demand and limited financial means to expand capacity, on the other, is a major challenge for Antiguan and Barbudian energy security. Between 2005 and 2009, Antigua and Barbuda's sole importer of energy products, the West Indies Oil Company (WIOC), spent on average the equivalent of 12 percent of the

country's GDP on energy, the highest share of all states in the Eastern Caribbean (Antigua Observer, 2015c; Government Antigua and Barbuda, 2010). In 2008, the costs of energy imports exceeded 20 percent of GDP and the import of oil products consumes about one-third of the country's foreign exchange and represents 35 percent of all imports (Sanguinetti and Gomes, 2013).

While Antigua and Barbuda has on average 268 hours of sunlight per month, off- or on-grid solar photovoltaic (PV) systems are only in limited use. However, solar energy has considerable potential and is already widely used to heat water (Gore-Francis, 2013).

Domestic Production

Antigua and Barbuda does not have known fossil fuel resources. The country imports 100 percent of its energy resources in the form of oil products, including gasoline, jet kerosene, gas, diesel, heavy fuel oil, and liquefied petroleum gas (LPG) (EIA, 2012; Gore-Francis, 2013).

Figure 3 Share of Total Energy Supply, 2014



Source: EIA (2015); Government of Antigua and Barbuda (2009).

Commercial Balance of Primary Energy

Antigua and Barbuda did not import any primary energy in 2012.

Domestic Primary Energy Supply

The primary energy supply of Antigua and Barbuda was 0 boe/day in 2012.

Electricity

Installed Capacity

Apart from a very limited number of off-grid solar PV and wind systems, electricity is supplied entirely by diesel generation by the Antigua Public Utilities Authority (the APUA) and one independent power producer (IPP), the Antigua Power Company Limited (APC). Electricity on Antigua is provided by five power plants with an installed capacity of 117.9MW (Wadadli Industrial Renewable Energy Limited, 2014). An additional 7.2MW owned and operated by the APUA are installed on Barbuda.

On Antigua, the APUA owns and operates three stations totaling 47.2 MW of installed capacity. The APC owns and operates two power plants with a total capacity of 77.9MW. The latest expansion of capacity was commissioned in 2011 with the opening of 30 MW at the Wadadli plant owned and operated by the APUA (Sanguinetti and Gomes, 2013). Prior to the commissioning of the Wadadli plant, the APUA leased facilities from the WIOC and Aggreko, an international power generator leasing company, to supplement its own and the APC's generation.

The APC's generation facilities are newer and operate more efficiently than the APUA's power plants, allowing the APC to produce electricity significantly more cheaply than the APUA, especially prior to the opening of Wadadli. To take advantage of these efficiencies, the APUA purchases a large share of the

electricity it sells to customers from the APC (Claude Davis and Associates, 2010; Government of Antigua and Barbuda, 2010). The APUA and APC entered into a joint venture to develop additional thermal generation, and the APUA has agreed with the APC to take control of its 27MW Black Pine facility in 2018 (NREL, 2015).

In June 2015, the Government of Antigua and Barbuda announced that it would be partnering with two international energy companies, PV Energy and MEEECO, for the installation of 10MW of grid-connected solar PV units to be placed on top of government facilities and other buildings throughout the country. During a first phase, 3MW will be installed at the VC Bird International Airport on Antigua, with the aim of supporting the new terminal. An additional 1MW will be installed on Barbuda, and future sites for the installations include hospitals and schools. The government did not provide a timetable for the completion of these initiatives (Government of Antigua and Barbuda, 2015a).

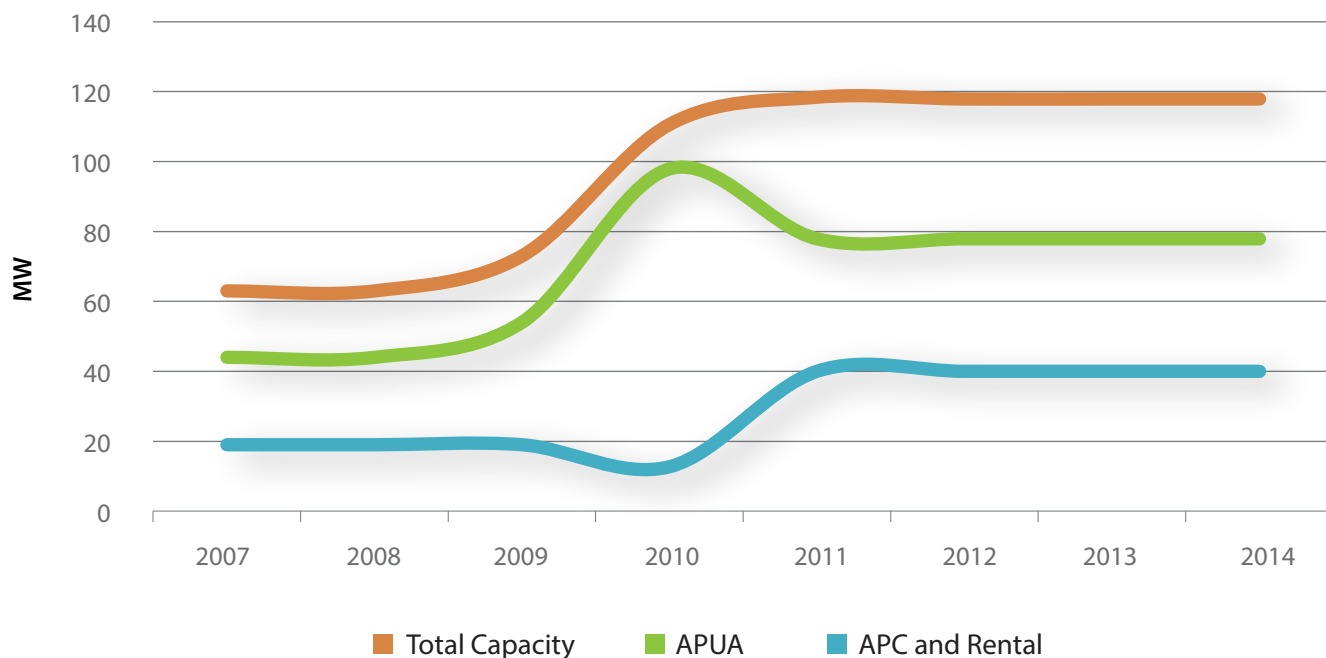
In 2009, the last full year for which yearly data are available, base load stood at 42 MW and peak load reached 51 MW (Government of Antigua and Barbuda, 2011). In July 2013, the latest month for which monthly data are available, peak demand stood at 49.2 MW on Antigua and 0.487 MW on Barbuda (APUA, 2014a).

Table 1 Inventory of Antigua and Barbuda's Power Stations, 2014

Power stations	Owner	Installed capacity
Crabbs Peninsula	APC	50.9 MW
Black Pine Plant	APC	27 MW
Friars Hill	APUA	10 MW (5 MW out of service, 5 MW temporarily out of service)
EGD (Barbuda)	APUA	2 x 3.6 MW
Wadadli Power Plant	APUA	6 x 5 MW

Source: Government of Antigua and Barbuda (2009); Wadadli Industrial Renewable Energy Limited, (2014).

Figure 4 Total Installed Capacity, 2007–14



Source: Samuel (2013).

Input to Electricity Generation

Of the 2039 boe/day intended for electricity generation in 2012, all 2039 boe/day came from liquid fuels. While recent data detailing individual consumption per power station are not publically available, the APUA states that in July 2013, the last month for which data are available, its Wadadli plant consumed 375,932 gallons of heavy fuel oil (Bunker C) and 1753 gallons of light fuel oil (diesel) to produce 2,204 MWh of electricity at a heat rate of 17.1 kWh/imperial gallon (APUA, 2014a).

Electricity Matrix

In 2012, net generation from fossil fuels stood at 329 GWh and sales stood at 200 GWh.² An additional 4.8 MWh were produced by a 3kW grid-connected photovoltaic installation (Sanguinetti and Gomes, 2013). Generation and sales remained relatively stable between 2007 and 2012.

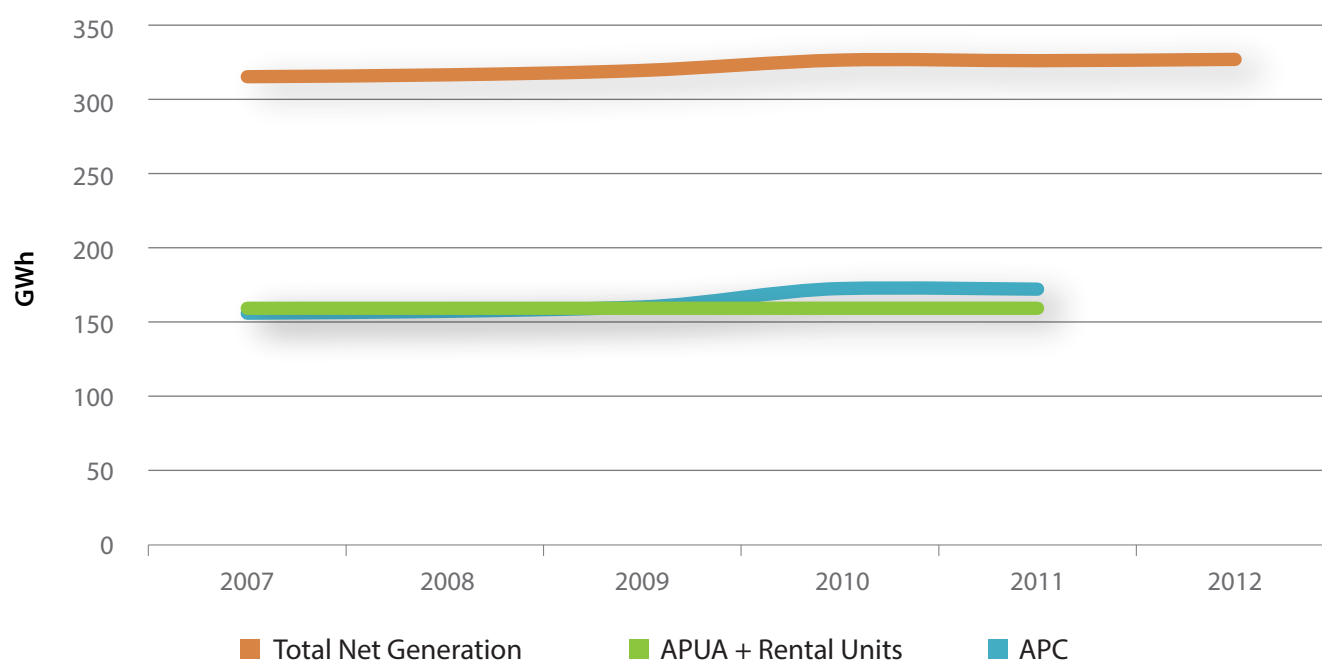
² The APUA provides electricity free of charge to its water and telecommunications divisions, as well as to the government, which, according to some sources, accounts for 8 percent of consumption. Thus, the sales figure is not an accurate representation of final consumption of electricity. Net generation minus losses is a more accurate figure and is in the range of 273 GWh for 2012.

Table 2 Total Net Generation and Sales of Electricity in GWh, 2007–11

Electricity in GWh	2012	2011	2010	2009	2008	2007
Generation	329	328	328	320	317	316
Sales	200	199	204	192	190	187

Source: Samuel (2013); Sanguinetti and Gomes (2013).

Figure 5 Net Generation in GWh, 2007–12



Source: Samuel (2013); Sanguinetti and Gomes (2013).

Between 2007 and 2012, electricity generation increased by 5 percent, from 316 GWh to 329 GWh. Over the same period, electricity sales increased 7 percent, from 187 GWh to 200 GWh (Government of Antigua and Barbuda, 2013; Samuel, 2013; Sanguinetti and Gomes, 2013).

In 2011, the last year for which the sales data are available, the commercial sector consumed 105 GWh of

electricity, accounting for 53 percent of overall consumption; the residential sector consumed 87 GWh³, representing 44 percent, followed by the industrial sector, with 7 GWh, representing 3 percent. Other consumption stood at 0.5 GWh, representing less than 1 percent⁴. System losses, including transmission and distribution as well as non-technical, stood at 17 percent (Samuel, 2013).

³ In some sources, the residential sector is referred to as the domestic sector. Herein, the term will be used interchangeably depending on the term used in the source document.

⁴ Additional consumption not reflected in the APUA's sales comes from its water and telecommunications divisions as well as government consumption. Together these account for around 10 percent of consumption (NREL, 2015).

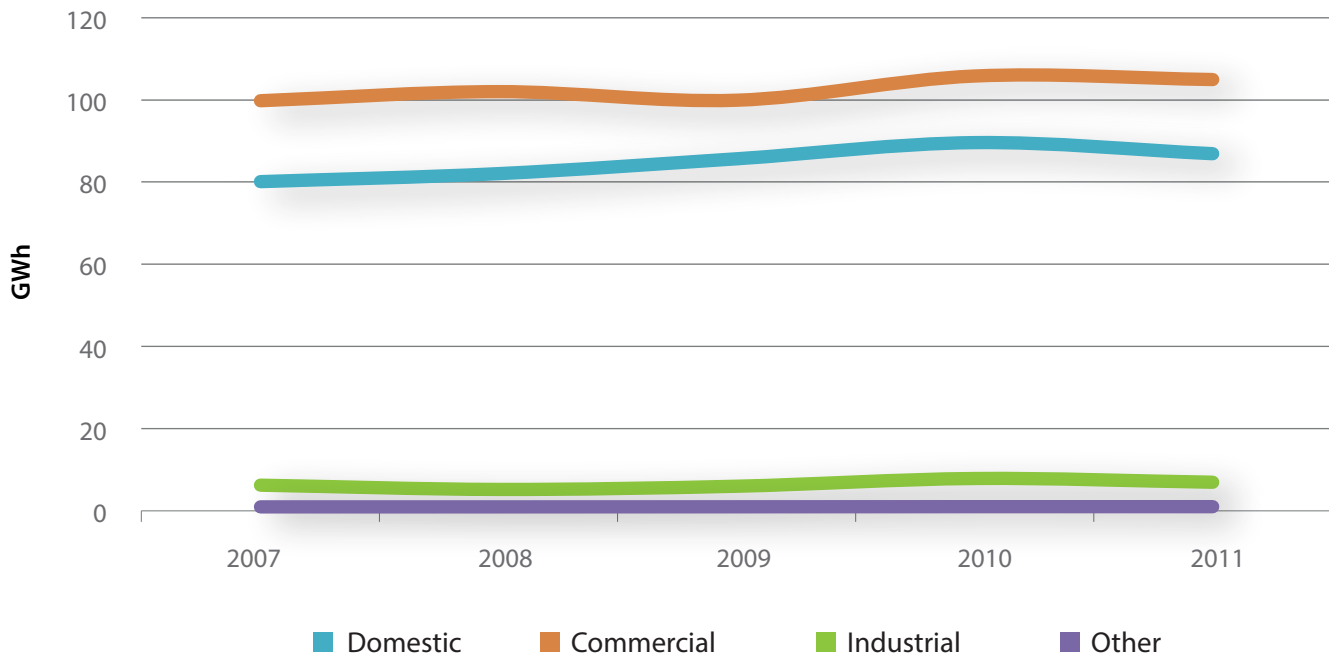
Figure 6 Electricity Sales by Sector, 2011



Source: Samuel (2013).

Based on the APUA's sales figures, consumption patterns of the various types of consumers have remained relatively stable between 2007 and 2011. Commercial consumption grew by 5 percent, from 100 GWh to 105 GWh. Residential sales increased by 8.7 percent, from 80 GWh to 87 GWh. Industrial sales experienced the largest gain, with 11 percent from 6.2 GWh to 6.9 GWh.

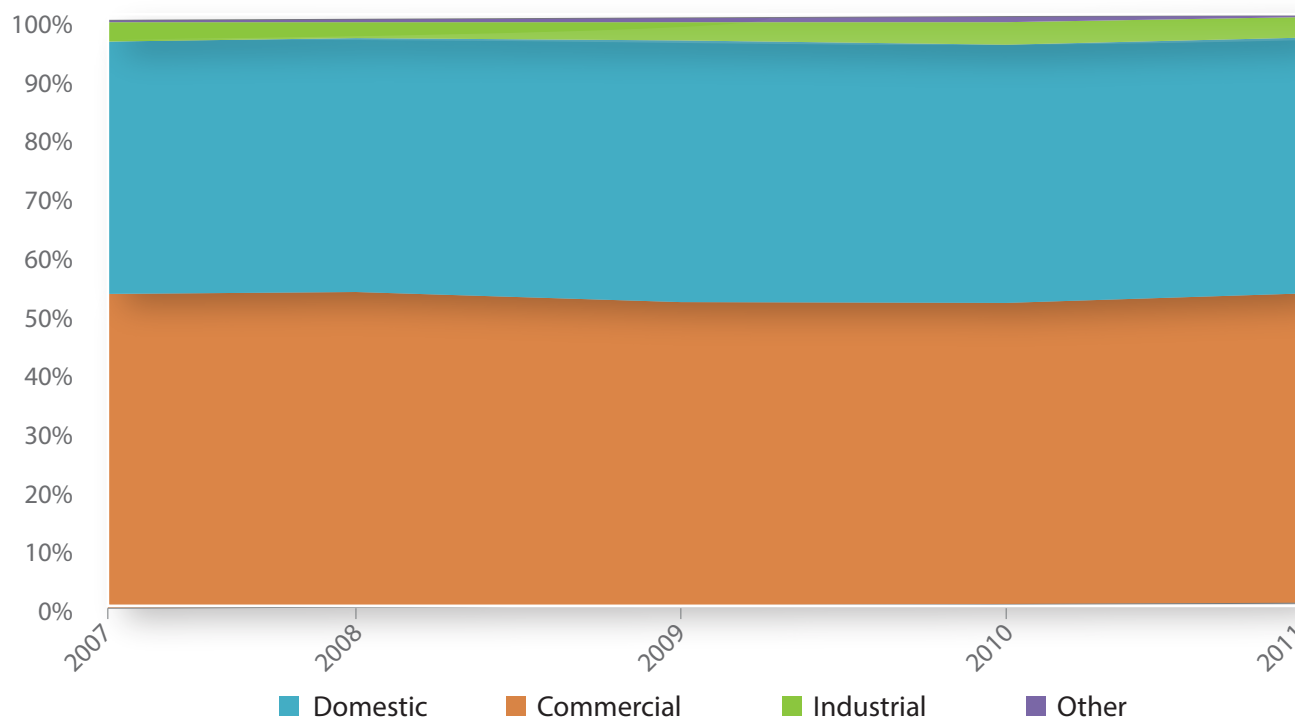
Figure 7 Electricity Consumption by Customer Type, 2007-11



Source: Samuel (2013).

There has been little change in terms of share of electricity consumption by customer type. Commercial entities were the largest consumers between 2007 and 2011. Their share decreased slightly, from 54 percent to 53 percent. Residential consumption increased from 43 percent to 44 percent. Industrial sales remained at 3 percent throughout the time period.

Figure 8 Share of Electricity Consumption by Customer Type, 2007–11



Source: Samuel (2013).

In the future, peak demand is projected to grow by 3.3 percent annually, almost doubling in total from 54MW in 2009 to 101MW in 2028. Based on projected trends the APUA's and the APC's installed capacity will be sufficient until around 2022–23, when additional generation capacity will be required to meet demand. However, due to ageing generation equipment, installed capacity may have to be replaced with newer units before the end of the decade.⁵

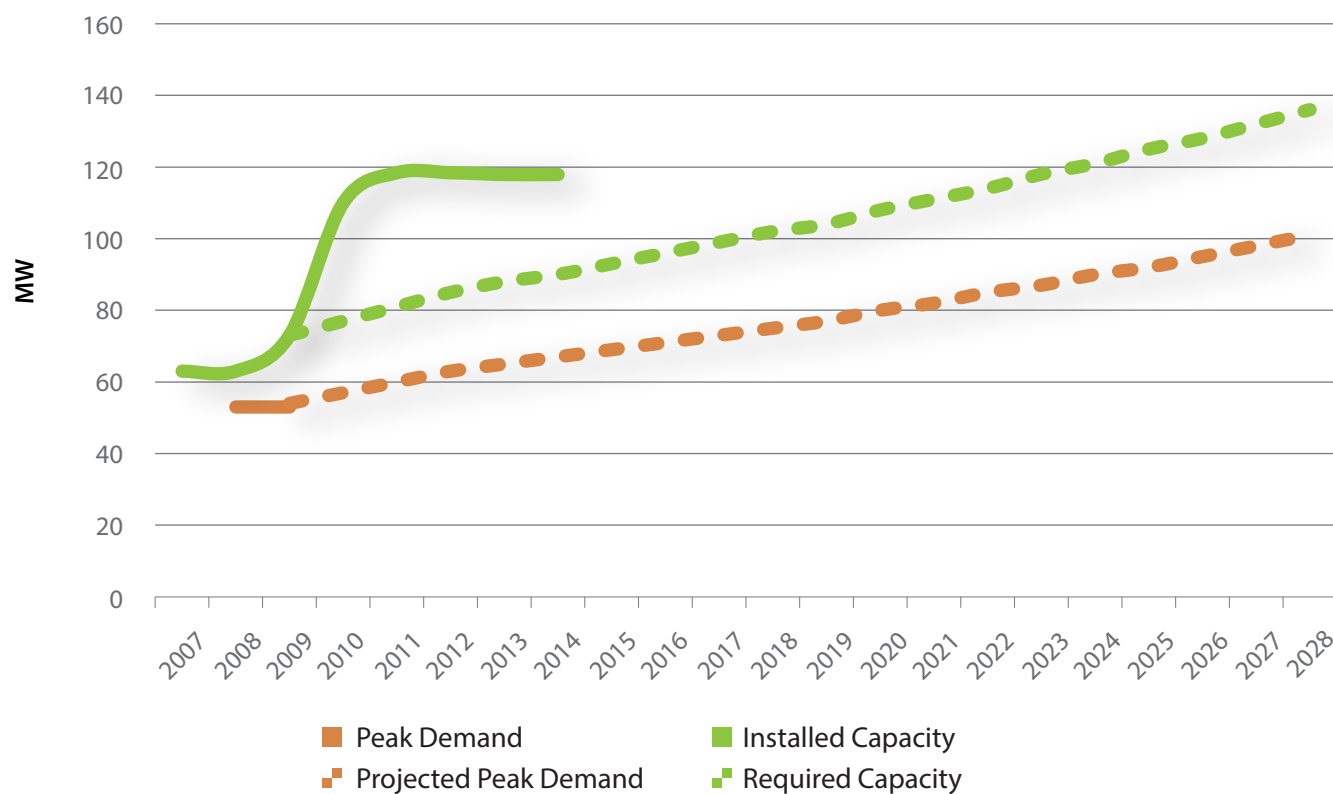
Table 3 Antigua and Barbuda's Projected Capacity Needs and Peak Demand (in MW)

	2015	2017	2019	2021	2023	2025	2027
Projected capacity needs	93	99	104	111	118	125	132
Projected peak demand	69	73	77	82	87	92	98

Source: World Bank (2010b).

⁵ Based on projections by World Bank (2010b).

Figure 9 Antigua and Barbuda's Projected Capacity Needs and Peak Demand



Source: Samuel (2013); World Bank (2010a).

In contrast to the other five Eastern Caribbean States, Antigua and Barbuda does not have geothermal potential. Also, unlike Dominica and Saint Vincent and the Grenadines, it does not have hydropower potential.

Table 4 Antigua and Barbuda's Resource Availability

Geothermal	Solar (PV and hot water)	Energy Efficiency	Waste to Energy	Wind	Hydro
	✓	✓	✓	✓	

Source: Castalia (2015).

Generation Forecast

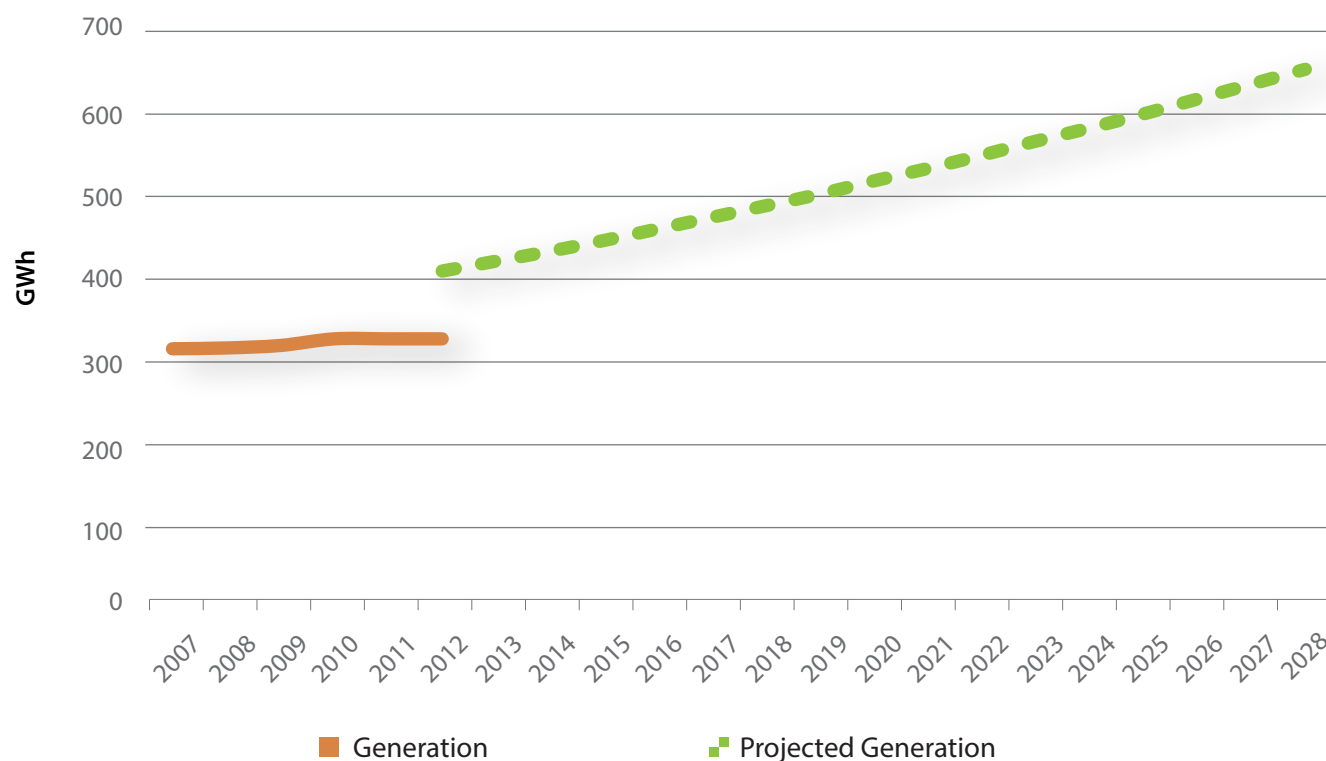
Antigua and Barbuda's net generation is projected to grow from 318 GWh in 2009 to 654 GWh by 2028, representing an annual growth rate of 3.9 percent. Due to the impact of the 2009–11 recession, from which Antigua and Barbuda has not yet fully recovered, this projected growth rate may prove to be too aggressive (CIA, 2015).

Table 4 Antigua and Barbuda's Projected Net Generation in GWh

	2015	2017	2019	2021	2023	2025	2027
Projected capacity needs	447	475	503	550	583	600	636

Source: World Bank (2010b).

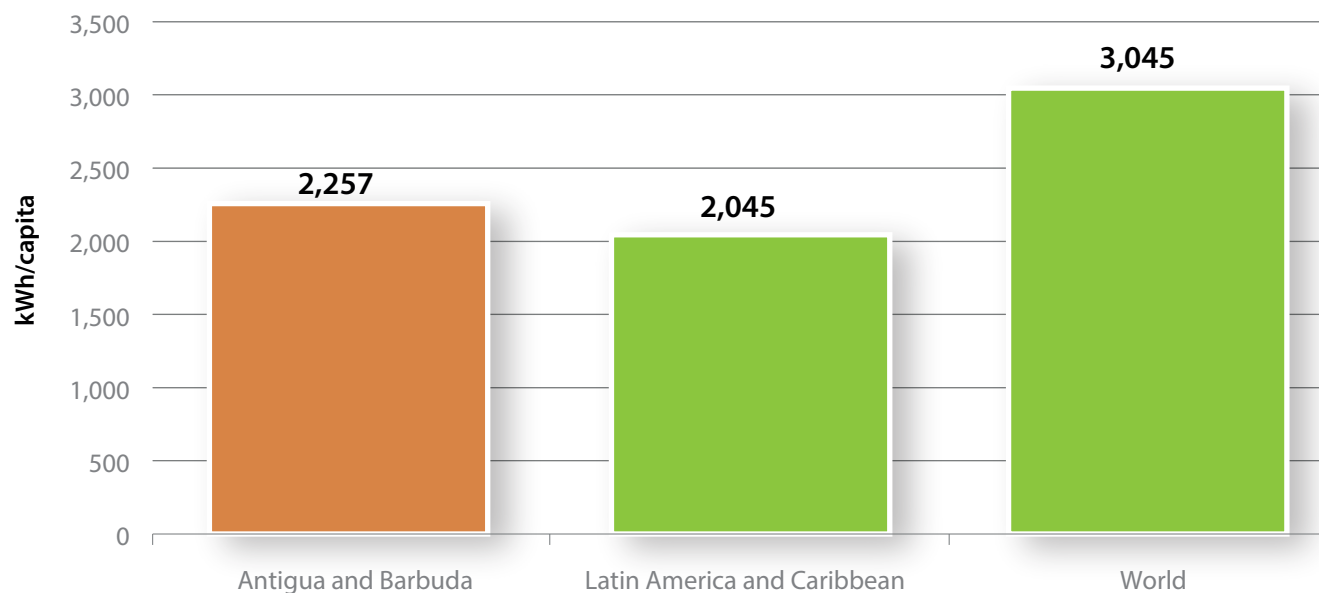
Figure 10 Antigua and Barbuda's Projected Net Generation



Source: Samuel (2013); World Bank (2010a).

Antigua and Barbuda's net generation is projected to grow from 318 GWh in 2009 to 654 GWh by 2028, representing an annual growth rate of 3.9 percent. Due to the impact of the 2009–11 recession, from which Antigua and Barbuda has not yet fully recovered, this projected growth rate may prove to be too aggressive (CIA, 2015).

Figure 11 Electricity Use per Capita, 2011



Source: Samuel (2013); UN (2014); World Bank (2014)

Secondary Balance and Final Consumption

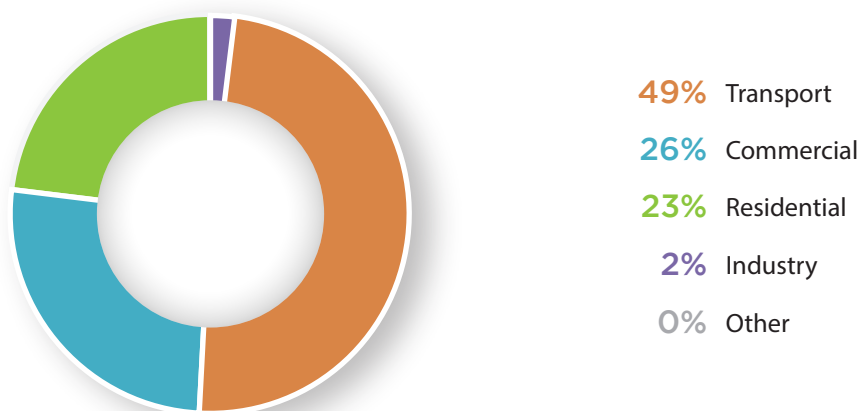
Secondary Energy Balance

Antigua and Barbuda imports all oil products, of which it subsequently exports 174 boe/day.

Final Consumption by Sector

Energy consumption in 2012 totaled 3,322 boe/day. The transportation sector consumed 49 percent of all energy, with 1631 boe/day, followed by the commercial sector, with 26 percent and 879 boe/day, and the residential sector, with 23 percent and 753 boe/day. Industrial consumption accounted for 2 percent and 55 boe/day. Other consumption is negligible, with only 3.5 boe/day.

Figure 12 Energy Consumption by Sector, 2012



Source: EIA (2015); Global Environment CIA Facility (2010); Government of Antigua and Barbuda (2009).

Note: Estimates based on CO₂ emissions per sector.

Similar to other small-island Caribbean states, Antigua and Barbuda's economy is heavily reliant on the transportation sector; air and marine travel, as well as private motor vehicles, account for the largest share of overall energy consumption. Antigua and Barbuda's tourism industry is highly dependent on transport fuels for air travel and local road transportation and is a significant consumer of transportation fuels. Furthermore, Antigua and Barbuda records a high level of private vehicle penetration. Ownership of vehicles increased by 28 percent between 2005 and 2009, from 23,930 to 30,525 (Sanguinetti and Gomes, 2013). Large SUV-type vehicles are proportionately over-represented due to specific tax duty waivers and customs incentives. The National Energy Policy (NEP) aims to improve the quality and attractiveness of public transport. It also aims to put standards in place to increase fuel efficiency for private vehicles, create tax and financial incentives for hybrid, flex-fuel, and electric vehicles, establish financial penalties and levies for SUVs and similarly sized vehicles, and increase the

use of cleaner fossil fuels such as liquefied natural gas (Government of Antigua and Barbuda, 2013).

Between 2001 and 2010, energy consumption on the two islands increased by 45 percent, and growth rates accelerated from 3.2 percent per annum between 2001 and 2006 to 5.6 percent between 2007 and 2010. Since 2010, however, the country has not seen a significant increase in energy demand (Government of Antigua and Barbuda, 2013). Until 2009, the government provided subsidies for transportation fuels. To offset the rising cost of this energy subsidy, the government announced a partial pass-through pricing system in August 2009 to raise prices and ended a period of subsidized fuel prices. Following this change in policy, energy costs have increased significantly and are now more in line with prices in other East Caribbean states (Government of Antigua and Barbuda, 2011; World Bank, 2010b). Subsidies for LPG, however, remain in place as part of the government's efforts to provide a social safety net (Sanguinette and Gomes, 2013).

Institutional Organization of the Energy Sector

Current Institutional Structure

The Government of Antigua and Barbuda has begun to design a reform of the institutional structure of the energy sector, following the country's first NEP approved in 2011 and the Sustainable Energy Action Plan (SEAP) of 2013. Actual reforms, however, have yet to be implemented, and the legislative, institutional, and regulatory structure of the energy sector remains insufficient: Governed primarily by the Public Utilities Act of 1973, updated in 1993 and 2004, the energy sector does not have a regulatory agency for public utilities, keeping regulatory and monitoring responsibilities split among a range of different government ministries and agencies.

Overall implementation and guidance of the further design and development of the NEP, including standards for renewable energy technologies, fall under the responsibility of the Sustainable Energy Unit (SEU), previously known as Sustainable Energy Desk, which, since its establishment in 2010, has been part of the Office of the Prime Minister. The NEP and SEAP were developed by the National Energy Task Force, a forum comprising government, business, financial, and utility stakeholders who were tasked with examining the current and anticipated energy consumption patterns and researching technological advances in renewable energy and energy conservation. It has since been reconstituted as the Energy Advisory Panel, which advises the government on the implementation of the two policies. It serves as a platform for industry players, policymakers, regulators, generators, consultants, and non-governmental organizations to meet, discuss, and make recommendations on current issues in the energy sector and advise the government on improvements to the NEP and SEAP (Government of Antigua and Barbuda, 2011, 2013; Sanguinetti and Gomes, 2013).

Following the parliamentary election in June 2014 and the subsequent formation of a new government, the future of the Energy Advisory Panel is unclear. The government proposed the formation of the Antigua and Barbuda National Energy Council, which will bring together private and public sector energy sector stakeholders to advise the Ministry of Energy on energy related policies and measures (Government of Antigua and Barbuda, 2015a).

The Ministry of Tourism, Economic Development, Investment, and Energy (hereafter Ministry of Energy) is responsible for implementing national energy policy and takes the lead on the development and changes to the country's electricity sector. The Ministry of Energy also connects with the Antigua and Barbuda National Energy Council (ABNEC), which brings together private and public sector energy sector stakeholders to advise the government on energy-related policies and measures.

The SEU within the Prime Minister's Office assists with coordination of the implementation of the national energy policy and provides a point of contact for industry and other actors. It is also responsible for updating and improving both the NEP and SEAP, ensuring that their goals are met, and implementing changes in the shortest time possible (Gore-Francis, 2013). The SEU was initially created to assist with the coordination of the implementation of the NEP and to provide a point of contact for industry and other actors. Currently, it is responsible for the overall implemen-

tation and updating of both the NEP and SEAP and ensuring that established goals are met and implemented in the shortest time possible. It will also serve as an observer body at the national level, assisting the Ministry in monitoring energy-related policies and laws.

The specific tasks and responsibilities of the SEU are to:

1. Propose standards for service quality and establish rules and conditions for a pricing system in accordance with NEP, SEAP, and the APUA;
2. Review and amend the existing legal and regulatory framework in collaboration with the APUA, the Attorney General's Chambers, and relevant international agencies;
3. Facilitate coordination among all key stakeholders and ensure their compliance with the NEP and SEAP;
4. Collect energy data to facilitate planning and evaluation activities and to assess and evaluate the impact of selected policies;
5. Establish a database of indicators to evaluate the efficacy of NEP and SEAP;
6. Mandate and coordinate studies on energy resources, generation, and transformation;
7. Initiate the development of appropriate legislation for the electricity, transportation, petroleum, and gas sector with a primary focus on cheaper and sustainable alternatives;
8. Foster the development and adoption of energy efficiency standards;
9. Promote and monitor programs designed to encourage the purchase of energy-efficient appliances; and
10. Encourage private and public sector participation throughout the reform of the energy sector through energy awareness campaigns, capacity building events, and dissemination of information (Gore-Francis, 2013; Government of Antigua and Barbuda, 2011, 2013; UNDP, 2014b).

Other actors are the Ministry of Public Utilities, Civil Aviation, and Transportation, which oversees the functioning of the Antigua Public Utilities Authority, and the Environment Division within the Ministry of Health and Environment, which is tasked with issues concerning environmental impact, sustainability, and clean development mechanisms (Sanguinetti and Gomes, 2013). The Ministry of Finance and Corporate Governance is responsible for the creation of tax incentives and energy sector subsidies, and the Ministry for Foreign Affairs and International Trade sets policy and regulates the import of oil products through the WIOC (Gore-Francis, 2013).

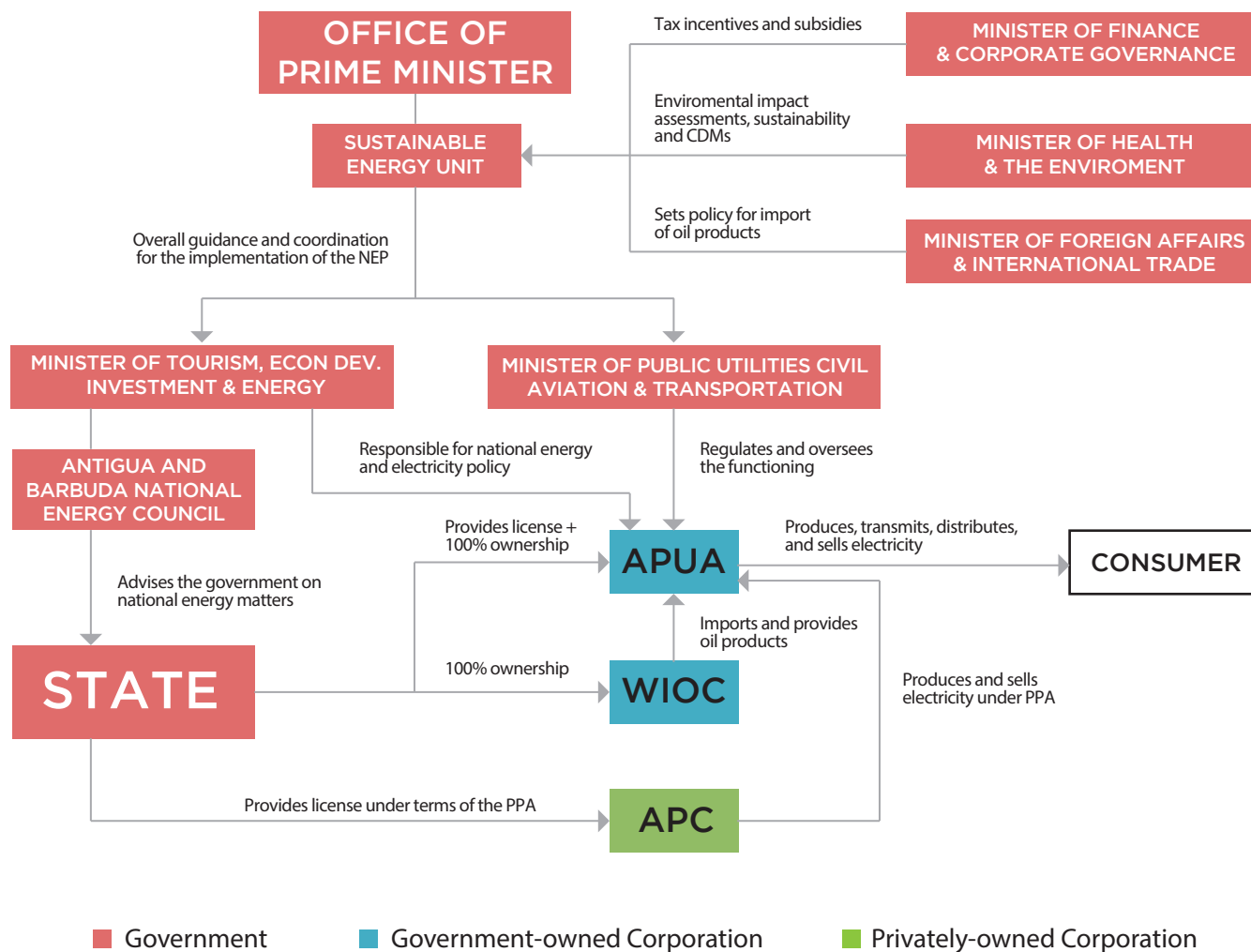
Table 5 Energy Sector Responsibilities

Ministry	Type	Tasks and Responsibilities
Office of the Prime Minister and Sustainable Energy Unit	Government ministry	Overall implementation, coordination, and guidance of the NEP.
Ministry of Finance and Corporate Governance	Government ministry	Creation of tax incentives and subsidies.
Ministry of Tourism, Economic Development, Investment and Energy	Government ministry	Responsible for national energy and electricity policy. Coordinates with the ABNEC.
Ministry of Public Utilities, Civil Aviation and Transportation	Government ministry	Oversees the functioning of the APUA.
ABNEC ^a	Task force	Advises the government on national energy matters. Representatives from the public, business, financial, and utility sector.
Ministry of Foreign Affairs and International Trade	Government ministry	Responsible for import of oil products.
Ministry of Health and the Environment	Government ministry	Responsible for issues concerning environmental impact, sustainability, and clean development mechanisms.
APUA	Vertically-integrated, state-owned utility company	Holds legal monopoly for production, transmission, and distribution of electricity. May grant licenses to IPP.
APCL	IPP	Holds license from the APUA to produce electricity and sell it to the APUA.
WIOC	100 percent state-owned enterprise	Provides 323,000 barrels of storage capacity for refined oil products. Also responsible for local retail sale of oil products.

Source: Caribbean News (2015); Gore-Francis (2013); Government of Antigua and Barbuda (2015a); Government of Antigua and Barbuda (2015c); Parliament of Antigua and Barbuda (1973); Parliament of Antigua and Barbuda (1993); Parliament of Antigua and Barbuda (2004); Samuel (2013); Sanguinetti and Gomes (2013).

^a The previous government maintained a National Energy Task Force/Energy Advisory Panel with similar functions. It is unclear if this Task Force remains in existence as a separate entity or if its role was absorbed by the ABNEC following the change in government.

Figure 13 Organization and Functioning of the Energy Sector



Source: Authors' elaboration based on information from Caribbean News (2015); Gore-Francis (2013); Government of Antigua and Barbuda (2015a); Government of Antigua and Barbuda (2015c); Parliament of Antigua and Barbuda (1973); Parliament of Antigua and Barbuda (1993); Parliament of Antigua and Barbuda (2004); Samuel (2013); Sanguinetti and Gomes (2013).

Table 6 Key Legislation and Structure of the Energy Sector

Key Legislation	Regulator	Utility	Ownership structure
Petroleum Act, 1949 Public Utilities Act, 1973, 1993, 2004 Minerals (Vesting) Act, 1949 National Energy Policy, 2011 Sustainable Energy Action Plan, 2013 Renewable Energy Act, 2015 (proposed)	Board of Commissioners / Ministry of Public Utilities	APUA	100 percent state-owned

Source: Castalia Consulting (2012); Government of Antigua and Barbuda (2011); Government of Antigua and Barbuda (2013); Government of Antigua and Barbuda (2015a); OAS (2010); Parliament of Antigua and Barbuda (1949); Parliament of Antigua and Barbuda (1973); Parliament of Antigua and Barbuda (2004).

Formulation of Policies in the Energy Sector

The formulation, updating, and implementation of policies in the energy sector, most notably the NEP and the SEAP, fall within the portfolio of the SEU within the Office of the Prime Minister and the Ministry of Energy. The SEU and the Ministry of Energy receive advice and feedback on energy policy from the ABNEC.

Recent and Ongoing Reform Efforts

On August 20, 2011, Antigua and Barbuda approved the 2010 Draft National Energy Policy, which outlines the government's goals for the energy sector until 2030.⁶ The policy aims to “create a stable, efficient, and sustainable energy sector that fosters national economic and social development by establishing an enabling environment that exploits indigenous energy resources and reduces the total dependence on fossil fuels.” It further states that: “By 2030 Antigua and Barbuda will meet the needs of the present generation while safeguarding the environment and enabling future generations to meet their own energy needs. All citizens and residents will have access to affordable efficient, socially responsible and reliable forms of energy” (Government of Antigua and Barbuda, 2011).

The policy suggests a number of changes to the existing institutional and policy framework, most notably substantial public participation in the energy sector, the creation of practicable free market mechanisms to achieve higher efficiency, reduced costs and lower prices, and an increase in the share of renewable energy sources.

The NEP sets out the government's approach to reform the national energy sector and ensure that current and future energy needs can be met. It aims to provide access to affordable, efficient, reliable, and socially and environmentally responsible forms of energy to all residents. The policy sets out five key goals: (i) reduction of energy costs by reducing the energy intensity of the economy by 10 percent (2010 baseline) within 10 years through efficiency and conservation measures; (ii) diversification of energy resources by mandating a 15 percent share of renewable energy in the electricity sector and reforming the market framework; (iii) improvement of electricity reliability by reforming the regulatory sector to ensure improved quality of service; (iv) protection of the environment by passing laws and regulations to place environmental consideration at the core of the energy permit and planning process; and (v) stimulation of new economic opportunities by enabling an environment for private investments in renewable energy and efficiency measures supported by tax incentives and market mechanisms.

⁶ Since the approved policy is not publicly available, this section refers to the content available in the draft policy (Government of Antigua and Barbuda, 2011).

The NEP also establishes guidelines to develop a SEAP, allowing for participation of governmental institutions as well as corporations, private citizens, and civil society in the formulation of the plan. According to the NEP, the SEAP aims to set out a path for implementing the reforms proposed in the NEP.

Following the NEP, Antigua and Barbuda prepared and published the draft SEAP in March 2013, which serves as a roadmap for the country's energy sector development between 2010 and 2030. It more specifically outlines the actions that will enhance the implementation of the policies and goals of the NEP. It contains short-term (1–5 years), medium-term (5–10 years), and long-term (10–20 years) goals to provide intermediate steps for the implementation of the goals of the NEP. The SEAP lays out strategies to reduce institutional and regulatory barriers and suggests specific measures to promote energy conservation

and efficiency, renewable energy and education and awareness (Sanguinetti and Gomes, 2013).

According to the SEAP, the APUA is expected to continue playing a key role in the energy sector, albeit within the constraints of the new energy policy. The policy's strategic objective is to develop and implement the appropriate legal, institutional, and economic structure to achieve sustainable and economically sound energy activities and services. Overall goals are to achieve a significant reduction of energy costs over the next 15 years in part by implementing efficiency measures to reduce operating costs in government, public and industrial facilities by 30 percent over the same time frame. The diversification of energy sources is emphasized and mandatory legislative measures for the use of solar passive systems and the use of utility scale solar facilities aim to add 15 percent renewable energy to the utility grid by 2025.

The Draft Sustainable Energy Action Plan

The Draft Sustainable Energy Action Plan, published in March 2013, aims to serve as a road map for the country's energy future until 2030.⁷ It contains short-term (1–5 years), medium-term (5–10 years), and long-term (10–20 years) goals aimed at enhancing the implementation of the NEP and reducing institutional and regulatory barriers. Similar to the NEP, the SEAP calls for the establishment of an Independent Regulatory Agency, an SEU, and an Energy Advisory Panel. Its focus is energy conservation and energy efficiency, diversification of energy resources, sustainable energy consumption, and generation and increase utilization of renewable energy. The SEAP lists timelines for implementation; defines priorities; specifies costs, feasibility, and synergies; and designates responsible agencies to implement and coordinate the actions and measures.

The SEAP's four strategies to achieve the goals of the NEP are as follows:

- Strategy 1: Overarching Reform of the Sector
 - Address institutional and regulatory barriers to foster energy efficiency and renewable energy development.
 - Create an independent regulatory agency, a dedicated SEU responsible for the energy sector, and an Energy Advisory Panel to advise the government on energy policy
- Strategy 2: Energy Conservation and Energy Efficiency
 - Address high-energy intensity and low levels of energy efficiency throughout all sectors and users by establishing new efficiency standards and building codes.
- Strategy 3: Renewable Energy Development
 - Reduce dependency on imported fossil fuels by increasing use of renewable energy resources.
- Strategy 4: Education and Awareness
 - Increase awareness, education, and technical capacity on energy efficiency and renewable energy resources.
 - Increase government resources dedicated to the energy sector and create certified renewable energy installers and certified efficiency auditors.
 - Involve the financial sector in energy efficiency and renewable energy projects.

As of mid-2015, the energy sector has not been reformed to the extent envisioned. Important goals such as streamlining governmental action and increasing clarity on roles and processes—both aimed at preparing the energy sector for a transition to a sustainable electricity system—have not been achieved. The clarification of the APUA's role, the establishment of an independent regulator, and the implementation of other key legal and regulatory reforms have not yet been achieved. In addition, the Government of Antigua and Barbuda has approved a Sustainable Island Resource Fund, which in part intends to finance renewable energy development (Castalia, 2015).⁸

⁷ This section refers to Government of Antigua and Barbuda (2013).

Regulator

Antigua and Barbuda does not have an overarching or independent energy sector regulator. For more information, please refer to the paragraph on the regulation of the electricity sector.

Institutional Structure of the Electricity Subsector

Current Institutional Structure

The Public Utilities Act of 1973, and its updated versions of 1993 and 2004, primarily govern the electricity sector. Under the Act, the APUA was set up as a tripartite government statutory agency, which controls and regulates telecommunications, electricity, and water services. Following the Act, it became an offense to generate, distribute, supply, or sell electricity without the prior written permission of the APUA, establishing a legislative monopoly in which the APUA holds the exclusive rights for the generation, distribution, transmission, and sale of electricity.

The APUA may grant permission to IPPs to generate and supply electricity, but this authorization has been limited to one IPP (the APC) as part of a long-term power purchase agreement. The APUA operates and manages an installed capacity of 77.9 MW, compared to a national peak demand of around 53 MW (Government of Antigua and Barbuda, 2011; Wadadli Industrial Renewable Energy Limited, 2014). The APUA purchases a large share of the electricity it distributes and sells to final consumers from the APC. The APC's electricity generation costs are below those of the APUA, as a result of which the APUA has historically become less and less active in investment in new generation capacity; instead, it has focused on its role as grid operator. It has kept its monopoly on the distribution and transmission of power, selling electricity to the end user. With the opening of the Wadadli plant in 2011, the APUA generation output increased for the first time in decades (Government of Antigua and Barbuda, 2011).

The APUA has allowed the supply of renewable energy into the national grid within very narrow limits. In 2011, the APUA released an Interconnection Policy Statement for non-fossil-fuel distributed generating facilities with capacities of 50kW or less. The policy took effect on December 1, 2011, and allows a maximum penetration of non-fossil fuel-based generation of 15 percent of the yearly maximum demand to ensure grid stability (Sanguinetti and Gomes, 2013). The policy is only applicable to systems connected to the national grid and not those running parallel to it. The

APUA will entertain a limited number of applications for commercial or industrial pilot system in the range of 50–225 kW for the purpose of gathering interconnection study data (APUA, 2011). As of mid-2015 less than 70 small-scale producers have been connected to the grid (APUA, 2015).

Under the Policy Statement, the APUA allowed net metering, where customers who fed electricity into the grid, would continue to operate a single meter which could run forward as well as backward. This allowed for one-to-one metering of electricity consumed versus electricity produced. Starting in March 2015, the APUA introduced a change to this policy, switching from net metering to net billing. Now, small-scale producers are instructed to install a second meter that records exclusively the amount of electricity produced. The electricity fed into the grid is then purchased by the APUA at a lower rate than the electricity it sells to the final consumers. Net billing policies are less favorable to small-scale producers, as they receive a lower rate than the one they are paying themselves for the electricity they receive from the grid. The APUA argued that the previous net metering policy was too generous, as it allowed customers who produced as much electricity as they consumed to reduce their electricity bill to just EC\$25 a month, the basic connection fee. According to the utility, net billing more accurately reflects and takes into account the costs incurred by the APUA, such as maintaining the grid. In the APUA's view, IPPs should contribute to the costs for delivering electricity to final consumers. The APUA has not yet publicly announced the rate it will pay IPPs under the net billing policy. This change in policy will significantly reduce the financial incentive for private producers to install or expand their capacities.

Even if the new guidelines set forth in the NEP and SEAP—allowing free market mechanisms to achieve higher efficiencies, lower generation costs and costs to consumers, and the operation of small and larger scale IPPs—are fully implemented, the APUA will continue to play a key role in the electricity sector due to its monopoly status as a grid operator.

The Antigua Public Utilities Authority (APUA)

The APUA was created on July 4, 1973, when the Electricity, Water, and Telephone department was incorporated under the Public Utilities Act. It controls and regulates telecommunications, electricity, and water services. The APUA holds the exclusive license for the generation, transmission, distribution, and sale of electricity and fuel. It may grant licenses to independent power producers where it deems it necessary or appropriate. Licenses have been granted to the WIOC, allowing it to operate storage facilities for oil products, and to the APC, allowing it to build, own, and operate electricity-generating equipment and subsequently transfer the electricity to the APUA for a fee.

The APUA commissioned the new 30 MW Wadadli thermal power plant in September 2011 at a cost of nearly US\$50 million. Notwithstanding this new facility, the APUA continues to suffer from operational inefficiencies, contributing to the company's very high production costs. The APUA remains in financial difficulty because, despite charging some of the highest electricity retail rates in the OECS, it also has some of the highest production costs in the region. The utility's financial difficulties have affected the quality of the electricity services provided, and outages are common. Following its opening, the Wadadli plant came under public scrutiny because of repeated outages, and it often operated below full capacity. Its six generators have been de-rated from 5MW to 4MW each to avoid overheating. According to newspaper reports, it may be using defective equipment (Antigua Observer, 2012; Castalia Consulting, 2012; Government of Antigua and Barbuda, 2011). In 2011, the last year for which data are available, the APUA generated only 40 percent of the annual electricity output, with the remaining 60 percent purchased from the APC. In October 2013, the APUA experienced temporary blackouts due to nonpayment of fuel bills from the WIOC. The WIOC implemented a cash-before-delivery policy to ensure payment of outstanding debt by the APUA (NREL, 2015).

The APUA and the government have been involved in an ongoing legal dispute with the APC since 2012. In October 2012, the APC informed the APUA of its intention to suspend power generation incrementally due to the APUA's failure to make weekly payments as agreed upon under the terms of the power purchase agreement. Following contracted negotiations, the case turned into a legal dispute and the APC won a breach of contract case against the APUA and the government. As of Spring 2015, the government and the APC were still negotiating in an attempt to settle out of court. While the APC is demanding over US\$220 million in damages, the government stated that compensation might end up being as low as US\$20 million. As part of the negotiation, the APC's license, set to expire in 2018, is also on table, with the APC suggesting an extension until 2029 (Antigua Observer, 2015b; APUA, 2012).

The Public Utilities Act

The Public Utilities Act (CAP 359) of 1973 grants the APUA the exclusive right to generate, distribute, supply, and sell electricity within Antigua and Barbuda. It furthermore gives the APUA the right to grant permission to third parties to operate as independent power producers. The APUA has granted a single license for the generation of electricity to the APC in 1996 under a power purchase agreement to meet peak demands. Its license expires in 2018. Under the Act the APUA was also given the right, with the approval of the Minister, to "borrow by way of advances from the Government such sums as may be necessary for carrying out its function under this Act. Furthermore, the APUA is exempt from consumption tax or custom duties or any other tax having a similar effect.

The Utilities Act provides for very limited regulatory oversight and for the most part the APUA self-regulates. The Act only states that the APUA is under the control of the Minister (of Energy) who has the authority to hand down directives and the APUA is required to provide the Minister with information on returns, accounts, and any other information that the Minister requests. Under the 1973 Act the Cabinet may assume control of the APUA if it acts contrary to the interests and needs of the people of Antigua and Barbuda.

The 2004 Amendment to the Act gives the APUA the authority to review electricity tariffs after consultation with such persons or groups of persons representing the public and private sectors and with approval of the Minister. This represents a change from the 1973 version of the Act under which tariffs were set by Order of the Cabinet after consultation with the APUA (Parliament of Antigua and Barbuda, 1973; Parliament of Antigua and Barbuda, 2004).

The Renewable Energy Act

The Renewable Energy Act of 2015 is Antigua and Barbuda's latest effort to reform the energy sector and create a clear and transparent regulatory framework. It aims to reduce foreign exchange spent on petroleum fuel imports, and to allow engineers to build expertise in the renewable energy technologies and the APUA to become involved in the renewable energy sector. It also aims to reduce pollution and CO2 emissions. According to the proposed Act, the government will develop and put in place feed-in tariffs and encourage net billing rather than net metering so as not to "jeopardize other interests in the process." It calls for prescribed renewable energy targets, interconnection standards, licensing rules, and increased awareness for RE to be presented within 180 days by the Ministry of Energy.

A key provision of the Act will be the introduction of electricity wheeling, which allows for privately produced electricity to be consumed at a different location than where it was produced. This will enable private producers, such as hotels or other large businesses that may not have sufficient land available at the place of operation, to produce electricity from renewable sources off-site and transmit it to its point of consumption. The APUA will receive a fee for the service of transmitting the electricity. Under the proposal, electricity produced by one private entity can also be sold to another private entity. Both the producer and the consumer will be required to obtain an interconnection license from the APUA and the producer will have to obtain a wheeling license from the Cabinet (Government of Antigua and Barbuda, 2015b).

Table 8 Selected Renewable Energy Support Policies, 2015

Feed-in tariff	Net metering/ net billing	Renewable portfolio standard	IPPs permitted	Tax credits	Tax reduction/ exemption	Public loans/ grants
Suggested	✓ ^a	Suggested	✓ ^b	— ^c	— ^d	Suggested

Source: APUA (2011); Government of Antigua and Barbuda (2011); Government of Antigua and Barbuda (2013); Government of Antigua and Barbuda (2015b).

^a Switched from net metering to net billing in March 2015.

^b The APUA can grant license to IPPs. No IPP license required for non-fossil fuel generation up to 50kW. New NEP aims to facilitate market conditions for IPPs. Electricity Wheeling proposed under the Renewable Energy Act 2015.

^c The new NEP discusses possible tax credits but their status remains unclear.

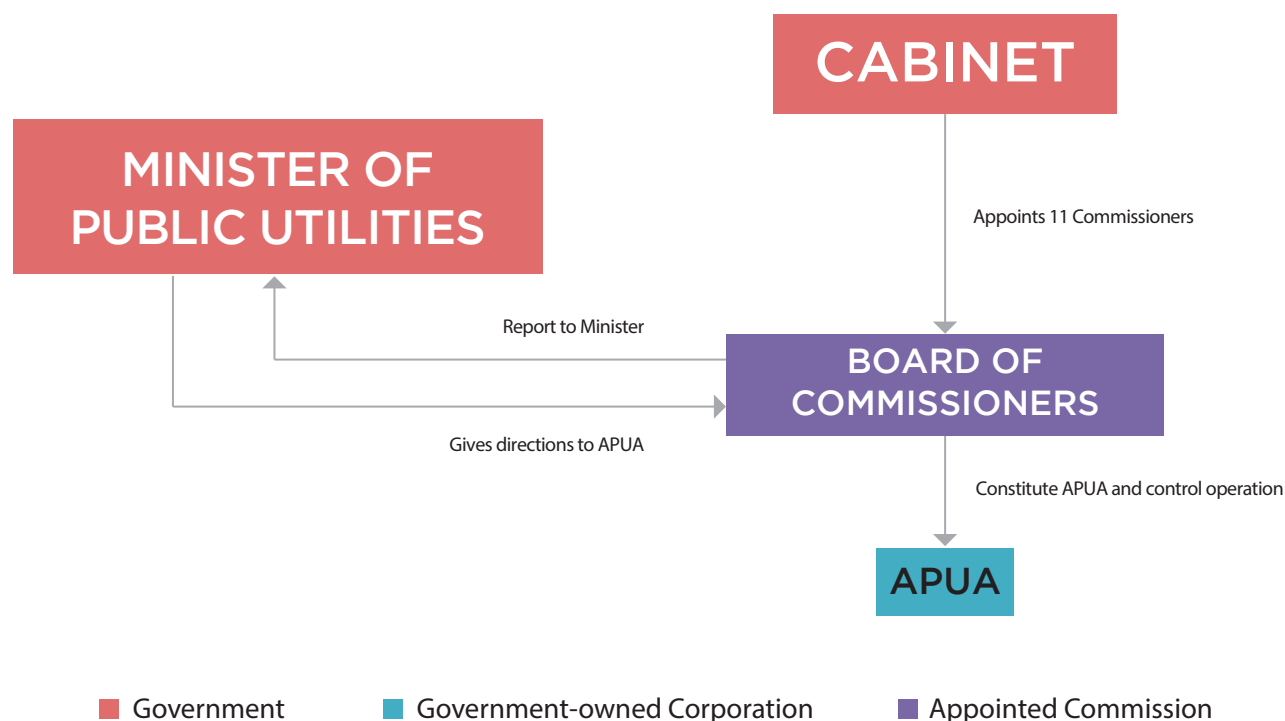
^d The new NEP discusses possible reductions/exemptions, but their status remains unclear.

Regulator

Antigua and Barbuda does not have an independent regulatory agency for the electricity sector. As a result, the APUA largely regulates itself with marginal oversight from the Cabinet-appointed Board of Commissioners. Under the Public Utilities Act, the Cabinet appoints an 11-member Board of Commissioners, which oversees the utility's operation. The minister responsible for energy (currently the Office of the Prime Minister) has also been given the authority to give direction to the APUA, and it is required to provide the minister with information on returns, account, and any other information that it requests (Parliament of Antigua and Barbuda, 1973).

The 2004 amendment to the Act reorganized the regulation of electricity tariffs, giving the APUA the authority to review tariffs after consultation with such persons or groups of persons representing the public and private sectors and with approval of the minister (Parliament of Antigua and Barbuda, 2004).

Figure 14 The APUA's Internal and Organizational Structure



Source: Authors' elaboration based on information in Parliament of Antigua and Barbuda (1973); Parliament of Antigua and Barbuda (1993); Parliament of Antigua and Barbuda (2004).

Although the NEP calls for the establishment of an independent regulatory agency, to ensure that consumers are guaranteed access to reliable and affordable energy services (Sanguinetti and Gomes, 2013), as of July 2015, no such regulatory agency had been designated. In the NEP, the government does not clearly define the role or authority of a new regulatory body. It does, however, emphasize the importance of participation in the planned Eastern Caribbean Energy Regulatory Authority (ECERA) (Government of Antigua and Barbuda, 2011; OAS, 2010).

The SEAP provides more detail on the independent regulatory agency, stating that it will be an independent arbiter in all matters relating to the sale of electricity. Its specific responsibilities will be to: (i) establish rules, guidelines, and standards to ensure consistent, predictable, and transparent regulation; (ii) set electricity tariffs and periodically review them; (iii) cooperate with the ECERA to incorporate the rules, guidelines, and stan-

dards needed for effective regulation of the electricity sector; (iv) monitor, develop, and implement technical standards to improve performance; (v) collect and assess data on the electricity sector; (vi) develop a modern market structure, create licensing terms, and implement fair and transparent rules especially to support renewable energy sources; (vii) develop and support a framework for sustainable investment in the sector by reviewing and approving investment plans and guiding through the procurement process with an emphasis on renewable energy resources; (viii) formulate and implement renewable energy targets and utility obligations to purchase generated electricity; (ix) provide expert advice on national energy policy at the request of the government; (x) support government policy related to the supply of electricity for national sustainable development; and (xi) engage and work with all relevant agencies to promote, protect, and enhance a sustainable environment (Government of Antigua and Barbuda, 2013).

Table 8 Electricity Sector Tariff Regime, 2015

Who sets tariffs	Who controls tariff changes	How is the tariff calculated	How are tariff changes calculated
The APUA by approval of Minister and consultation of public/private sector. ^a	The APUA determines fuel price charges. It can offer lower tariffs to select customers.	No criteria are set by the Act	No criteria are set by the Act
Who monitors and enforces fairness of tariff	Who can alter terms of how tariff is calculated	How frequently is tariff revised	Is there a guaranteed rate of return
The APUA must present audited reports of activities to Parliament through Minister.	Parliament	From time to time. No time interval specified by the legislation.	No guaranteed rate.

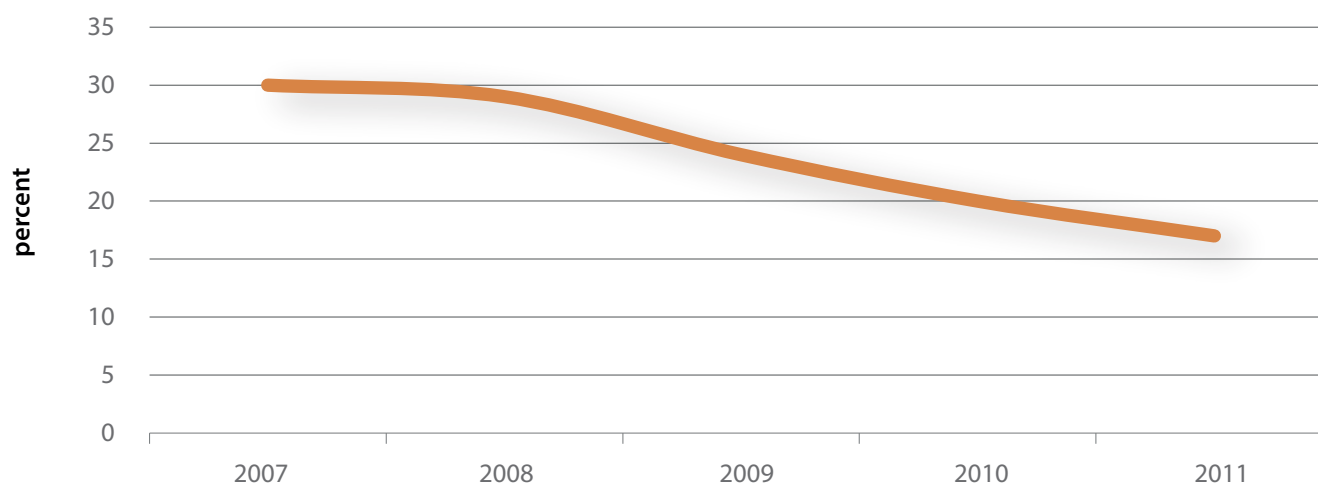
Source: Parliament of Antigua and Barbuda (1993); Parliament of Antigua and Barbuda (1973); Parliament of Antigua and Barbuda (2004).
a Changed in a 2004 amendment; previously, it could only be set by Order of Cabinet.

Transmission and Distribution

Electricity is transmitted along a 69kV distribution ring as well as 11kV lines and subsequently distributed to households via 22 feeder stations (Banhan and Lewis, 2012; Sanguinetti and Gomes, 2013).

The APUA's system losses remain significant, despite recent improvement. System losses have fallen from 30 percent in 2007 to 17 percent in 2011. At least up to 2010, system losses also included electricity distributed free of charge to the APUA's water and telecommunications divisions. It is unclear if that practice ended; if it did, it would help to explain the rapid decline in losses between 2007 and 2011 (Castalia Consulting, 2012). According to EIA (2015) losses during distribution alone stood at 8.3 percent in 2011.

Figure 15 System Losses, 2007-2011



Source: Samuel (2013); World Bank (2010b).

Electricity Rate

Antigua and Barbuda's electricity prices rank among the highest in the world and are the highest among the Eastern Caribbean states. The government does not provide blanket subsidies for residential, commercial, or industrial consumers, such as the elimination of the value-added tax below a certain limit to encourage conservation. It does, however, subsidize electricity for civil servants, public officials, and the elderly. Eligible civil servants and the elderly are exempt from electricity charges up to a limit of EC\$250, after which they pay the regular electricity tariff. Senior government officials as well as judges are exempt up to EC\$1,000–1,500 depending on their position and seniority (Castalia Consulting, 2012). In total, the government provides subsidized utility services (electricity and water) to more than 700 civil servants, public officials, and senior citizens. The total annual cost of these subsidies is EC\$5.2 million (Government of Antigua and Barbuda, 2012a).

Electricity costs vary slightly between Antigua and Barbuda. In July 2013, the last month for which the APUA published data, consumers paid an average rate of EC\$1.19/kWh on Antigua and EC\$1.32/kWh on Barbuda, of which EC\$0.79 represents the adjustable fuel surcharge.

The electricity rate varies between residential and commercial consumers. Residential customers pay EC\$0.40/kWh for the first 300 kWh and EC\$0.38/kWh thereafter. Commercial customers pay between EC\$0.45/kWh for the first 100kWh, followed by EC\$0.42/kWh for the next 150kWh and EC\$0.38/kWh thereafter. In addition to this basic consumption charge, consumers are also subject to a variable fuel surcharge, which was EC\$0.60/kWh as of March 2015 (APUA, 2014b).

The cost of production varies widely based on the operating efficiency of the plants and ranges from EC\$0.43/kWh to EC\$1.24/kWh with an average of EC\$0.76 (Gore-Francis, 2013).

Table 9 APUA Electricity Tariffs and Charges, 2014 (in EC\$)

Charge	Domestic	Commercial
Tariff	1-300kW: \$0.40/kWh >300kW: \$0.38/kWh	<100 kWh: \$0.45/kWh 100-250kWh: \$0.42/kWh >250kWh: \$0.38/kWh
Fuel surcharge (March 2015)	\$0.60/kWh	\$0.60/kWh
Minimum charge	\$25 per month	\$45 per month
Demand charge	n/a	\$8/kVA

Source: Antigua Observer (2015a); APUA (2014b).

Table 10 Matrix of the Electricity Sector

Generation		Utility	Ownership structure
APUA	100 percent state-owned	APUA	APUA
APC	100 percent privately-owned		

Institutional Structure of the Hydrocarbon Subsector

As Antigua and Barbuda does not produce any hydrocarbon resources and has no refining capacity, its hydrocarbon subsector imports oil products for use in electricity generation and transportation. The Petroleum Act of 1949 defines rules for the import and storage of petroleum and designates the responsibility for this function to the Minister. Furthermore, it specifies that the Comptroller of Customs may grant licenses to any person to deal in or sell petroleum in accordance with the prescribed regulations (Parliament of Antigua and Barbuda, 1949).

The WIOC currently holds a license for the import and storage of petroleum products. National Petroleum Limited of Bermuda acquired the WIOC in 1980 for US\$6 million from the government of Antigua and Barbuda. On April 1, 2015, the government bought back all of the shares for around US\$150 million. Included in the sale were 280 acres of land in the Friars Hill area. The WIOC operated an oil refinery until 1982, and has since reduced its business to the terminalling of oil products. It provides 322,000 barrels of storage capacity. It also operates service stations throughout the island. The WIOC imports Venezuelan oil products on preferential terms under the PetroCaribe initiative, which Antigua and Barbuda joined on July 14, 2006 (Caribbean News, 2015; WIOC, 2014). Under the initiative, the government founded the state-owned company PDV Caribe Antigua and Barbuda Ltd., which receives and commercializes oil product under the preferential terms of the PetroCaribe agreement (Government of Antigua and Barbuda, 2012b; PDVSA, 2006). Antigua and Barbuda can import up to 4.4kboe/day under the preferential terms. However, it only imported 830 boe/day, equal to 18.8 percent of its quota in 2014. Since joining PetroCaribe at the end of 2014, the country has imported a total 2.5 million boe (PDVSA, 2014).

Table 11 Matrix of the Hydrocarbon Sector

Production	Imports	Transformation	Commercialization
	WIOC PDV Caribe Antigua and Barbuda Ltd.		WIOC Sol Petroleum PDV Caribe Antigua and Barbuda Ltd. + additional distributors

Methodology for Energy Matrix

The Energy Matrix was constructed using data from APUA (2014a); Castalia Consulting (2012); EIA, (2015); Government of Antigua and Barbuda (2009); IRENA (2012); Samuel (2013); Sanguinetti and Gomes (2013) and NREL (2015)

The composition of total primary energy supply comes from IRENA (2012). The figures on oil imports and exports as well as consumption come from EIA (2012), and oil products input into electricity was calculated using gross generation and average heat rate. The

gross generation figure is based on net generation figure from Sanguinetti and Gomes and average self-consumption by the APUA based on Castalia Consulting (2012). Share of renewables as part of generation comes from NREL (2015). Average heat rate was calculated from the APUA (2014a). Electricity output was based on net generation calculated by Sanguinetti and Gomes (2013) minus losses based on Samuel (2013), and consumption by sector was calculated based on CO2 emission by sector from Government of Antigua and Barbuda (2009).

	Gross generation	Net generation	Sales	Losses	Consumption
2012	335 GWh	329 GWh	200 GWh	17%	273 GWh
Source	Estimate based on average difference of 1.8 percent between gross and net generation, 2007–11.	Sanguinetti and Gomes (2013)	Estimate based on 2007–11 figures from Samuel (2013).	Estimate based on 2007–11 figures from Samuel (2013).	Estimate based on net generation minus losses.

	Output electricity in GWh	Heat rate	Input electricity in boe/day
2012	335 GWh	450kWh/barrel	2039 boe/day
		Based on the APUA generation figures July 2013.	

	Net generation of electricity	Losses in %	Consumption of electricity GWh	Consumption of electricity in boe/day
2012	329 GWh	17	273 GWh	459 boe/day

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