Caribbean Sustainable Energy Roadmap (C-SERMS), Phase 1

Baseline Report and Assessment

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Table of Contents

Acknowledgments **5**

List of Acronyms and Abbreviations **6**

Executive Summary **8**

1 The Caribbean at an Energy Crossroads **10**

1.1 CARICOM and Regional Context **10**

1.2 CARICOM Energy Policy **13**

1.2.1 Benefits of a Regional Approach to Energy Development in CARICOM 13

1.2.2 Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS): Setting Initial Sustainable Energy Targets 14

1.3 Methodology and Structure of Report **15**

2 Current Regional Energy Situation **16**

2.1 Energy Inputs and Outputs **16**

2.1.1 Energy Source Matrix 16

2.1.2 Quantities Produced and Consumed 17

2.1.3 Petroleum Imports and Exports 19

2.1.4 Natural Gas 24

2.1.5 Energy Consumption by Sector 25

2.1.6 New Developments and Ongoing Exploration 26

2.2 Electricity Sector **28**

2.2.1 Overview 28

2.2.2 Electricity Access 28

2.2.3 Status of Generation, Transmission, and Distribution Systems 31

2.2.4 Projected Forecast of Electricity Consumption 34

2.2.5 Gap Analysis 37

2.3 Transportation Sector **38**

2.3.1 Best Practices in Road Transportation 39

2.3.2 Aviation and Maritime Transportation 40

2.3.3 Gap Identification 41

2.4 Carbon Dioxide Emissions **42**

2.4.1 Current Emissions Accounting 42

2.4.2 Future Projections of Emissions from the Power Sector (Business-as-Usual Scenario) 43

2.4.3 Gap Analysis: Emissions 44

3 Renewable Energy and Energy Efficiency Potential **44**

3.1 Renewable Energy Potentials **44**

3.1.1 Modern biomass 46

3.1.2 Geothermal 46

3.1.3 Hydro 47

3.1.4 Municipal Solid Waste 48
3.1.5 Ocean Energy 48
3.1.6 Solar 49
3.1.7 Wind 50
3.1.8 Comparative Costs of Renewable Energy Technologies 50
3.1.9 LCOE + ... 51
3.2 Current Sustainable Energy Initiatives 52
3.3 Potential of Energy Efficiency in the Region 54
3.4 Current Energy Efficiency Initiatives 56
3.5 Renewables and the Grid 57
3.6 Regional Interconnection Potential 57
3.7 Gap Analysis 58

4 Existing Policy Framework 59
4.1 Existing National Energy Plans and Long-Term Visions in CARICOM 60
4.1.1 Existing Renewable Energy Targets 61
4.1.2 Existing Energy Efficiency Targets 62
4.1.3 Existing Emissions Reductions Targets 62
4.2 Existing Concrete Policies and Mechanisms 63
4.2.1 Existing Renewable Energy Support Policies 63
4.2.2 Existing Energy Efficiency Support Policies 65
4.2.3 Existing Support Policies for Sustainable Transportation 66
4.2.4 Policy Effectiveness 67
4.3 Existing Governance and Administrative Structures 68

5 Setting CARICOM Targets for Renewable Energy, Energy Efficiency and Emissions Reductions 72
5.1 Setting Regional Energy Targets Worldwide 72
5.2 Recommended Renewable Power Targets for CARICOM 73
5.2.1 Renewable Power Targets Agreed Upon by COTED 73
5.2.2 Methodology 73
5.2.3 Suggesting Country-Specific Targets 75
5.2.4 Advantages 76
5.2.5 Challenges 77
5.2.6 Recommendations for Moving Forward 78
5.3 Recommended Energy Efficiency Targets for CARICOM 79
5.4 Recommended Emissions Reduction Targets for CARICOM 81

6 Looking Forward: Designing and Implementing a Strategy to Achieve Regional Targets 83
Annex A 99

Endnotes 147

List of Figures, Tables, and Sidebars

Figure 1. Major Energy Challenges in CARICOMPrimary Energy Production and Consumption in CARICOM Member States, 2010 18
Figure 2. C-SERMS Phase I Methodology 19
Figure 3. Primary Energy Production and Consumption in the CARICOM Member States, 2010 19
Figure 4. Primary Energy Production and Consumption in Trinidad and Tobago, 2001-10 18
Figure 5. Primary Energy Production and Consumption in the CARICOM REgion, 2001-10 19
Figure 6. Total Petroleum Imports in CARICOM Member States, 2000-10 22
Figure 7. Refined Petroleum Imports in CARICOM Member States, 2000–10 23
Figure 8. Refined Petroleum Imports in CARICOM Member States, by Fuel Type, 2000–10 23
Figure 9. Total Petroleum Exports in CARICOM Member States, 2000-10 24
Figure 10. Refined Petroleum Exports in CARICOM Member States, 2000-10 25
Figure 11. Refined Petroleum Exports in CARICOM Member States, by Fuel Type, 2010 26
Figure 12. Natural Gas Use in Trinidad and Tobago, by Sector, 2011 29
Figure 13. Energy Consumption in CARICOM Member States, by Sector, 2010 26
Figure 14. Electricity Access in CARICOM Member States 29
Figure 15. Estimated Technical and Non-Technical Electricity Losses in CARICOM Member States, 2012 35
Figure 16. Residential Electricity Tariffs of CARILEC Members, 2009/2010 36
Figure 17. Electricity Generation and Consumption in the CARICOM Region,2012 and Projections for 2017, 2022, and 2027 38
Figure 18. Net Peak Demand Load Forecast in CARICOM Member States, 2010-17 38
Figure 19. Existing Capacity and Projected Capacity Needs in 2027 37
Figure 20. Transportation's Share of Total Energy Consumption in CARICOM Member States, 2010 38
Figure 21. Carbon Dioxide Emissions from Energy Consumption in CARICOM Member States, 2000-10 ..... **Error! Bookmark not defined.**
Figure 22. Per Capita Carbon Dioxide Emissions from Energy Consumption in CARICOM Member States, 2010 55
Figure 23. Projected Power Sector Emissions in the CARICOM Region, 2017, 2022, and 2027 44
Figure 24. Global Power Generation Costs by Technology Compared to the Range of Electricity Tariffs in CARICOM 51
Figure 25. Carbon Abatement Cost Curve Analysis for the Dominican Republic 55
Figure 26. Energy Intensity of CARICOM Member States, 2005-09 56
Figure 27. Observed Permitting Processes for Adding Small Hydro Capacity (100 kW to 25 MW) in a CARICOM Member State 70
Figure 28. Methodology for Recommending Renewable Power Capacity Targets 73
Figure 29. Regional Gap Analysis 82
Figure 30. Achieving Targets through Coordinated Regional and National Efforts 83

Table 1. Selected Indicators of CARICOM Member States 11
Table 2. Petrocaribe Financing Terms 20
Table 3. Installed Power Capacity and Share of Renewables in CARICOM Member States 31
Table 4. Renewable Electricity Installed Capacity in CARICOM Member States 32
Table 5. Potential Average Fuel Economy for New Vehicles, 2005–2030 39

Table 6. Renewable Energy Potentials in CARICOM Member States 45
Table 7. Existing National Energy Plans in CARICOM Member States 60
Table 8. Overview of Renewable Energy Targets in CARICOM Member States 61
Table 9. Overview of National Energy Efficiency Targets in CARICOM Member States 62
Table 10. Renewable Energy Support Policies in CARICOM Member States 64
Table 11. Energy Efficiency Support Policies in CARICOM Member States 66
Table 12. Transportation Policies in CARICOM Member States 67
Table 13. Institutional and Governance Structure of the Energy Sector in CARICOM Member States 69
Table 14. Global Renewable Energy Scenarios 71
Table 15. Renewable Energy and Energy Efficiency Targets of Regional Associations and Organizations Worldwide 71
Table 16. Proposed Renewable Energy Targets for the CARICOM Region 73
Table 17. Redefining National Renewable Energy Targets in CARICOM Member States 74
Table 18 Proposed Power Sector Carbon Dioxide Emissions Reduction Targets for the CARICOM Region 81
Table 19. Proposed National Power Sector Carbon Dioxide Emissions Reduction Targets for 2027 for CARICOM Member States 81
Table 20. Priority Initiatives, Policies, Projects and Activities (PIPPA) for CARICOM 85
Table 21. Priority Action Areas for CARICOM Member States 93
Table 22. Overview of Important Products from Existing Regional Sustainable Energy Initiatives 94
Table 23. Immediate Next Steps in Facilitating the Transition to Sustainable Energy in CARICOM 97

Sidebar 1. The Impact of Petrocaribe on the CARICOM Region 20
Sidebar 2. Renewable Self-Generation: L'Hôpital Mirebalais in Haiti 30

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Mark Konold, Project Manager

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List of Acronyms and Abbreviations

APUA	Antigua Public Utilities Authority
BAU	Business-As-Usual
BNEF	Bloomberg New Energy Finance
C-SERMS	Caribbean Sustainable Energy Roadmap and Strategy
CAFE	Corporate Average Fuel Economy
CARICOM	Caribbean Community
CCCCC	Caribbean Community Climate Change Centre
CDB	Caribbean Development Bank
CEIS	Caribbean Energy Information System
CIPORE	Caribbean Information Platform on Renewable Energy
CNG	Compressed Natural Gas
COTED	Caribbean Community Council on Trade and Economic Development
CREDP	Caribbean Renewable Energy Development Program
CSEP	Caribbean Sustainable Energy Program
CSME	Caribbean Community Single Market and Economy
CSP	Concentrating Solar Power
DBJ	Development Bank of Jamaica
DOMLEC	Dominica Electricity Services
EBS	Energie Bedrijven Suriname
ECGP	Eastern Caribbean Gas Pipeline
ECLAC	Economic Commission for Latin America and the Caribbean
ECOWAS	Economic Community of West African States
ECPA	Energy and Climate Partnership for the Americas
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EDF	Electricité de France
EDH	Electricité d'Haïti
EREP	Renewable Energy Policy for ECOWAS
ESMAP	Energy Sector Management Assistance Program
ETS	Emissions Trading Scheme
EU	European Union
FiT	Feed-in-Tariff
GDP	Gross Domestic Product
GIZ	German Agency for International Cooperation
GRENLEC	Grenada Electricity Services Limited
GW	Gigawatt
HFO	Heavy Fuel Oil
HUM	L'Hôpital Universitaire Mirebalais
IDB	Inter-American Development Bank
IMF	International Monetary Fund
IPP	Independent Power Producer
JPS	Jamaica Public Service Limited
kW	Kilowatt
kWh	Kilowatt-hour
LCOE	Levelized Cost of Electricity

lge	Liters of gasoline equivalent
LNG	Liquefied Natural Gas
LUCELEC	St. Lucia Electricity Services Limited
MENA	Middle East and North Africa
META	Model for Electricity Technology Assessments
MSTEM	Jamaica's Ministry of Science, Technology, Energy and Mining
MSW	Municipal Solid Waste
MW	Megawatt
NEVLEC	Nevis Electricity Company Limited
OLADE	Latin American Energy Organization
OTEC	Ocean Thermal Energy Conversion
PPA	Power Purchase Agreement
PPP	Purchasing Power Parity
PV	Photovoltaic
RCREEE	Regional Centre for Renewable Energy and Energy Efficiency
SE4ALL	Sustainable Energy For All
SIDS	Small Island Developing State
SKELEC	St. Kitts Electricity Company Limited
T&D	Transmission and Distribution
T&TEC	Trinidad and Tobago Electricity Commission
VINLEC	St. Vincent Electricity Services Limited

Executive Summary

The Caribbean region currently stands at a crossroads, faced with several critical challenges associated with the generation, distribution, and use of energy. Despite tremendous renewable energy resources, the region remains disproportionately dependent on imported fossil fuels, which exposes it to volatile and rising oil prices, limits economic development, degrades local natural resources, and fails to establish a precedent for global action to mitigate the long-term consequences of climate change, which pose a particularly acute threat to small-island states and low-lying coastal nations.

The Caribbean Community (CARICOM) is poised to play a crucial role in the regional transition to sustainable energy. CARICOM represents 15 diverse member states: Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago. Although the geography, culture, and economic structures of these states vary widely, they face many common energy challenges. Recognizing the need to develop a **coordinated regional approach to expedite the increased use of renewable energy and energy efficiency** and chart a new, climate-compatible development path that harnesses indigenous renewable energy resources, maximizes energy use, minimizes environmental damage, and spurs economic growth and innovation, CARICOM adopted its regional **Energy Policy** in 2013 after a decade in development. To facilitate the process of translating intentions into action, the CARICOM Secretariat commissioned the **Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS)**, designed to build on existing efforts in the region and to provide CARICOM member states with a coherent strategy for transitioning to sustainable energy.

In this C-SERMS Phase 1 *Baseline Assessment and Report*, the Worldwatch Institute provides a **baseline assessment** of the region's current energy situation, **recommends regional targets** for renewable power generation, energy efficiency, and carbon emissions reductions in the short-term (2017), medium-term (2022), and long-term (2027), and **outlines key strategies** for achieving those goals. Based on this assessment, a detailed strategy for priority project, policies, and initiatives to be undertaken in the region can be found here and in the corresponding *Summary and Recommendations for Policymakers report* prepared by Worldwatch.

This report explores the options for energy reform across a wide range of sectors, nearly all of which face significant energy challenges. In the **power sector**, current generation relies heavily on dirty and expensive fuels, and is often insufficient to meet the needs of local populations. These challenges are often accentuated by isolated grid networks, high losses, small overall generation capacity, outdated equipment, and a lack of financial resources to make needed advancements. **Transportation** accounts for a significant share of total energy consumption in nearly all member states, while energy production, manufacturing, and extractive industries account for a majority of energy consumption in certain member states. The **tourism** sector presents unique opportunities for rapid and significant impact because of its high energy consumption and enormous economic importance regionally. Significant data gaps across all sectors continue to hinder comprehensive assessment of the region's current energy situation. Although still relatively marginal in terms of their overall contribution to the region's energy mix, renewable energy technologies are playing an increasingly large role throughout CARICOM.

Fortunately, **extremely strong potential for utilizing domestic renewable resources** exists across the region. Initial technical assessments indicate enormous opportunities for sustainable energy solutions based on energy efficiency improvements and the development of both baseload and variable renewable resources including geothermal, hydropower, modern biomass, solar, and wind. Current grid

and storage infrastructure, however, is generally insufficient to support such developments on a large scale. Harnessing observed potential will require that a number of **key technical assessment gaps be filled**. Detailed renewable energy, energy efficiency, and grid and storage assessments are still lacking in many areas across the region and, in cases where these have been conducted, they are often not communicated or are not made publically available.

Despite the strong potential for energy efficiency and renewable energy observed in all CARICOM member states, the development of sustainable energy systems will not occur organically. The successful expansion of sustainable energy depends largely on the presence of a **long-term vision**, the **effectiveness of existing policy and regulatory structures**, and the surrounding **governance and administrative framework**. To date, all 15 member states have adopted a **national energy policy** or have a document in advanced stages of development. National policymakers across the region have set **domestic targets** to promote renewable energy use. Many member states have already taken the lead in developing and implementing **domestic policy mechanisms** to support an increase in renewable energy and energy efficiency. At the regional level, policymakers have jointly established **net-billing** as the appropriate minimum standard for policy support across CARICOM. Despite these important initial steps, sustainable energy development across the region continues to be limited by policy and data gaps, administrative ineffectiveness, and often inefficient and uncoordinated implementation efforts.

Regional collaboration between member states can significantly transform the CARICOM energy sector. Based on an initial assessment of renewable resource potentials, existing energy policy frameworks, and international best practices, Worldwatch has developed and recommended **regional sustainable energy targets for renewable power generation, energy efficiency, and reductions in carbon dioxide (CO_2) emissions** in the short-, medium-, and long-terms. In this report, Worldwatch recommends targets of **20 percent renewable power capacity by 2017, 28 percent by 2022 and 47 percent by 2027**; a **33-percent reduction in energy intensity by 2027**; and **power sector CO_2 emission reductions of 18 percent by 2017, 32 percent by 2022 and 36 percent by 2027**. These ambitious targets, many of which were adopted at the 41st Special Meeting of the Commission on Trade and Economic Development (COTED) on Energy, unite the region under a common vision and establish CARICOM as a global leader in renewable energy promotion.

Through **regional collaboration**, CARICOM's 15 member states have a tremendous opportunity to maximize their individual resources and spearhead renewable energy development regionwide by working together toward common and coherent goals. The CARICOM Energy Policy and the C-SERMS project are both critical steps toward a more cohesive approach to regional energy planning. Many obstacles remain, however, that must be overcome through the promotion of priority projects, policies and initiatives at the regional and national level.

Full transformation of the CARICOM energy sector will be a long-term process requiring extensive commitment and dedicated collaboration between all member states, regional and international actors. The regional approach outlined by C-SERMS will ensure that no member state will be forced to travel this path alone, but will instead be supported by a network of actors and institutions united under a common vision. With continued commitment to transforming the regional energy sector, CARICOM and its 15 member states can become global leaders in sustainable energy development.

Caribbean Sustainable Energy Roadmap and Strategy Phase 1 (C-SERMS-I)

Baseline Report and Assessment

Recognizing the need to develop a **coordinated approach to addressing regional energy challenges,** the Caribbean Community (CARICOM) began developing its Energy Policy in 2002. Approved in 2013, the document promotes a shift to sustainable energy through increased use of renewable energy sources and improvements in energy efficiency. In 2009, the Secretariat commissioned the **Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS)**, designed to build on existing efforts in the region and to provide CARICOM member states with **joint regional sustainable energy targets and a common, coherent strategy** for transitioning to sustainable energy systems.

The C-SERMS-I *Baseline Report and Assessment* provides an **overview of the regional energy situation**, identifies **critical information and data gaps**, and recommends **short (2017), medium (2022), and long-term (2027) targets** for share of renewable energy in electricity production, energy efficiency improvements, and carbon dioxide emissions reductions in the power sector. It also **recommends a series of priority actions** that CARICOM and its member states can undertake to achieve these goals.

1 The Caribbean at an Energy Crossroads

1.1 CARICOM and Regional Context

The Caribbean region currently stands at a crossroads, faced with several critical challenges associated with the generation and use of energy (See Figure 1). Heavy dependence on imported fossil fuels exposes many Caribbean countries to volatile and rising oil prices, limits economic development, produces high electricity tariffs, negatively impacts human health and the environment, and fails to establish a precedent for global action to mitigate the long-term consequences of climate change, which pose a particularly acute threat to small-island states and low-lying coastal nations.

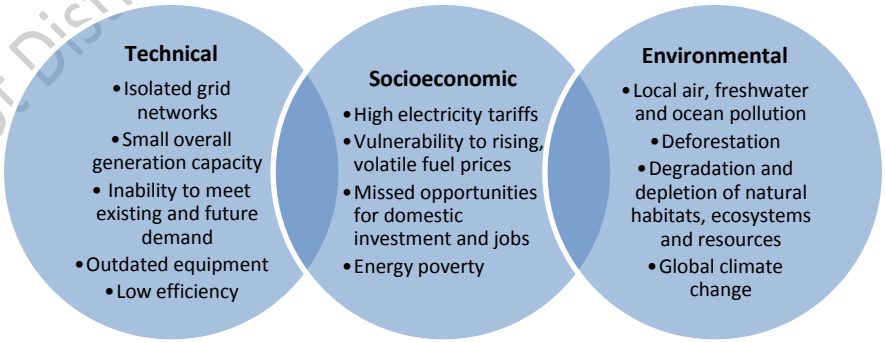

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Figure 1. Major Energy Challenges in CARICOM

Fortunately, these challenges are far outweighed by the region's tremendous opportunities for sustainable energy solutions. The Caribbean now has an opportunity to take a leading role in climate-compatible development by crafting innovative legislative and regulatory frameworks, and by fostering the vision and political will required to harness renewable energy and energy efficiency for economic, social, and environmental good.

The Caribbean Community (CARICOM) is well positioned to play a crucial role in leading and coordinating this effort on a regional scale. Established in 1973 under the Treaty of Chaguaramas, CARICOM is a regional organization representing 15 member states: Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago.

CARICOM member states, representing a total population of nearly 17 million people, exhibit a high degree of geographic, cultural, and economic diversity. Although many CARICOM states are located close to one another, their topography varies widely, with significant implications for both available energy resources and options for energy sector development. The CARICOM region comprises several relatively large states in the Greater Antilles, a number of much smaller island states in the archipelago of the Lesser Antilles, and three low-lying coastal states.

Although tourism and the services sector represent the economic mainstays of many CARICOM member states, other important industries, including agriculture, manufacturing, and mining, flourish across the region. In 2012, the per capita gross domestic product (GDP) (at purchasing power parity, PPP) ranged from USD 1,300 in Haiti to USD 31,300 in The Bahamas, demonstrating both the region's economic diversity and the need for a regional energy strategy to consider a wide range of development capacities and priorities.[1]

Despite this diversity, CARICOM member states face many shared energy challenges. Most CARICOM members rely almost exclusively on fossil fuels for both transportation and electricity generation. As most member states have little-to-no currently exploitable domestic fossil fuel reserves, their reliance on imported fossil fuels to meet domestic demand threatens their energy security, exposing them to the volatility of international oil markets and requiring that a large portion of their annual GDP be devoted to energy imports. In many cases, this impedes broader economic and social development by depleting and damaging natural resources, diverting to foreign producers large sums of money that otherwise could be invested domestically, increasing national debt at the expense of a country's financial ratings, and generally resulting in high electricity tariffs that can discourage foreign investment and economic development.[2]

Table 1. Selected Indicators of CARICOM Member States

	Population (as of July 2013)	Total Land Area (square kilometers)	Urban Population Share (2010)	GDP (million USD, PPP) (2012)	GDP Per Capita (USD, PPP)	Major Industries
Antigua and Barbuda	90,156	442.6	30%	1,535	17,500	Tourism, construction, light manufacturing
The Bahamas	319,031	13,380	84%	11,040	31,300	Tourism, banking, cement, oil transshipment
Barbados	288,725	430	44%	7,091	25,500	Tourism, sugar, light manufacturing, component assembly
Belize	334,297	22,966	52%	2,896	8,400	Tourism, marine products,

						citrus, cane sugar, bananas, garments
Dominica	73,286	751	67%	497	14,600	Agriculture, tourism, financial and other services, water bottling, soaps, essential oils
Grenada	109,590	344	39%	1,471	14,100	Food and beverages, textiles, light assembly, tourism
Guyana	739,903	214,969	29%	6,164	8,000	Bauxite, sugar, rice milling, timber, textiles, gold mining
Haiti	9,893,934	27,750	52%	12,920	1,300	Textiles, sugar refining, flour milling, cement
Jamaica	2,909,714	10,991	52%	25,180	9,100	Alumina, bauxite, sugar, rum, coffee, yams, beverages, chemicals; Tourism
Montserrat	5,189	102	14%	43.78	8,500	Tourism, rum, textiles, electronic appliances
St. Kitts and Nevis	51,134	261	32%	890	15,500	Tourism, cotton, salt, copra, clothing
St. Lucia	162,781	616	28%	2,234	13,300	Tourism, clothing, assembly of electronic components, beverages
St. Vincent and The Grenadines	103,220	389	49%	1,301	11,900	Tourism, food processing, cement, furniture, clothing
Suriname	566,846	163,820	69%	6,685	12,300	Bauxite and gold mining, alumina production, oil, lumber, food processing
Trinidad and Tobago	1,225,225	5,128	14%	27,120	20,400	Petroleum and petroleum products, LNG, methanol, ammonia, urea, steel products, beverages, food processing, cement

Source: See Endnote 1. © Worldwatch

Power systems throughout the region—typically characterized by isolated grids, small overall generation capacity, and often single utility monopolies—pose significant challenges to the development of sustainable energy solutions. With the exception of Trinidad and Tobago, which uses domestic natural gas for power generation, most of these systems rely on expensive fuels like heavy fuel oil (HFO) or diesel, further exacerbating the cost issues faced by CARICOM nations. Low efficiency across the region in both the transportation and electricity sectors further aggravates energy system costs. Moreover, CARICOM member states share a particular vulnerability to the environmental and socioeconomic impacts of climate change, including sea-level rise, water scarcity, coral bleaching, and the increased strength and frequency of tropical storms.

Fortunately, each of CARICOM's 15 member states possesses significant renewable energy resources including biomass, geothermal, hydropower, solar, waste-to-energy, and wind, as well as tremendous opportunities to make dramatic improvements in energy efficiency. Caribbean states, under the political and economic umbrella of CARICOM, have the potential to become global leaders in climate-compatible development by collectively pursuing an alternative, less emissions-intensive path. Small-island states like those in CARICOM can serve as ideal showcases for low-carbon development strategies because of the congruence of their national economic and security interests with the global climate agenda, as well

as their small size and relative economic homogeneity. With adequate support, they can demonstrate on a localized scale the kind of sustainable energy transition that ultimately needs to be achieved globally.

1.2 CARICOM Energy Policy

In recent decades, Caribbean governments have become increasingly aware of the enormous economic, environmental, and social costs associated with continuing dependence on fossil fuels. These concerns have helped spur a broad regional dialogue focused on improving energy security and independence, fostering sustainable economic growth, and reducing greenhouse gas emissions through development of indigenous and renewable energy resources.

The CARICOM Energy Policy, approved in 2013, looks to maximize the positive economic, social, and environmental benefits that have come from developing renewable energy around the world. The renewables sector has become a powerful economic force, with investments topping a record USD 300 billion globally in 2011.[3] Increased investment and technology deployment have contributed to a robust industry network that supports more than 5 million jobs worldwide, twice as many as in 2008.[4] When developed in an efficient, coordinated manner, renewables can provide extensive benefits to society, including the opportunity to expand energy access, reduce the negative health impacts of fossil fuel use, and reduce environmental depletion and degradation. These benefits should not be underestimated: in the United States alone, reliance on fossil fuels results in estimated annual "hidden costs" related to pollution control and health care of some USD 120 billion.[5]

Recognizing the need to develop a coordinated approach to addressing regional energy challenges, CARICOM began developing a regional energy strategy in 2002. At the Twenty-Fourth Meeting of the Conference of Heads of Government of CARICOM in July 2003, the Task Force on Energy was tasked with drafting a regional Energy Policy to address issues that initially included energy security, energy pricing policy, and arrangements for transportation and fuel purchasing.[6] Now, roughly a decade later, promoting a shift to sustainable energy through increased use of renewable energy sources and improvements in energy efficiency has become a central focus of the CARICOM Energy Policy.

1.2.1 Benefits of a Regional Approach to Energy Development in CARICOM

Passage of the CARICOM Energy Policy in 2013 demonstrates the region's understanding that a cohesive and coordinated regional approach will facilitate a broad transition and help achieve sustainable energy goals most efficiently and cost-effectively. While individual CARICOM member states can have a significant impact on advancing the production and efficient use of renewable energy technologies, regional collaboration presents opportunities to share best practices, experience, and expertise while drawing on a common vision and shared resources to drive development more effectively. Successful regional cooperation can leverage both the combined economic resources of individual states and the complementary renewable energy resources of the region as a whole. Integrated regional markets allowing energy to be produced where it is cheapest, and then traded, can result in cost-effective sustainable energy supply options to the benefit of all participating states.

In the Caribbean region, where most states are too small to independently develop renewable energy projects on a scale large enough to attract investments from international financial markets, a regional approach can aggregate projects, reduce transaction costs, and increase financing opportunities. If designed effectively, it also can contribute to the development of regional supply chains and capacity

building, leading to increased job creation, knowledge sharing, and broader economic and social benefits.

Given these advantages, regional cooperation on sustainable energy development is already taking place in many parts of the world. The European Union represents only one example of multi-nation cooperation on regional energy planning. Organizations such as the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in West Africa, the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) in the Middle East North Africa (MENA) region, and the Union for the Mediterranean all exemplify regional inter-governmental efforts to cooperate on renewable energy development.

Regional coordination comes with its own unique set of challenges, however. The diversity of regional members must be recognized and respected, and a consolidated effort must be made to ensure that each is willing and able to contribute to a joint program for regional sustainable energy development. Member states must agree on how to share burdens fairly and equitably in a practicable way. Its implementation must be measured, reported, and verified in a transparent manner. Realizing the full benefits of a transformational shift to renewable energy and energy efficiency requires regional cohesion coupled with support mechanisms to keep each actor on track to achieving common goals.

In the Caribbean, CARICOM is well positioned to steer this effort. The Secretariat already plays an integral role in leading and coordinating the regional effort to transition to sustainable energy. The Secretariat and the CARICOM member states have already made significant progress by passing the CARICOM Energy Policy, adopting initial regional targets for renewable energy penetration in the power sector, and using the C-SERMS initiative to drive data gathering and energy sector reform.

1.2.2 Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS): Setting Initial Sustainable Energy Targets

In addition to the CARICOM Energy Policy, various programs and initiatives—including the CARICOM Energy Program, the Caribbean Renewable Energy Development Program (CREDP), the Caribbean Sustainable Energy Program (CSEP), and the OAS Global Sustainable Energy Islands Initiative—have been established to help address sustainable development challenges in the region. They have resulted in many important studies and projects, as well as widespread recognition that energy sector reform must be a priority.[7] Even so, the CARICOM Secretariat notes that the region's approach to sustainable energy development has generally lacked cohesiveness, with some member states establishing energy policies and targets on an individual basis, often in short-sighted response to volatile oil prices. As a result, despite abundant renewable resources and relatively widespread recognition among both policymakers and the general public of the importance of embracing sustainable energy, renewable energy deployment remains relatively marginal throughout the region.

To facilitate development of a common strategy and to encourage greater commitment from national governments, CARICOM agreed in 2009 to develop and implement a regional Sustainable Energy Roadmap focused on improving energy efficiency and increasing use of renewable energy. Phase 1 of the Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS I) is meant to serve as a key planning tool for setting and communicating priorities and policy goals, and for identifying strategies to overcome the various technical and non-technical barriers that continue to limit deployment of renewable energy and energy efficiency technologies in the region.

Phase 1 of C-SERMS is also intended to recommend preliminary sustainable energy targets for the region based on an initial assessment of renewable resource potentials, existing energy policy frameworks, and international best practices. Setting appropriately ambitious targets establishes a long-term vision for future development, serving to transcend changes in leadership while committing all necessary actors and stakeholders to a common path. Beyond setting a clear vision for sustainable development, targets provide investors with the signals of long-term stability they need to commit the financing required for project implementation.

On a global scale, national targets for renewable energy capacity and shares are being adopted at an increasing rate. As of 2012, at least 118 countries worldwide had renewable targets, more than half of which were developing countries.[8] Regional organizations have begun to set similar targets for cooperation among their member states in the renewables sector. Although the pace of regional target adoption remains slow compared to the impressive uptake seen at the national level, intergovernmental organizations such as the European Union (EU) and the Economic Community of West African States (ECOWAS) have taken the lead in pioneering this regional approach. (See Section 5.1.)

CARICOM's determination to set regional targets represents a significant milestone for the organization and the region as a whole, placing it within a select group of leading organizations that are setting the groundwork for comprehensive regional energy planning. Ultimately, these targets, designed with assistance from the Worldwatch Institute and input from member states, and supported by targeted policy measures and governance structures, will serve as an important strategic planning mechanism to achieve overarching regional goals. The initiative will help to make CARICOM a global leader in sustainable development, as well as an example of successful policy implementation and regional commitment and cooperation.

1.3 Methodology and Structure of Report

C-SERMS I builds on existing regional efforts by examining previous analyses and available data and working with the CARICOM Secretariat and its member states to push forward a new vision for the region's future energy landscape. This phase of the project explores and defines short-term (2017), medium-term (2022), and long-term (2027) targets for renewable energy penetration, energy efficiency improvements, and CO_2 emissions reductions.

Milestone I of this project, which was submitted to the 41st Special Meeting of the Council for Trade and Economic Development (COTED) (Energy) in Trinidad and Tobago on February 28, 2013, provided an initial overview of the current energy situation in CARICOM member states. This final Baseline and Assessment report builds on that analysis and on regional and international best practices to present a strategic overview of how CARICOM can continue to advance the C-SERMS project and its objectives.

Based on available data, the report **surveys key aspects of the region's current energy situation**, including overall energy inputs and outputs, electricity, transportation, and CO_2 emissions. It **identifies significant data gaps** within each of these categories. The report subsequently **details the region's potential for both renewable energy and energy efficiency** and reviews the socioeconomic impacts of renewables to better inform policymakers of their true value, particularly in the long-term. The report then **proposes a set of renewable energy, energy efficiency and emissions reduction targets** and identifies critical gaps that must be filled.

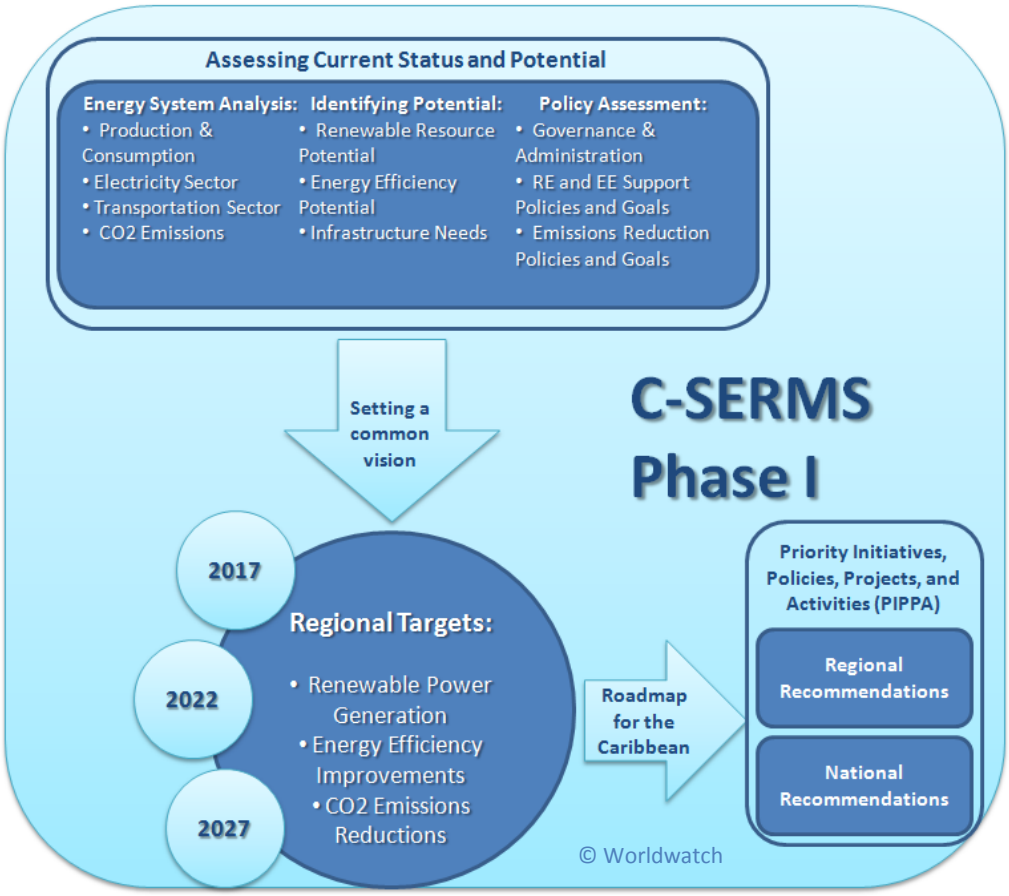


Figure 2. C-SERMS Phase I Methodology

Finally, the report **recommends a series of priority projects, policies and initiatives** that should be undertaken by CARICOM and its member states to achieve these goals.

2 Current Regional Energy Situation

Although CARICOM member states share many common challenges associated with their energy systems, they also face their own unique conditions and opportunities. Designing an effective energy strategy requires a detailed understanding of each member's situation, as well as of general patterns throughout the region.

2.1 Energy Inputs and Outputs

2.1.1 Energy Source Matrix

In general, CARICOM member states exhibit heavy—and in many cases, nearly exclusive —reliance on fossil fuels to fulfill their energy needs, mainly distillates (diesel) and fuel oil. In most cases, they rely on these sources because of the low capital costs and ease of modularity associated with their use.[9] Yet there are several important exceptions to this general pattern: Haiti, for example, in contrast to most other CARICOM member states, obtains approximately half of its primary energy from traditional

biomass, particularly charcoal.[10] In addition to being an emissions-intensive energy source, widespread charcoal consumption contributes to Haiti's severe deforestation, increasing the country's vulnerability to severe weather events and limiting opportunities for agricultural development.

Although some member states have recently asserted their continued interest in coal, it currently plays a minimal role in the region's overall energy balance.[11] Nuclear power capacity has not been developed by any CARICOM member and is unlikely to factor into any regional energy outlook considering that nuclear's capital costs remain exorbitant and the perceived risks to potential investors have been augmented by the region's growing vulnerability to hurricanes and strong tropical storms.

Despite generally widespread reliance on petroleum for power generation in the region, notable exceptions exist. Trinidad and Tobago generates nearly all of its power with natural gas, and remains CARICOM's primary producer and sole exporter of that resource.[12] Although the regional use of renewable energy is comparatively minor, hydropower produces a significant share of electricity in Belize, Haiti, and Suriname. Belize also relies extensively on modern biomass, and Jamaica has taken the regional lead in developing wind power. Other countries, such as Guyana, have turned to solar.

Renewable technologies are beginning to have an impact outside the power sector as well. With strong government backing, Barbados has become a global leader in the deployment of solar water heaters, with some 50,000 now installed nationwide.[13] Important synergies between the agricultural sector, which accounts for a significant share of GDP in some CARICOM member states, and the energy sector are being developed through the use of agricultural waste in bagasse systems. The evolving renewable energy sector is discussed in greater detail in Chapter 3.

2.1.2 Quantities Produced and Consumed

In the majority of CARICOM member states, energy consumption continues to outweigh primary energy production. (See Figure 3.) In consequence, most CARICOM members exhibit a heavy reliance on fuel imports to meet energy needs. Overall, the region has seven primary energy-producing states, including the four oil-producing nations of Barbados, Belize, Suriname, and Trinidad and Tobago. Even in these countries, however, production is often insufficient to meet domestic demand, and only Suriname and Trinidad and Tobago are net producers by volume.[14] Due to the high overall volume of oil produced and consumed in Trinidad and Tobago, the country remains a regional outlier.

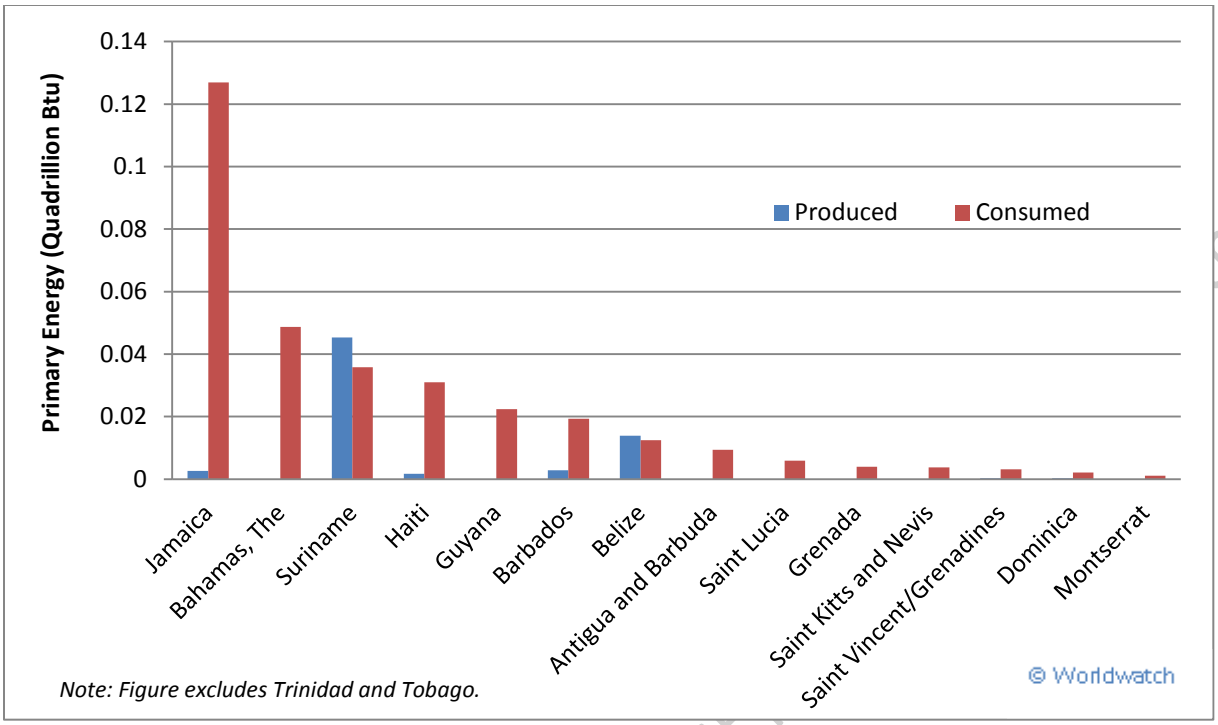


Figure 3. Primary Energy Production and Consumption in CARICOM Member States, 2010

Given that energy production represents the cornerstone of Trinidad and Tobago's economy, accounting for some 44 percent of nominal GDP and 58 percent of government revenue in 2010, the country produces energy at levels far above those seen in other CARICOM states, accounting for roughly 96 percent of regional primary energy production in 2010.[16] It also consumes much more than the other member states, accounting for 75 percent of all primary energy consumed within the region that year.

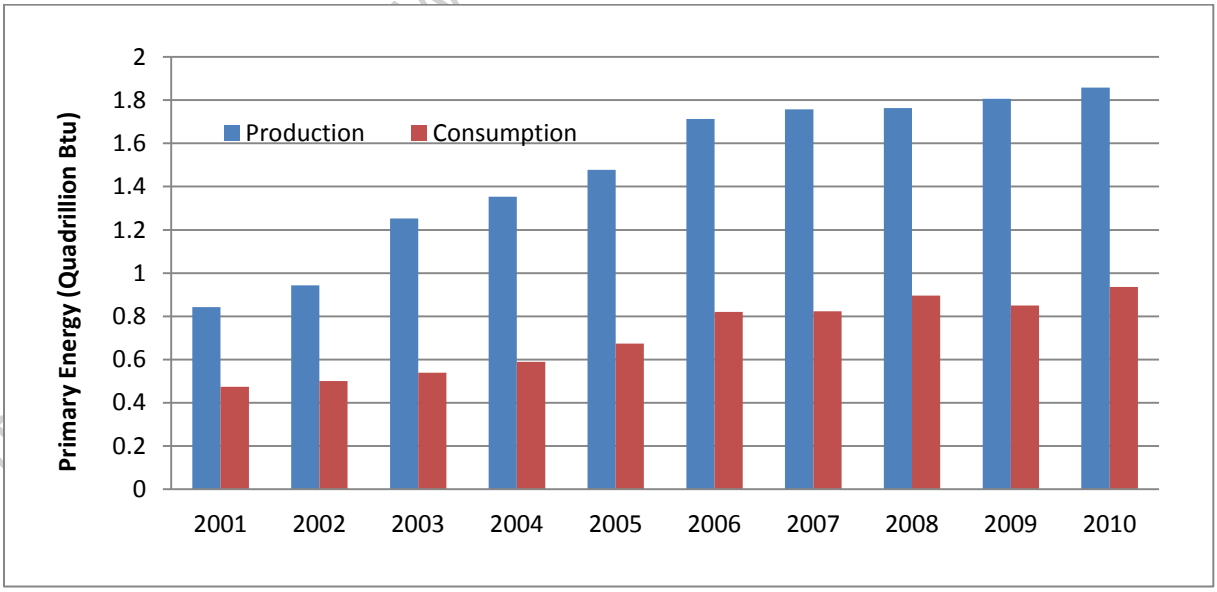


Figure 4. Primary Energy Production and Consumption in Trinidad and Tobago, 2001–10

Despite the fact that most member states remain dependent on imported energy sources to meet their domestic needs, the large imbalance in primary energy production and consumption within Trinidad and Tobago results in a different picture at the regional level. Because of that country's extensive energy export industry, CARICOM as a whole produces more energy than it consumes. (See Figure 5.)

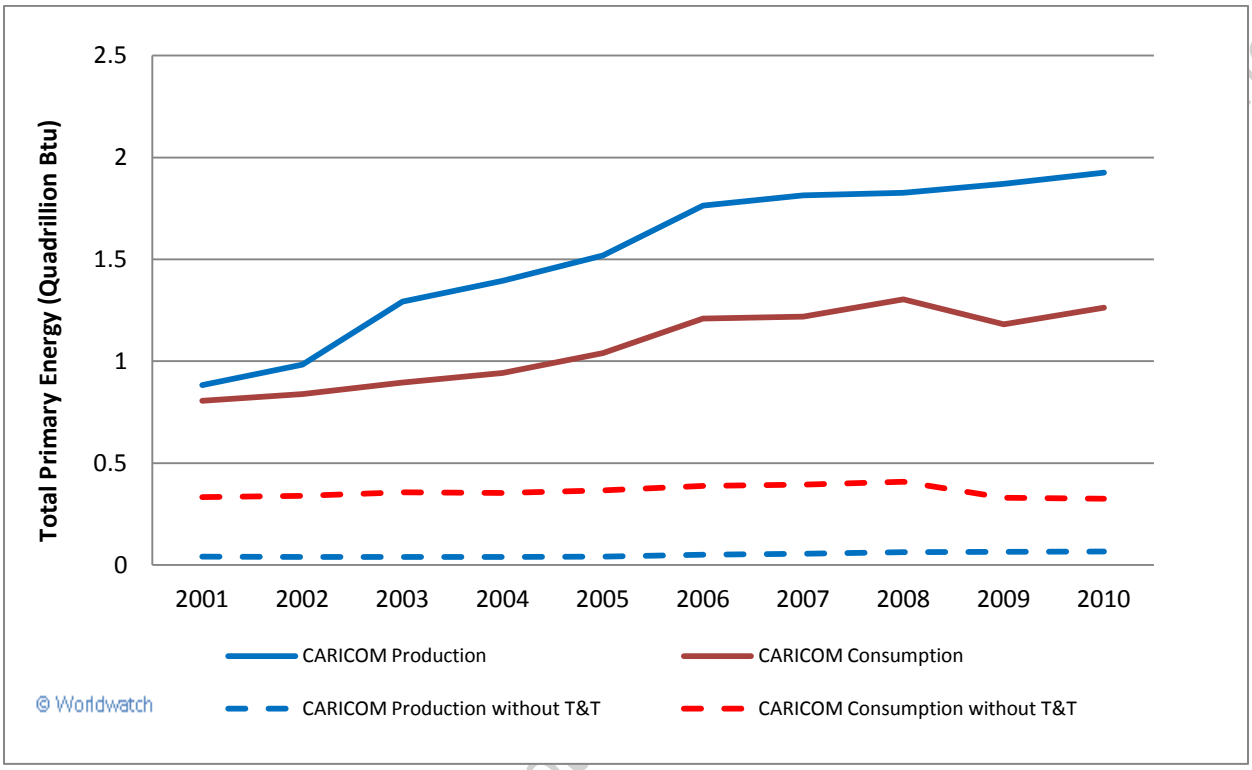


Figure 5. Primary Energy Production and Consumption in the CARICOM Region, 2001–10

2.1.3 Petroleum Imports and Exports

Petroleum Imports

Most CARICOM member states remain heavily dependent on imported fossil fuels. For several members, particularly the larger energy consumers, the global economic recession triggered a general downward trend in petroleum imports during the years leading up to 2011. Only a few countries (Jamaica, Suriname and Trinidad and Tobago) currently have the refining capacity to process crude oil, with Trinidad and Tobago importing and processing significantly more than either of the other two.

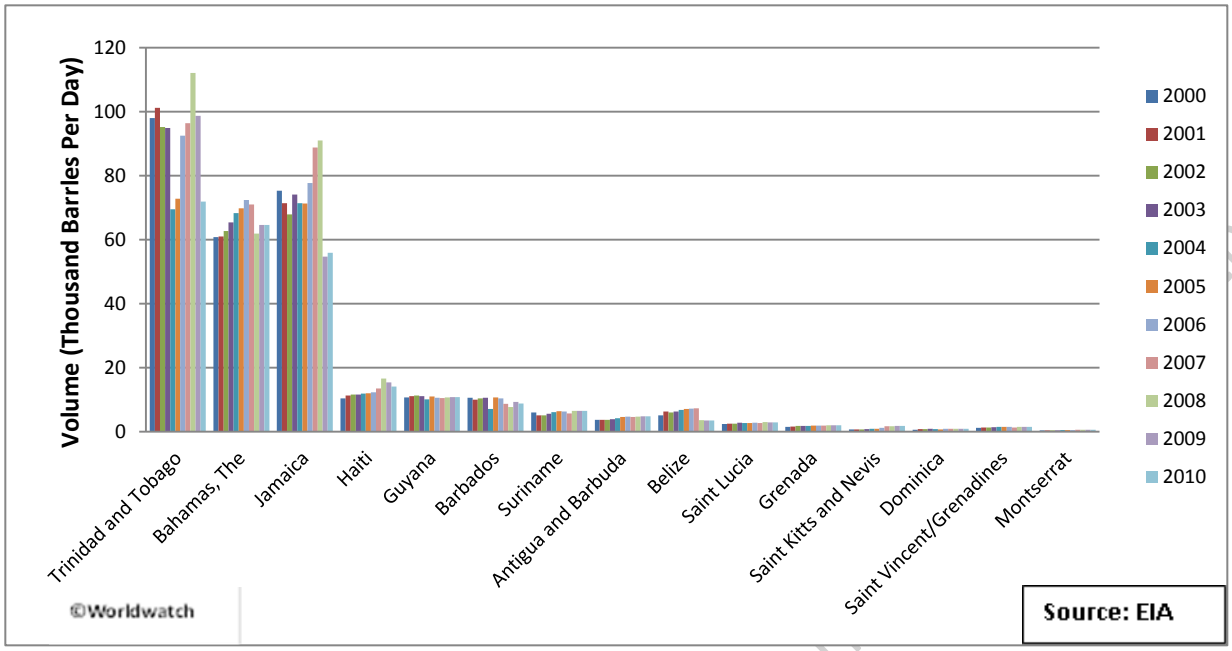


Figure 6. Total Petroleum Imports in CARICOM Member States, 2000–10

Sidebar 1. The Impact of Petrocaribe on the CARICOM Region

The Petrocaribe S.A. agreement has been an important factor in energy policy throughout the region since its inception in 2005. 12 of the 15 CARICOM member states (with the exception of Barbados, Montserrat, and Trinidad and Tobago) are parties to the Agreement. By limiting upfront payment requirements and providing preferential long-term financing for oil imports from Venezuela (see Table 2), Petrocaribe has made oil more accessible at a time when many CARICOM states otherwise would have struggled to meet their energy needs.

While important at a time of rising oil prices and considered highly beneficial by many participating countries, Petrocaribe's overarching impact on both the regional and national energy sectors is much debated. The agreement has had mixed impacts on energy security, as it reduced intra-regional trade, while leaving many countries highly dependent on Venezuelan oil imports and vulnerable to terms that can change on fairly short notice. It has also contributed to the high debt-to-GDP ratios of many Caribbean nations. The agreement also can be seen as a significant disincentive for investments in domestic renewable energy, as the preferential financing for oil stands in stark contrast to the poor financing terms often available for renewable projects.

Table 2. Petrocaribe Financing Terms

Oil Price (U.S. dollars/barrel)	Share Financed Through Loans (%)	Interest Rate (%)	Financing Period (years)*
>15	5	2	15
>20	10	2	15
>22	15	2	15
>24	20	2	15
>30	25	2	15
>40	30	1	23
>50	40	1	23
>100	50	1	23

* An additional two-year grace period is included on top of the given financing period for total repayment periods of 17 and 25 years

The combination of changing domestic economic conditions in Venezuela, reductions in oil production, and the death of President Hugo Chavez has made the future of Petrocaribe unclear. The agreement costs Venezuela an estimated USD 5 billion in forfeited revenue annually.[19] With the country's production now declining, many have speculated that Petrocaribe will not survive long into the future. For those countries currently dependent on the agreement, this would pose a major challenge, further underscoring the importance of developing a reliable and diversified domestic energy supply.

All CARICOM member states import refined petroleum products, mainly residual and distillate fuel oils, reflecting the region's widespread use of diesel generators. (See Figures 6 and 7.) The relatively significant amounts of imported motor gasoline reflect the importance of the transportation sector, discussed in greater detail in Section 2.3.

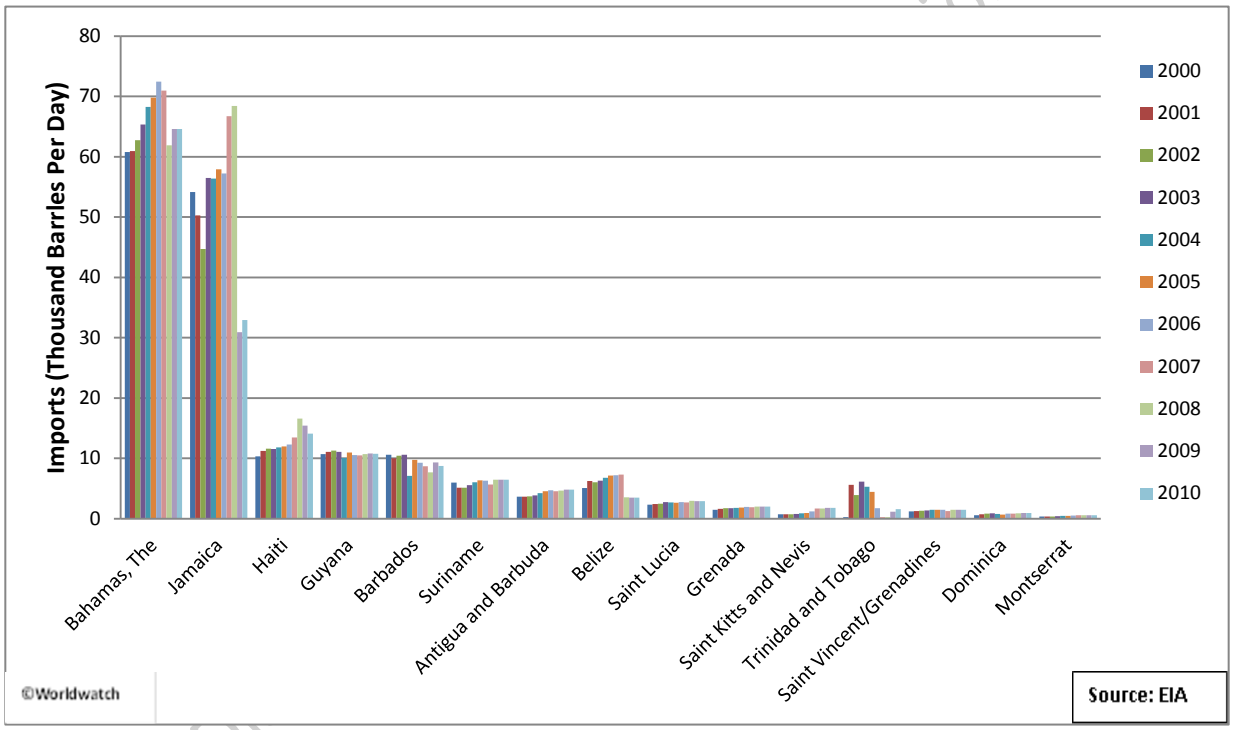


Figure 7. Refined Petroleum Imports in CARICOM Member States, 2000–10

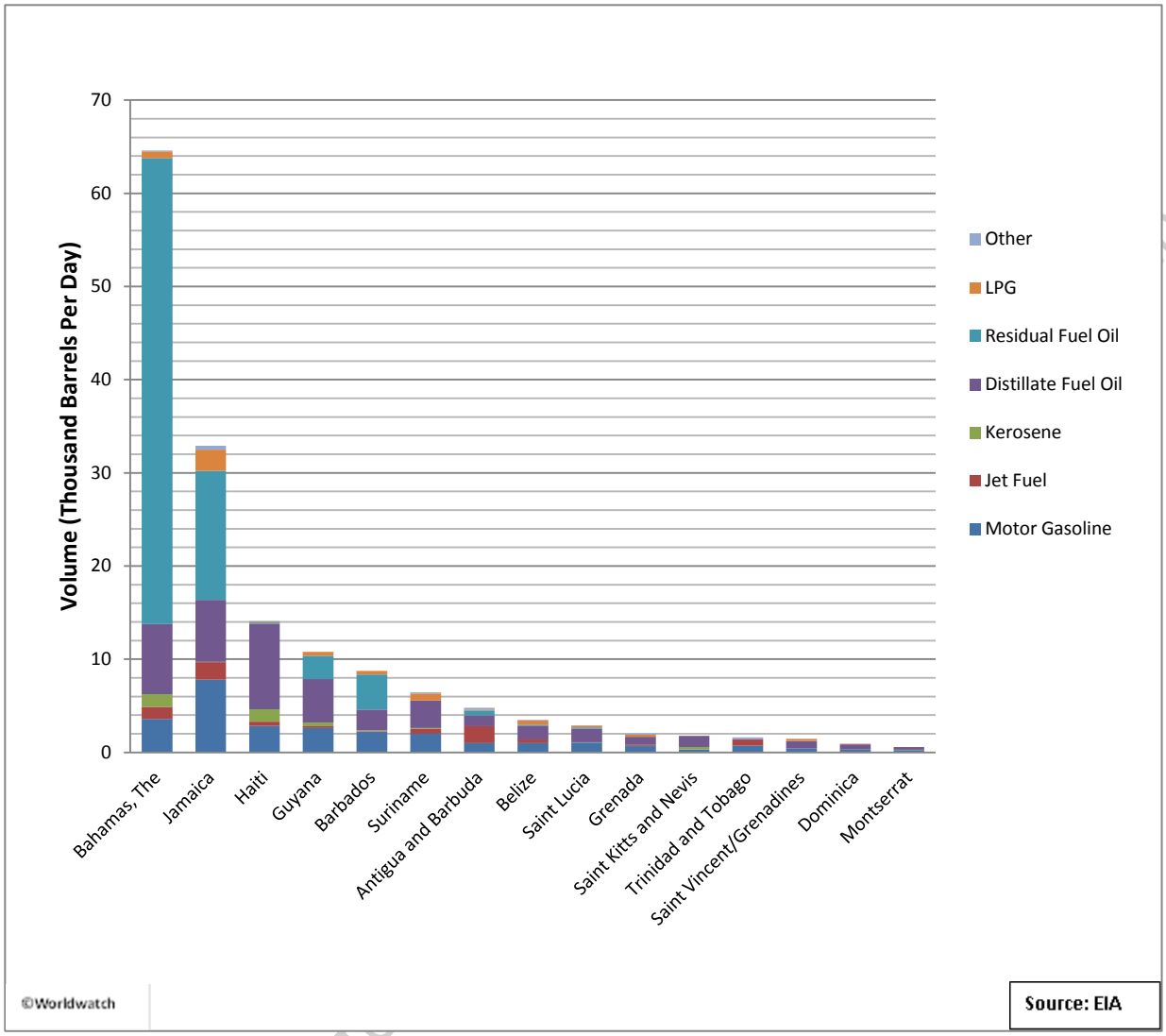


Figure 8. Refined Petroleum Imports in CARICOM Member States, by Fuel Type, 2010

Petroleum Exports

Although in general the CARICOM region is heavily import-dependent, six countries have exported either crude or refined petroleum since 2000: The Bahamas, Barbados, Belize, Jamaica, Suriname, and Trinidad and Tobago, which exports far more than the others. (See Figure 9.)

Belize and Jamaica, however, last exported in 2000 and 2008 respectively, indicating regional shifts in the import/export balance. Of these six countries, only four (Barbados, Belize, Suriname, and Trinidad and Tobago) were exporters of crude, with Barbados exporting crude oil to Trinidad and Tobago for refining. In 2010, the majority of refined petroleum exports were residual fuel oils. (See Figures 10 and 11.)

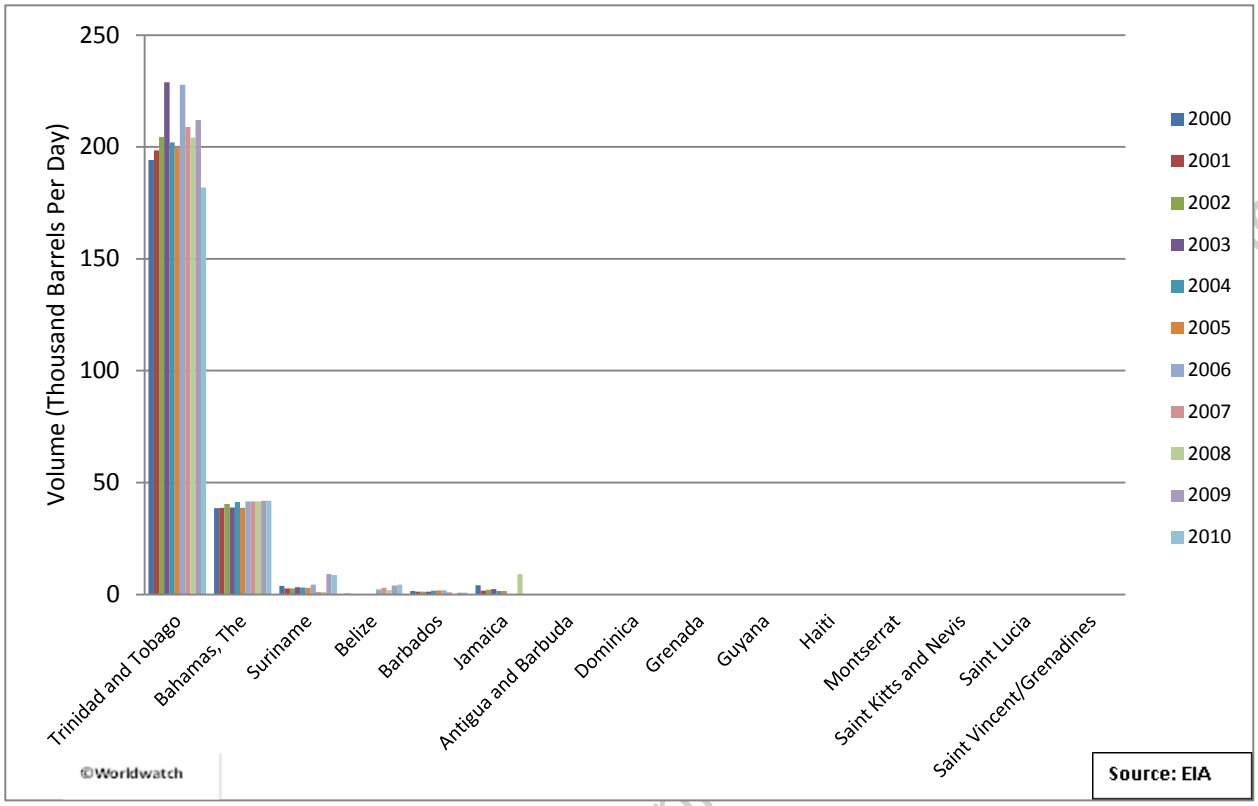


Figure 9. Total Petroleum Exports in CARICOM Member States, 2000–10

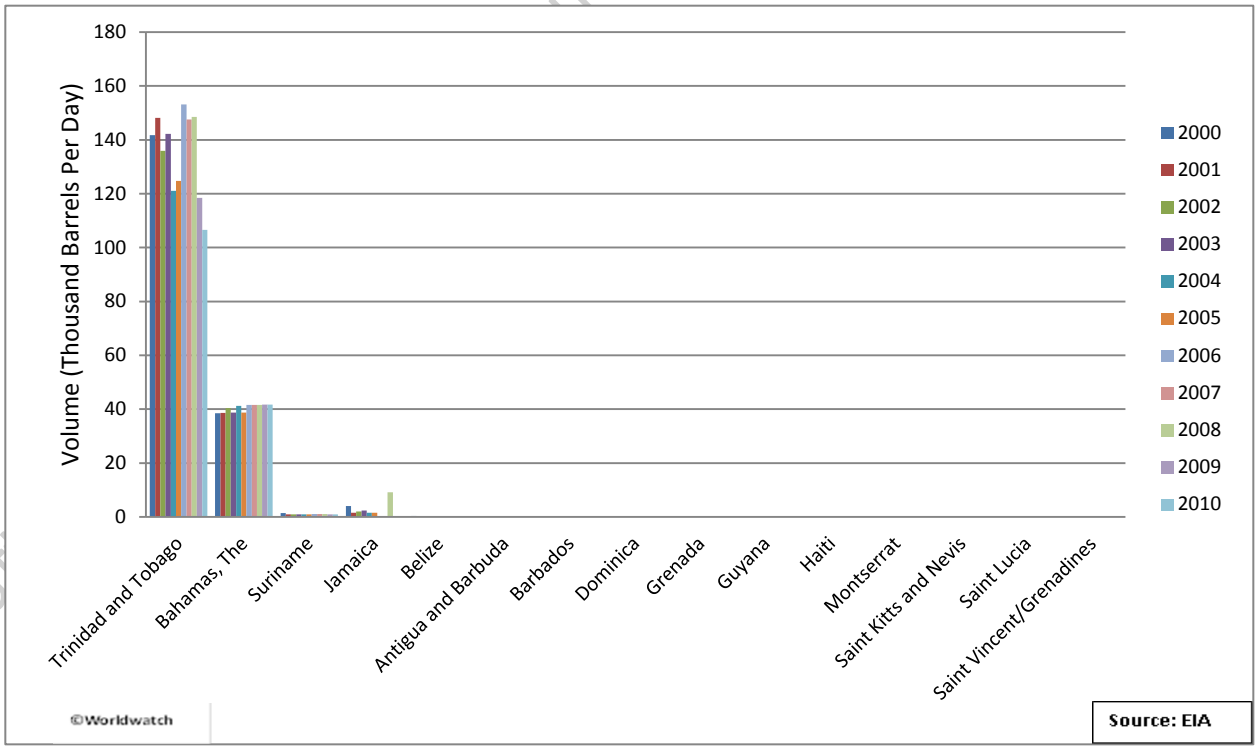


Figure 10. Refined Petroleum Exports in CARICOM Member States, 2000–10

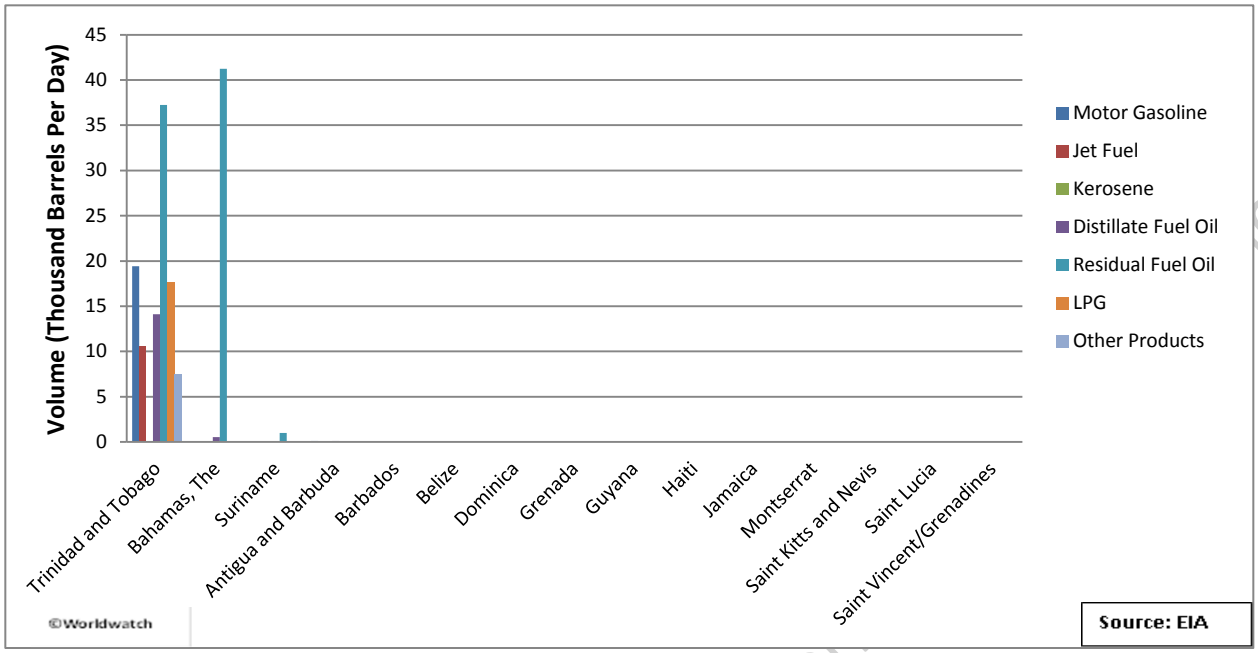


Figure 11. Refined Petroleum Exports in CARICOM Member States, by Fuel Type, 2010

2.1.4 Natural Gas

Despite oil's predominance, natural gas also plays a role in energy production and consumption within CARICOM. Trinidad and Tobago transitioned its hydrocarbon sector from oil to primarily natural gas in the early 1990s; by 2011, the country's natural gas output was approximately eight times higher than that of oil.[20] The gas produced in Trinidad and Tobago is used for a variety of purposes, including electricity generation (8 percent), petrochemical manufacturing (28 percent) and liquefied natural gas (LNG) production (57 percent).[21] (See Figure 12.) In 2011, Trinidad and Tobago was the world's sixth largest LNG exporter, representing about 6 percent of the global export market.[22] This LNG is exported outside CARICOM, however, since member states currently do not have the capacity to import and utilize it.

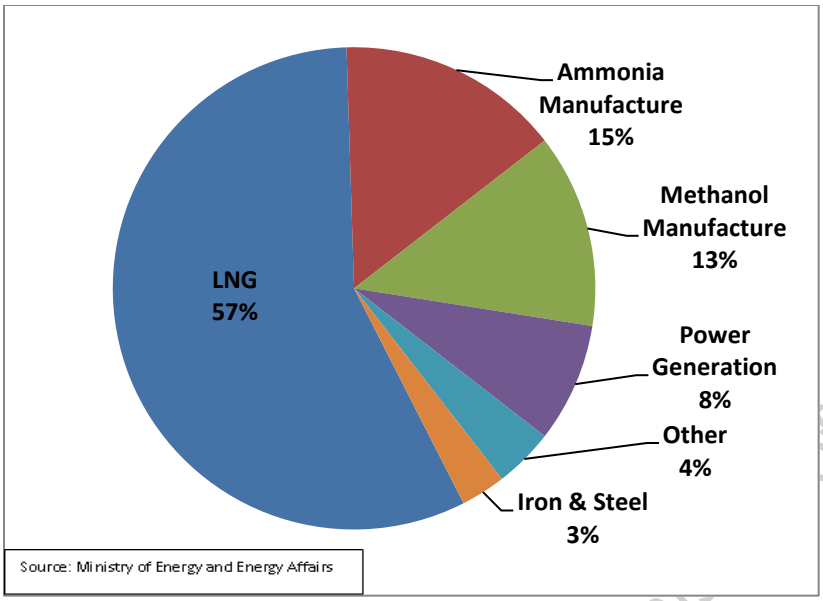


Figure 12. Natural Gas Use in Trinidad and Tobago, by Sector, 2011

In the Caribbean region as a whole, only the Dominican Republic and Puerto Rico had operational LNG regasification terminals as of year-end 2011. The current scale of LNG shipping infrastructure, coupled with certain economic challenges, has so far proven prohibitive for most small-island states in developing LNG import infrastructure. Trinidad and Tobago therefore exports significant quantities of natural gas to major consumers in other parts of the world, including Argentina, South Korea, Spain, and the United States. Nevertheless, some member states continue to consider the option of LNG – particularly in light of advances in infrastructure technology.

Outside of Trinidad and Tobago, Barbados has developed an extensive domestic natural gas network connecting 16,575 residential and 640 commercial customers.[23] Jamaica is considering natural gas for the planned expansion of its generation system, with 360 megawatts (MW) of natural gas-fired combined-cycle capacity scheduled to come online by 2014. In this case, compressed natural gas (CNG) is being used because it avoids the disadvantages discussed above, allowing for delivery of modest volumes of gas over relatively short distances, and foregoing the need for regasification.[24]

2.1.5 Energy Consumption by Sector

Preliminary analysis of energy consumption by sector highlights the diverse economic makeup of CARICOM member states, as well as major gaps in the data available to the researchers. (See Figure 13.) Transportation accounts for a significant share of total consumption in all states for which data are available, indicating the critical role that this sector needs to play in any effective regional energy strategy. Transportation accounts for particularly large shares of overall energy consumption in Barbados (48 percent), Belize (50 percent), Grenada (73 percent) and Jamaica (52 percent). Transportation will be discussed in greater detail in Section 2.3.

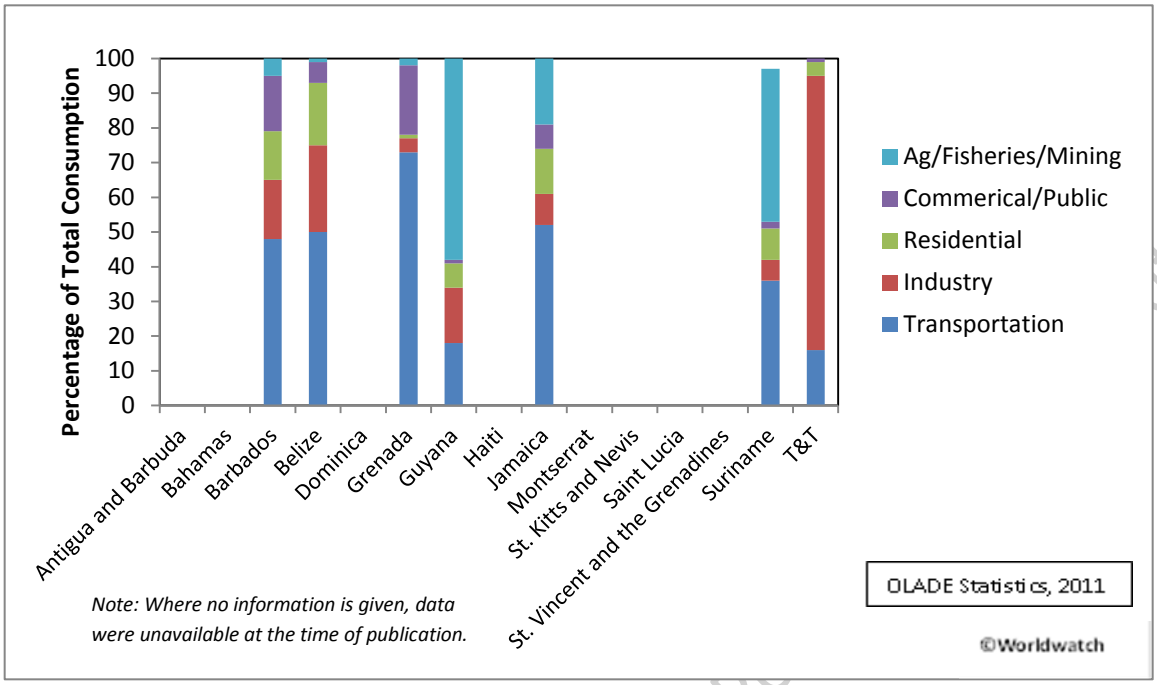


Figure 13. Energy Consumption in CARICOM Member States, by Sector, 2010

Energy production, manufacturing, and extractive industries account for a majority of energy consumption in Guyana, Suriname, and Trinidad and Tobago, which is reflected in the high energy intensities of those countries. Despite its emphasis on reducing emissions, a Sustainable Energy Roadmap and Strategy for the region must take into account the economic importance of such energy-intense industries for individual member states, as well as for the region as a whole. In Suriname, for example, the bauxite/alumina industry represents the mainstay of the country's economy, accounting for 15 percent of GDP and 70 percent of export earnings in 2008.[25]

More climate-compatible industry alternatives do exist, however. The potential for eco-tourism in Suriname is significant, with nearly 12 percent of the country's land area already incorporated in national parks.[26] Achieving regional targets for renewable energy, energy efficiency, and emissions reductions will require thorough and innovative analysis of ways in which major energy-intense industries can be integrated into a Sustainable Energy Roadmap, likely through a combination of energy efficiency improvements, co-generation opportunities, and development of climate-compatible industry alternatives.

In general, the tourism sector has enormous economic importance throughout CARICOM, as well as high levels of energy consumption. Before Hurricane Omar struck the region in October 2008, a single resort on Nevis—the Four Seasons hotel—demanded nearly 30 percent of the island's total generation capacity, highlighting the crucial role the sector must play in a regional energy strategy.[27] Many resorts and tourism operators in the region are already engaged in efforts to boost energy efficiency and reduce environmental impacts. These are discussed in more detail in Section 3.4.

2.1.6 New Developments and Ongoing Exploration

Over the coming years, the potential for several key energy developments stands to dramatically change the Caribbean energy sector.

Increased deployment of mainstream renewable energy technologies and energy efficiency: The region is paying increased attention to mainstream renewable energy sources, and several projects already in the pipeline could have dramatic impacts on the region's energy mix. Interest in technologies including biomass, hydro, solar, and wind, is growing in the region, offering new opportunities for power generation, heating, cooling, and transportation. Existing projects and potential will be discussed in later sections of the report.

Geothermal Energy Development: While geothermal energy has been slow to develop in CARICOM, it offers tremendous opportunities for member states that possess the resource, as well as for the region as a whole, which stands to benefit from opportunities for interconnection and trade. The high investment risks, long lead-time, and significant expense of geothermal exploration have hampered the sector's development in the Caribbean thus far, but a handful of new initiatives indicate that several CARICOM member states may be close to overcoming these challenges. Exploratory drilling has taken place in Dominica, and is now taking place in Montserrat. Member states including St. Lucia, St. Vincent and the Grenadines, and Grenada are conducting preliminary investigations, and have discussed the possibility of exploratory drilling in the near future. These developments will be discussed in detail in Chapter 3.

Regional Electricity Connection: The potential for regional electricity interconnection has been widely discussed, and stands to dramatically change the region's energy sector by providing increased opportunities for trade, more cost-effective supply options, and increased impetus for development of renewable resources like geothermal and large-scale hydropower.

Increased Use of Distributed Renewable Technologies: Although most CARICOM member states have high rates of electricity access, several countries continue to face significant or – in the case of Haiti – severe access challenges (See Section 2.2.2.) The increased use of distributed renewable technologies offers opportunities to expand electricity in remote and underserviced areas in a more cost-effective manner.

Eventual Use of Nascent Renewable Energy Technologies: Nascent renewable energy solutions are being explored as well, in light of the Caribbean's unique geographical characteristics. Ocean cooling is being considered as a potential solution to large-scale air conditioning needs. Although initial resource mapping has shown that the region has a weaker tidal and wave resource than other parts of the world, enough potential may exist to serve the electricity needs of hotel resorts, thereby reducing the overall strain on national grids. Further research and development in this area is needed before these technologies can be widely deployed.

Offshore Oil Production: While the focus on renewable energy technologies has increased in recent years, regional interest in offshore oil exploration has also grown recently, triggered by hopes of easing demand for imported oil and diversifying economies. In addition to Trinidad and Tobago, which already has many offshore oil facilities, several other CARICOM member states are exploring the option. The Bahamas is currently drilling in water adjacent to Cuba's offshore territory, and development ultimately will depend on the results of the exploration process and a voter referendum. Barbados, Guyana, Jamaica, and Suriname also are engaged in exploratory drilling. A similar offshore drilling program in Belize has recently been halted by Belize's Supreme Court.[28] If offshore oil drilling gains significant ground in the Caribbean, it will have large ramifications for the region's future energy development.

2.2 Electricity Sector

2.2.1 Overview

Although the major challenges facing the CARICOM region's electricity sector vary widely by country, most regional power systems share several defining characteristics. The vast majority of member states rely on a single utility with monopoly control over the transmission and distribution of on-grid electricity. Certain multi-island nations including The Bahamas and St. Kitts and Nevis have separate utilities with exclusive rights to operate on specific islands. In many, but not all, cases, energy regulators, either under the authority of the government or operating as independent entities, monitor the utilities. In some member states, independent power producers (IPPs) are in operation, while in others they are prohibited by law. Since most CARICOM member states are relatively small, with isolated grids and no existing connections to other member states, they have small power systems that require high reserve margins to ensure reliability.

In other respects, member states face unique challenges. Although electricity access is generally high across the region, some states face low quality of service and significant unmet demand, as well as deteriorating equipment and high technical and non-technical losses. In several states, nonpayment for electricity services makes electricity more expensive and hinders the profitability and sustainability of utilities. Nonpayment presents further challenges to utilities because it can discourage investment in new energy infrastructure, making expansion, repair, and development more difficult. Inappropriate tariff levels and a lack of effective regulations in some member states limit both innovation and efficiency.[29]

2.2.2 Electricity Access

In general, CARICOM member states have relatively high rates of electricity access. (See Figure 14.) Current research indicates seven states with universal or near-universal access and 10 with access rates of 90 percent or higher, although gaps in data collection exist for Montserrat. Significant exceptions to this pattern include Belize, Guyana, Haiti, and Suriname, which face challenges related to rural electrification and/or energy poverty.

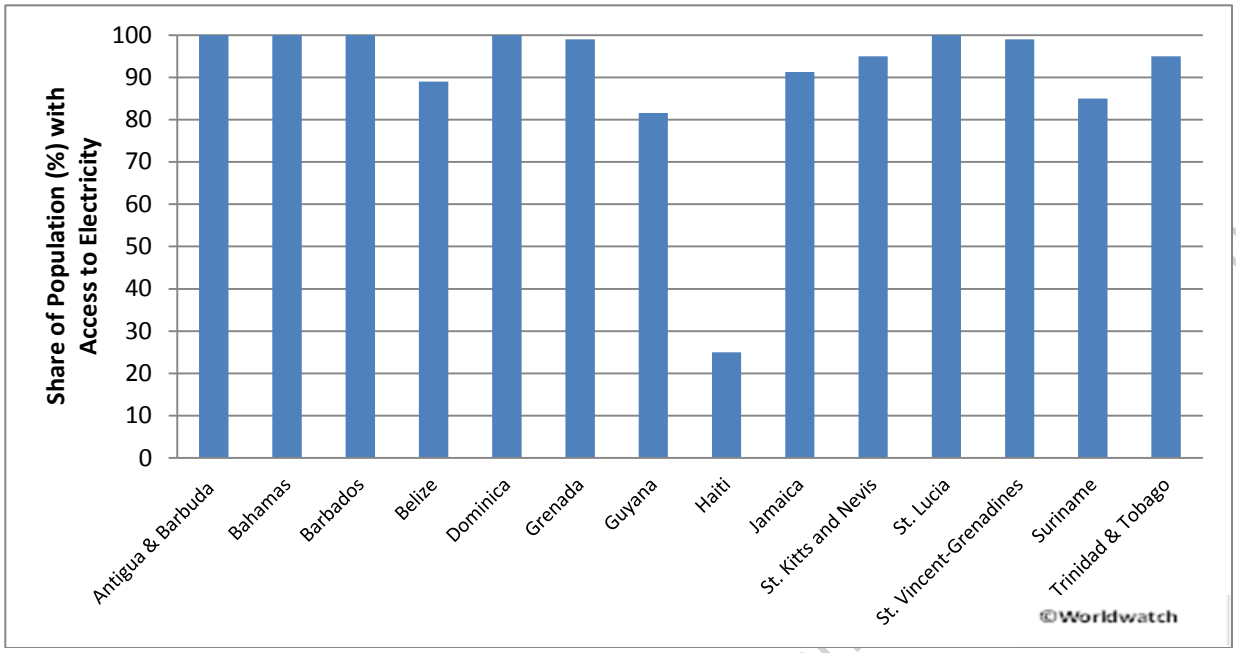


Figure 14. Electricity Access in CARICOM Member States

Although Suriname and Guyana are the two largest CARICOM states by land area, their populations are densely centered in the capital cities, with the remainder living in scattered rural settlements throughout the interior.[31] This poses significant challenges to electrification. In contrast to most CARICOM island states, Suriname does not have a singular national grid, but relies instead on a main grid serving the capital Paramaribo and surrounding areas, and several smaller isolated power systems serving the rest of the country.[32] The Hinterlands region of Guyana is similarly disconnected from the national grid. Both governments therefore face the challenge of extending power to citizens in remote communities, and have taken measures to address the issue.

In Suriname, the government has attempted to address rural electrification by providing daily allowances of diesel fuel to isolated communities. The fuel, generally sufficient to provide power for several hours a day, is transported by truck to remote villages. This method, however, has proven expensive, prompting growing interest in distributed renewable power as a potential solution. According to CREDP's 2009 report, the average cost of Suriname's Rural Electrification Program in 2008 was approximately 62 U.S. cents per kilowatt-hour (kWh), compared to the average national price of 7 cents per kWh, prompting the report to cite "a need for the government to find a less costly approach to Rural Electrification with special consideration given to the use of renewable energy resources."[33]

A renewable approach to extending electricity services to rural areas has already proven effective in Guyana, where the country's Hinterlands Solar PV Program has installed PV systems on approximately 15,000 households, for a total of 2 MW of capacity. The use of small-scale renewable systems could provide electricity services to similar communities in other member states (including Suriname) at a much lower cost. Additional renewable energy technologies, such as small hydropower and wind, have also been assessed and are planned for use in targeted rural areas in Guyana as part of the overall Unserved Areas Electrification Programme.[34]

Energy Poverty in Haiti

In Haiti, which faces the most dramatic energy access issues in the CARICOM region, only 12.5 percent of the population has official access to the grid. An additional 12.5 percent is connected illegally, bringing the total electrification rate to only 25 percent. **Although the majority of CARICOM member states have high rates of electricity access, the comparative size of Haiti's population means that approximately only half of CARICOM's total population has access.**

Given the dilapidated state of Haiti's grid system, even those who are officially connected receive only about 15 hours of electricity service per day.[35] Approximately 75 percent of Haiti's total installed capacity is located in the greater Port-au-Prince area, despite the fact that only about a quarter of the country's population lives there.[36] Because of this disproportionate concentration of power infrastructure in the capital, electrification rates in other areas are only about 5 percent.[37]

These critical challenges mean that Haiti's power sector priorities necessarily differ significantly from those of most other CARICOM states; installed capacity must be increased dramatically and rapidly simply to meet existing demand. Given the Haitian utility's limited capacity to expand electricity services and the fact that it already struggles to provide electricity to the urban population of Port-au-Prince, it is unlikely that the utility will attempt to extend grid services to the remaining 75 percent of the population in the near future.[38] This makes distributed and renewable energy sources the most viable option for providing energy services to rural communities.

Under President Jean-Claude Martelly, the Haitian government has made rural electrification via renewable technologies a major priority. In January 2012, he declared an ambitious goal of electrifying 200,000 rural households over the course of two years through the "*Ban m limyè, Ban m lavi*" ("Give me light, give me life") program, which is based primarily on use of solar energy.[39] While the feasibility of this initiative remains uncertain, it can at least be recognized as an acknowledgement by the Haitian government that the future of its electricity sector, particularly in areas outside Port-au-Prince, must focus on renewable energy.

Given the electrification and reliability issues in Haiti, Guyana, and Suriname, self-generation remains a common way for firms and larger consumers to ensure that they have reliable electricity access. In Guyana, a number of firms meet most or all of their energy needs through self-generation. In Haiti, the unreliability of the existing grid system prompts even those consumers who are grid-connected to rely (if they can afford it) on self-generation, primarily with inefficient diesel generators. This affects not only emissions levels and local pollution, but also the financial viability of the national utility. Increasingly, however, organizations and private institutions are demonstrating the feasibility and affordability of self-generation via renewables. (See Sidebar 2.)

Sidebar 2. Renewable Self-Generation: L'Hôpital Mirebalais in Haiti

In areas where the electricity grid is unreliable or inaccessible, consumers who can afford it often rely on self-generation to ensure adequate power supply. In the Caribbean, this has traditionally been done mainly through the use of privately owned diesel generators, an inefficient and often expensive source of power that contributes to local pollution. Increasingly, however, consumers—including hotels, businesses, and private institutions—are turning to renewables. In Haiti, the newly constructed L'Hôpital Universitaire de Mirebalais (HUM) is illustrating the degree to which self-generation from affordable, renewable electricity sources can have broad, positive impacts.

Even before the disastrous 2010 earthquake, Haiti's electricity and public health systems ranked among the worst in the Western hemisphere. In addition to damaging energy infrastructure and disrupting already-limited

electricity services, the quake ruined existing health clinics, killed many skilled medical professionals and nursing students, and severely damaged the General Hospital in Port-au-Prince.

HUM, a joint initiative of Boston-based Partners-in-Health and its Haitian partner organization Zanmi Lasante, is a 205,000-square-foot, solar-powered facility with more than 300 beds. Once fully operational, it will provide primary care services to an estimated 185,000 people in Mirebalais and other nearby communities, with patients from Central Haiti and Port-au-Prince able to access secondary and tertiary care. As the largest hospital in the country—with six operating rooms, a neonatal intensive care unit, and the only public facility in Haiti with a CT scan machine—HUM also will serve as a teaching hospital for the next generation of Haitian nurses, medical students, and physicians, serving to build much-needed human capacity.

Renewable energy has been at the core of the hospital's design and mission since its inception. HUM is powered by the 1,800 solar panels that blanket its rooftop, which cumulatively total 400 kW of capacity, cover 100 percent of the hospital's electricity needs during peak hours and also produce surplus power that can be fed back into the grid. The hospital is currently in the process of negotiating the terms of this arrangement with the national utility, EDH. Although the specifics have yet to be finalized, this could serve as a model for feeding renewable energy self-generation into the grid, potentially serving as a pilot project for replication elsewhere in the country and the region.

If an effort is made to communicate the role that solar energy can and is already playing in improving public health services in Haiti, as well as the fact that the hospital is able to feed its excess energy back into the grid, it could galvanize interest in and support for renewable energy and self-generation among the broader populace.

2.2.3 Status of Generation, Transmission, and Distribution Systems

Installed Capacity

The range of current installed capacities varies significantly by member state. Because of their diversity in size and economic development, installed power capacity ranges from more than 2,000 MW in Trinidad and Tobago to less than 10 MW in Montserrat. (See Table 3.) Some member states, such as Guyana and Haiti, must increase their capacities significantly to meet existing demand. In both of these countries, current power sector infrastructure is unable to meet basic needs, with existing grids failing to reach large segments of the population. In the region as a whole, energy systems are often hindered by widespread disrepair and inefficiencies. In many cases, actual rates of generation and consumption are far below installed capacity as a result of aging fossil fuel plants and the additional strain that technical and non-technical losses put on power systems.

Table 3. Installed Power Capacity and Share of Renewables in CARICOM Member States

Country	Installed Capacity (MW)	Installed Renewable Power Capacity (MW)	Installed Renewable Power Capacity (%)
Antigua and Barbuda	113	0.05	0.0
The Bahamas	575	0.0	0.0
Barbados	240	1.4	0.6
Belize	136	80.4	59.1
Dominica	24	4.8	0.2
Grenada	53	0.38	0.7
Guyana	435	54.2	12.5
Haiti	261	54.0	20.7
Jamaica	925	64.7	8.0
Montserrat	2	0.0	0.0
St. Kitts and Nevis	63	2.2	19.4

St. Lucia	86	0.07	0.0
St. Vincent and the Grenadines	60	5.6	9.3
Suriname	410	189	46.1
Trinidad and Tobago	2,416.7	0.0	0.0
CARICOM Total	5,800.7	456.8	7.9

Note: Data reflect the most updated information available for each member state at the time of publication, compiled from a variety of sources including national utilities, country representatives, and secondary sources.

Although installed capacity throughout CARICOM remains predominantly fossil fuel-based, renewable technologies (both grid-tied and off-grid) are already being used in the region. (See Table 4.) A small share of this is distributed and self-generation via solar PV and wind. In Guyana, PV is used for rural electrification. And in Haiti, there is momentum behind increased use of PV, biomass, and waste-to-energy technologies, many of which are implemented by local entrepreneurs and often with the backing and support of non-governmental and international agencies.

In the CARICOM region, as elsewhere in the world, large hydropower comprises the majority of installed renewable capacity for power generation. Although hydropower offers a cost-efficient, low-carbon alternative to fossil fuels for certain CARICOM member states, it often has significant environmental and socioeconomic impacts, which must be considered in any integrated energy planning. The potential implications of both large- and small-scale hydro are discussed in greater detail in Section 3.1.3.

Although geothermal exploration is ongoing, no projects have been fully developed to take advantage of this tremendous potential observed in the region. Geothermal developments could drastically change the CARICOM power mix over the medium- to long-term, but no capacity exists at this point. Overall, the rate of additions in renewable capacity has been relatively slow, although a variety of proposed projects in the pipeline, if completed, would dramatically alter installed capacity figures in the region.

Table 4. Renewable Electricity Installed Capacity in CARICOM Member States

	Hydro	Wind	Geothermal	Solar	Biomass and Other	Total (MW)
Antigua and Barbuda	None	Small capacity of micro-wind	None	50 kW	None	0.05
The Bahamas	None	None	None	Unknown	None	0.0
Barbados	None	None	None	1.4 MW	None	1.4
Belize	53.2 MW	None	None	Unknown	27.2 MW	80.4
Dominica	4.76 MW	None	None	None	None	4.8
Grenada	None	80 kW	None	303 kW	None	0.38
Guyana	None	20 kW	None	204 kW	54 MW	54.2
Haiti	54 MW	None	None	<1 MW	None	54.0
Jamaica	23 MW	41.7 MW	None	~1 MW	None	64.7
Montserrat	None	None	None	None	None	0.0
St. Kitts and Nevis	None	2.2 MW	None	None	None	12.2

St. Lucia	None	None	None	65.2 kW	None	0.065
St. Vincent and the Grenadines	5.6 MW	None	None	None	None	5.6
Suriname	189 MW	None	None	None	None	189
Trinidad and Tobago	None	2.0–2.4 kW micro-wind	None	2–5 kW	None	0
CARICOM Total (MW)	329.6	44	0	2.0	81.2	466.8

Note: Data reflect the most updated information available for each member state at the time of publication, pulled from a variety of sources including national utilities, country representatives, and secondary sources. While small solar projects are known to exist in The Bahamas and Belize the total capacity is unknown at this time.

T&D Losses

Although significant data gaps prevent full accounting for electricity losses across the region, both technical and non-technical losses present critical challenges in many CARICOM member states. The scale of the challenge varies widely by member state, with countries such as Haiti and Guyana facing extremely high losses and Barbados experiencing minimal losses in the sector.[40] (See Figure 15.)

A large share of observed technical losses occurs as a result of old and inefficient generation plants and transmission and distribution lines. High levels of non-technical losses, including those due to electricity theft and un-billed customers, also plague the sector in some member states. The resulting financial strain on utilities often impedes necessary improvements and infrastructural development, leading to even lower quality services. In Haiti, for example, this can result in increasing social acceptance of theft, triggering a vicious cycle that impairs electricity services countrywide.

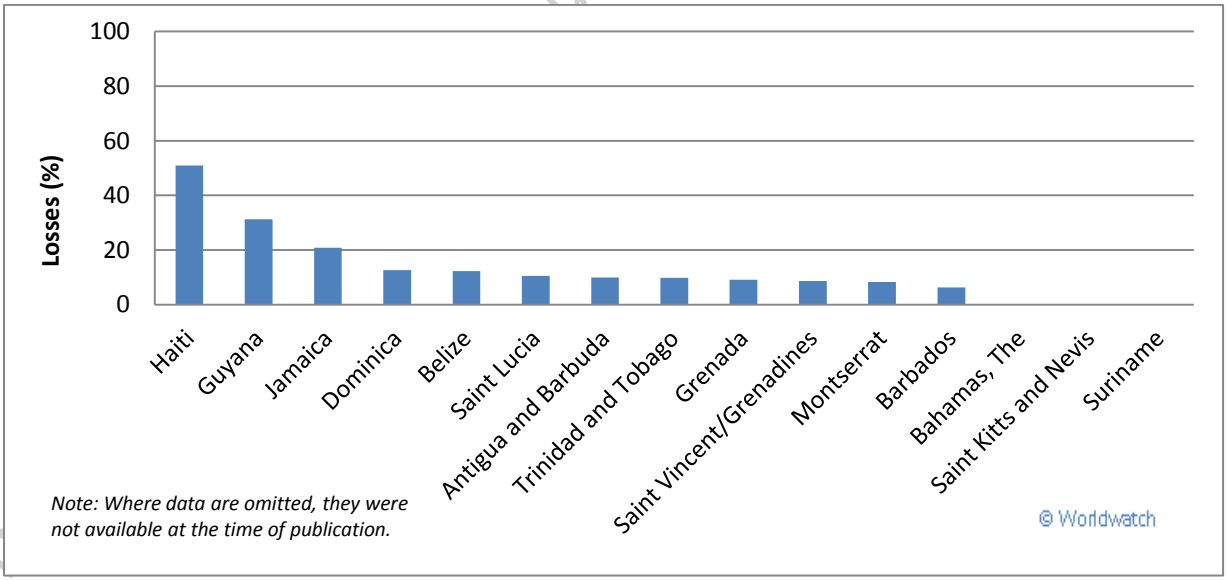


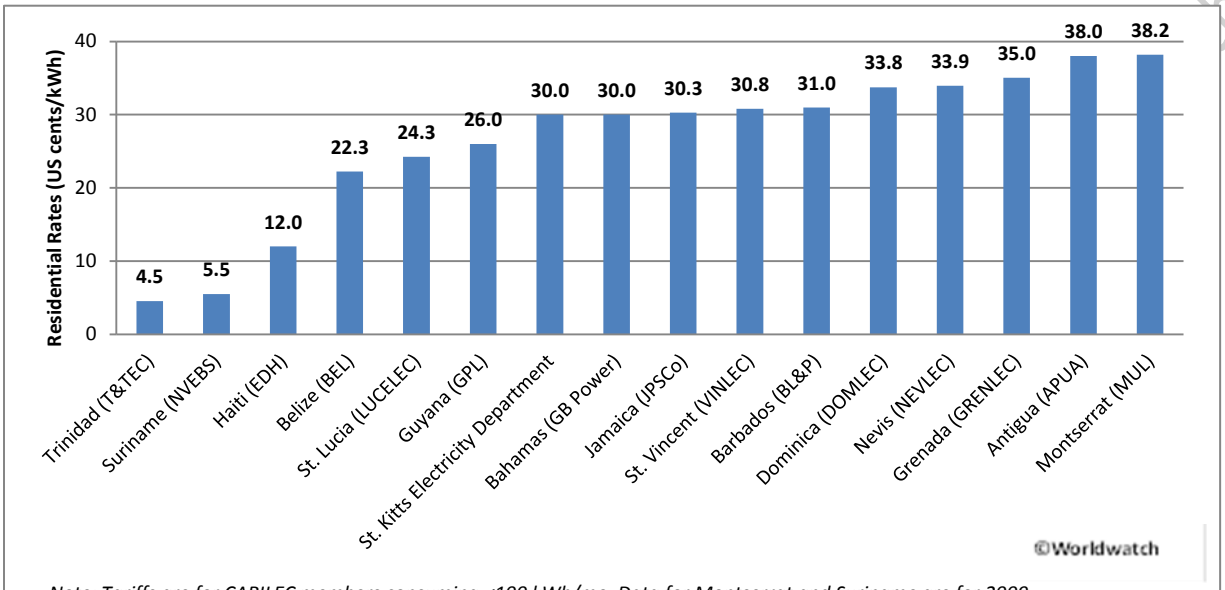
Figure 15. Estimated Technical and Non-Technical Electricity Losses in CARICOM Member States, 2012

Electricity Costs

In general, Caribbean electricity prices rank among the highest in the world, largely because of high operating costs linked to rising fuel prices, inefficient T&D networks, and the inability to benefit from economies of scale given the small market size of individual island states. Geographic remoteness, steep

topography, and other characteristics typical of small island states further increase costs.[41] Even so, electricity tariffs vary widely throughout the CARICOM region.

Due to the wide-ranging differences in existing installed capacity, the diversity of generation sources, and other factors, electricity tariffs charged to residential consumers in CARICOM states range from as low as 4.5 U.S. cents per kWh to just over 38 cents per kWh.[42] (See Figure 16.)



Note: Tariffs are for CARILEC members consuming <100 kWh/mo. Data for Montserrat and Suriname are for 2009.

Figure 16. Residential Electricity Tariffs of CARILEC Members, 2009/2010

2.2.4 Projected Forecast of Electricity Consumption

In 2012, the CARICOM region generated an estimated 20,993 GWh of electricity and consumed an estimated 18,037 GWh.[43] There is a growing need to invest in power infrastructure across the region in order to meet existing and future electricity demand. This offers the chance to systematically deploy complementary renewable energy technologies capable of mitigating the challenges posed by certain intermittent renewables when deployed on their own. Many states, such as Haiti and Guyana, need to add additional capacity to meet existing domestic demand. Others, such as Belize, which imports nearly half of its electricity from neighboring Mexico, need to develop additional capacity if they want to achieve domestic energy autonomy.[44]

Generation and consumption figures are expected to increase dramatically over the coming years unless the region takes measures to reduce overall electricity use. Net electricity generation and consumption are projected to reach 37,114 GWh and 32,812 GWh by 2027, an increase of 76.8 percent and 81.9 percent, respectively, over 2012. (See Figure 17.) This highlights the need for widespread adoption of energy efficiency and demand management measures to curb growth in the sector.

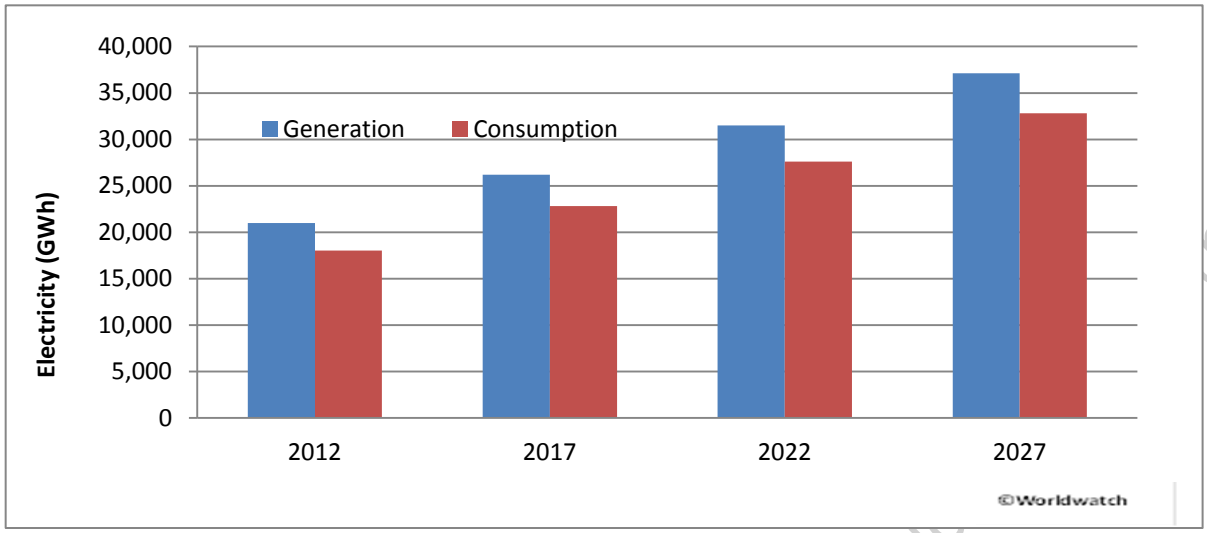


Figure 17. Electricity Generation and Consumption in the CARICOM Region, 2012 and Projections for 2017, 2022, and 2027

At the state level, electricity generation is expected to more than double by 2027 in four CARICOM member states (Grenada, Guyana, Haiti, and St. Vincent and the Grenadines), while consumption is projected to double in five (these four plus Jamaica). Future growth will continue to show large diversity in the levels of national electricity generation and consumption. (See Figure 18.)

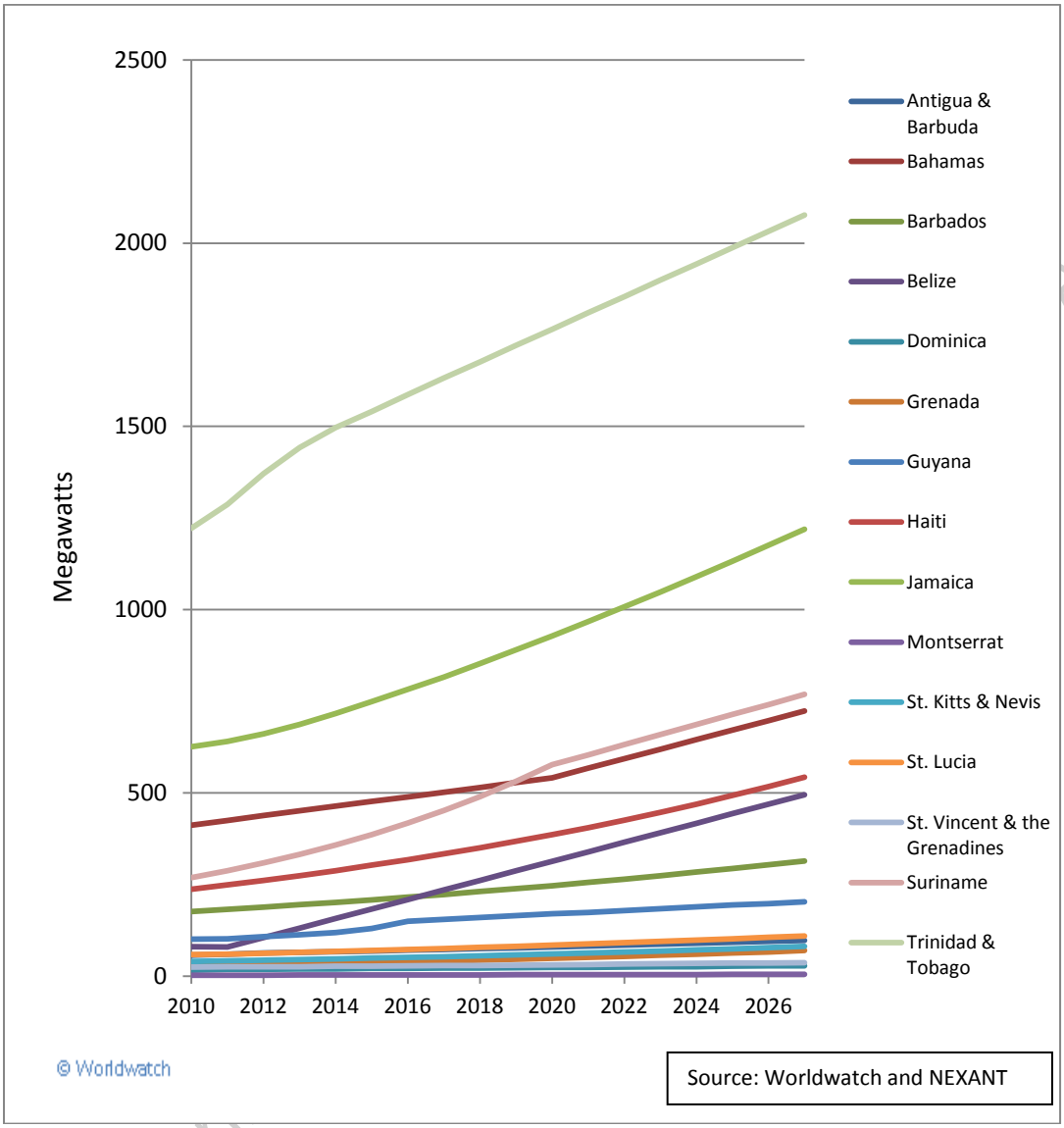


Figure 18. Net Peak Demand Load Forecast in CARICOM Member States, 2010–27

In the absence of mechanisms designed to increase efficiency, this will necessitate significant expansion of generation capacity in all 15 CARICOM member states. (See Figure 19.)

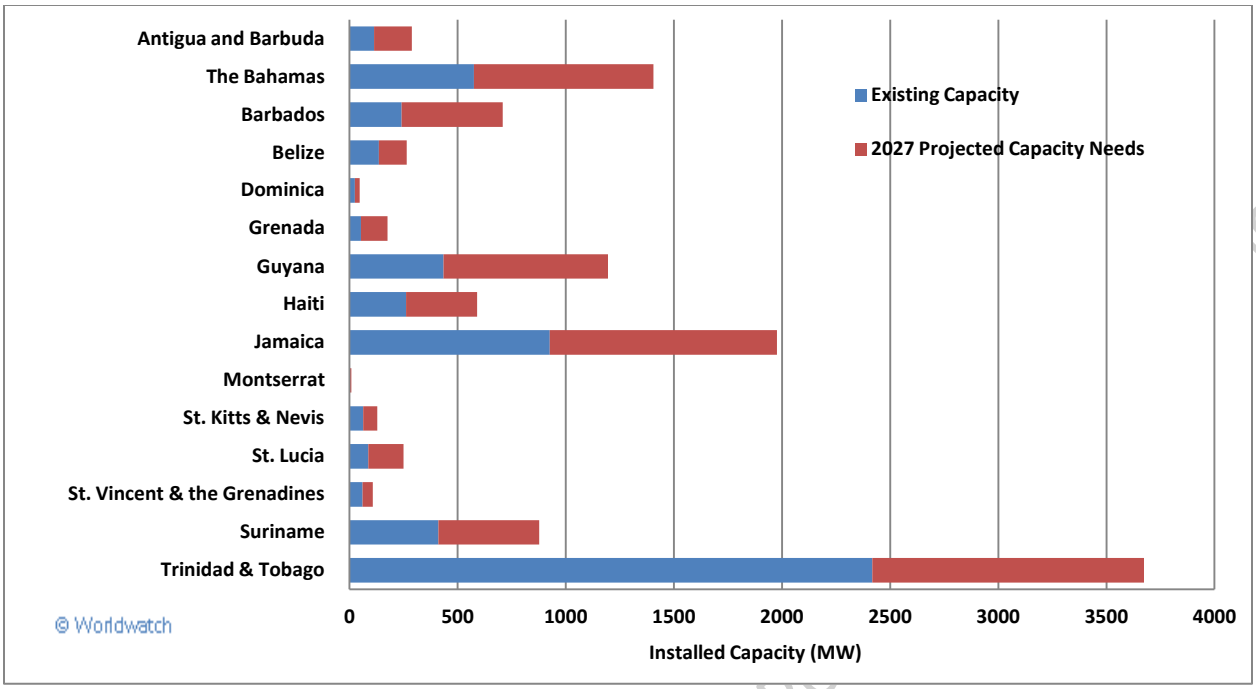


Figure 19. Existing Capacity and Projected Capacity Needs in 2027 (business-as-usual scenario not including future energy efficiency and conservation policies and measures)

2.2.5 Gap Analysis

Among all issue areas addressed in this initial phase of C-SERMS, the electricity sector is supported by the most widely available and verifiable data. Significant gaps remain, however, that must be filled in order to move this priority sector forward on the pathway envisioned by CARICOM. These priority gaps include:

1. **Detailed analysis of electricity end-users:** A thorough analysis of electricity end users will be critical in making the most efficient use of power generation. Often these data are not calculated, or not reported, making fully integrated planning difficult. A more detailed assessment will allow for energy efficiency measures targeting priority sectors for reducing electricity consumption to be implemented. Having a better understanding of consumer behavior will play a role in developing and targeting educational programs designed to reduce electricity consumption.

2. **Assessment of grid functionality and storage potential:** As detailed above, updated grid and storage capacity will be increasingly necessary as utilities look to incorporate greater levels of renewable generation into their systems. These updates are often far less attractive to investors than investments in new generation capacity; nevertheless, they play just as central a role in the development of renewable energy-based electricity networks. To date, information is lacking to truly assess the extent to which these networks will need to be updated. Assessments of current capacity and future needs should be undertaken and made available to ensure that T&D networks are developed in concurrence with the deployment of new power generation.

3. **Detailed data on power plants currently in operation:** Although regional utilities provide significant information, readily available data on the current status and operation of existing power plants is often lacking or contradictory.

4. **Updated power sector capacity plans:** Reporting on newly added generation capacity within a country often lags behind the capacity addition itself. Although member states have identified numerous new plans and strategies for future developments in the power sector, it is often difficult to assess the role these play in national planning. With regard to both new and planned capacity, available information is often out of date, and existing plans may be postponed or canceled altogether without public notification, posing a challenge for future energy planning and policy development.

2.3 Transportation Sector

Transportation is one of the world's four largest energy end-use sectors, accounting for about a fifth of global energy use in 2008.[45] Although energy use for transportation within CARICOM varies widely by member state, in most cases its share of total consumption significantly exceeds the global average. (See Figure 20.) In Grenada, for example, transportation accounted for more than 70 percent of total energy use in 2010, illustrating the sector's overwhelming importance and affirming that any effective regional approach to energy reform will need to address transportation. Within CARICOM, transportation – despite its importance – currently represents the **energy sector for which the least information is available.**

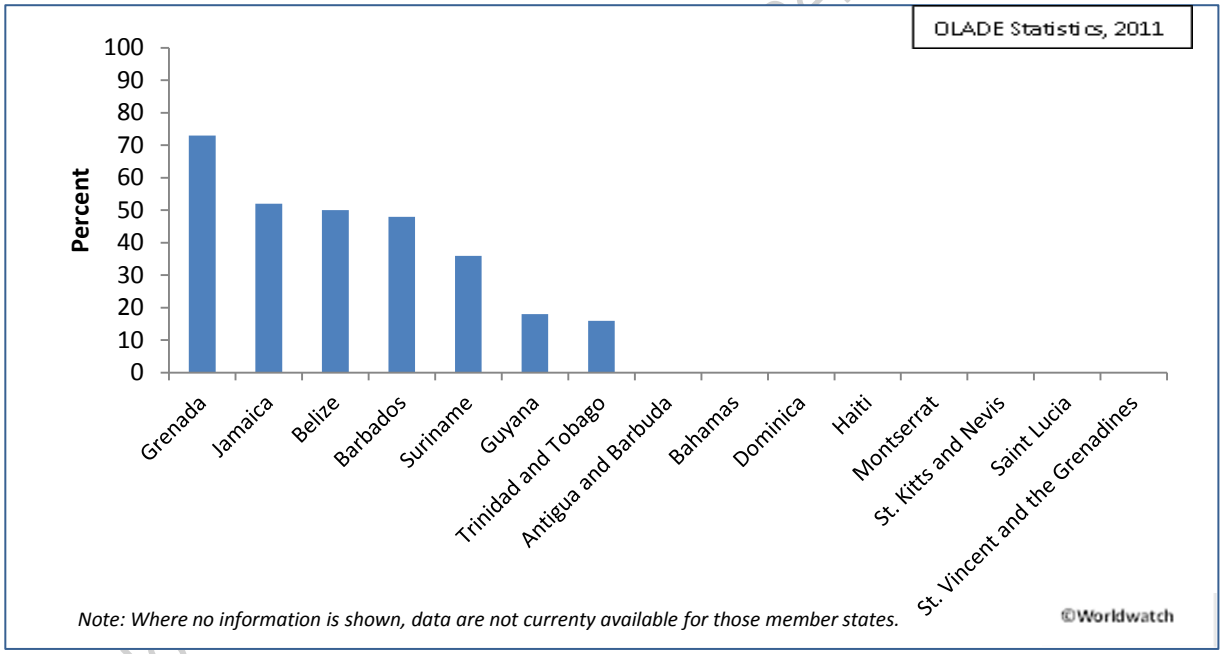


Figure 20. Transportation's Share of Total Energy Consumption in CARICOM Member States, 2010

Transportation's impacts in the Caribbean are sometimes overlooked because of the sector's complexity and the general lack of available data on its status. In addition to substantial fuel requirements and significant greenhouse emissions, the sector can have negative effects on local pollution, noise, congestion, health, and safety if it is not well designed and regulated.[46] These impacts influence the overall costs of goods and services in the region and have been recognized as one of the "most important barrier[s] to development for small islands," highlighting the importance of shifting to more-efficient transportation systems.[47] Although additional data are needed to fully understand and address these challenges within CARICOM, regional and international best practices can provide guidance for

improving efficiency and mitigating the sector's heavy reliance on imported fuels through reforms in the road, aviation, and maritime sub-sectors.

2.3.1 Best Practices in Road Transportation

CARICOM member states could consider a variety of policy, planning, and technology options and international best practices to reduce fossil fuel use and related greenhouse gas emissions in the transportation sector. Countries across the region already have implemented or are considering policies to promote biodiesel and ethanol blends as well as fuel share mandates, tax incentives, and fuel efficiency standards. (See Section 4.2.3. and Table 12.) In the near term, however, the most economical option for reducing fossil fuel use in transportation is improving vehicle fuel economy.[48] (See Table 5.)

Table 5. Potential Average Fuel Economy for New Vehicles, 2005–2030

	2005	2010	2020	2030	Reduction by 2030
	Liters of gasoline equivalent/100 km				
Passenger LDVs	8.1	7.6	5.4	4.1	49.4%
Light/medium trucks	13.7	13.4	10.7	9.5	30.7%
Heavy trucks and buses	39.1	35.9	31.8	27.1	30.7%
Two-wheelers	2.8	2.9	2.6	2.3	17.9%

Source: See Endnote 48.

Worldwide, there is tremendous potential to reduce fuel use drastically by engineering more fuel-efficient vehicles, and many governments have mandated fuel economy standards for new vehicles. In the United States, the Corporate Average Fuel Economy (CAFE) Standard now requires that domestic auto producers achieve an average fuel economy of 54.5 miles per gallon for their fleet of cars and light-duty trucks by 2025. The policy is expected to reduce oil consumption by 12 billion barrels and to save consumers some $1.7 trillion in fuel costs.[49] Although this kind of production-based standard could not be implemented within CARICOM due to a lack of vehicle production, governments could implement policies that mandate or create incentives for imports of fuel-efficient vehicles.

The promotion of hybrid and electric vehicles, capable of reducing fuel consumption by 47 percent and 73 percent, respectively, could greatly benefit the CARICOM region.[50] Electric vehicles are significantly more energy efficient than their internal combustion engine counterparts, converting approximately 60 percent of grid power to energy at the wheels. By contrast, traditional gasoline-powered vehicles make use of only some 20 percent or less of the energy in gasoline for power at the wheels.[51] If regional electricity systems were powered sustainably, electric vehicles could produce significant benefits.

Electric vehicles also can provide ancillary benefits when integrated with renewable energy and smart grid development. In addition to reducing local pollution and greenhouse gas emissions when charged by renewable power sources, these vehicles can play a critical role in providing stability to electricity grids that use greater shares of intermittent renewable sources. Electric vehicles can be charged at times of low demand and high production, further limiting stress on the power grid, reducing greenhouse gas emissions, and allowing consumers to benefit from charging at periods when electricity tariffs are low.[52] Electric vehicles may also be able to serve as energy storage and provide some backup power to homeowners in case of power cuts, which are common in many Caribbean countries. The viability of this approach within individual CARICOM member states, however, would require a significantly more detailed analysis to determine how charging needs align with country-specific load profiles.

Although their limited range remains a major criticism of electric vehicles globally, the small size of most CARICOM member states is well suited to the current distance limitations of batteries used in these vehicles today. Even within the United States, the average driver travels only 37 miles (59.5 kilometers) per day, well within the current 100–200 mile (160–320 kilometer) range of electric vehicle technologies.[53] Although the average costs of electric vehicles remain high, they have been dropping steadily, while at the same time the vehicles have become more reliable as a result of technological advancements. A transition to electric vehicles would require extensive investments in infrastructure, although the many associated benefits could significantly outweigh the initial costs. It would also likely require implementation of mechanisms such as subsidies or rebates designed to ensure that, given the comparative expense of these vehicles, mandates or incentives do not marginalize lower-income consumers.

Liquid biofuels are another option for limiting fossil fuel use in the transportation sector. Blends of ethanol and biodiesel with fossil fuels typically produce a cleaner-burning fuel than burning gasoline or diesel alone. For select CARICOM member states, namely the mainland countries of Belize, Guyana, and Suriname, as well as Jamaica, domestic production and use of biofuels could be a useful substitute for fossil fuels. Given the significant land-use requirements, however, biofuel production is generally not seen as an appropriate solution in smaller island states. The development of a regional market for liquid fuels based on production in more advantageous environments within CARICOM, however, could benefit the region. Moreover, the environmental impacts and the food vs. fuel conflict associated with the use of biofuels in the transportation sector have come under increasing criticism worldwide, including in the United States and European Union. Even in areas where these technologies are deemed potentially viable, serious challenges must be addressed. (See Section 3.1.1.)

Beyond fuel switching and fuel replacement, limiting the need for personal vehicle use will be an important factor in decreasing the environmental impact of CARICOM's transportation sector. Congestion due to heavy reliance on personal vehicles and inadequate planning is both disruptive and inefficient, and can inhibit economic activity. Vehicle use can be limited through measures such as increasing public transportation options and putting transportation planning at the core of urban development plans. Several islands worldwide have successfully introduced such measures: in Toyama, Japan, for example, rates of car ownership above the national average prompted the government to improve public transportation, resulting in a 12 percent shift from cars to public transportation, decreasing air pollution, and easing traffic congestion.[54]

2.3.2 Aviation and Maritime Transportation

Aviation and maritime transportation—both crucial to the Caribbean—use significant volumes of fuel and are large emitters of greenhouse gases, together accounting for some 5 percent of global emissions.[55]

For CARICOM member states that rely heavily on tourism, aviation is particularly important. To date, the global community has implemented few concrete policies to make this critical sub-sector more sustainable, although best practice examples exist for increasing aviation's energy efficiency, which could inform decisions made within CARICOM. As airports seek to add capacity and as new hubs are built, for example, improving the layout of terminals and runways can cut taxiing time for airplanes, an approach that has reduced annual CO_2 emissions by 11,000 tons at the Zurich Airport in Switzerland.

Simply updating air traffic control systems can reduce the carbon footprint of commercial travel by 12 percent. Furthermore, because airplanes burn fuel to cool the main cabin while waiting at the gate, fuel

consumption can be cut significantly and local air quality improved substantially by incorporating fixed ground power systems and pre-conditioned air at new gates. Finally, as Caribbean airlines seek to expand their fleets, they can look to the example of the Philippines, which recently purchased a batch of new, highly efficient airplanes that are 15–20 percent more fuel efficient than the previous fleet.[56]

Given the island or coastal status of CARICOM member states, maritime transportation offers a unique challenge as well as opportunity for improvement. The shipping industry relies heavily on low-grade bunker fuels. Within CARICOM, maritime transportation is important for the import and export of goods as well as inter-island personal transportation and tourism. Internationally, there have been efforts to establish efficiency standards for shipping vessels, such as the Vessel Efficiency Incentive Scheme promoted by the Japanese in collaboration with the World Shipping Council.[57]

Unfortunately, regulating the environmental impacts of both aviation and marine transport represents a major challenge given the general exemption of these sub-sectors from normal tax regulations and the difficulty involved in allocating impacts and responsibilities to any one country. Market-based instruments, such as carbon pricing mechanisms or emissions trading schemes, could be valuable tools in reducing related emissions. The World Bank has suggested that a carbon tax of $25 per ton could raise aviation fuel prices by an estimated 8 percent with only a 2–4 percent reduction in consumer demand, thereby helping to reduce emissions while limiting the negative economic impact to a potentially manageable level.[58] There is global support for including aviation emissions in emissions trading schemes, namely the EU ETS. Overall, however, implementation of any measures to curb the environmental impacts of either aviation or maritime shipping will likely require large-scale international commitments that are beyond the scope of CARICOM alone.

2.3.3 Gap Identification

Although it is possible to make general observations about trends in CARICOM's transportation sector, **many critical information gaps must be filled** before fully integrated planning can occur. This is not unique to CARICOM member states. The Small Island Developing States (SIDS) DOCK Initiative has noted that, "there is no available information regarding sustainable transportation for [small-island developing states]."[59] Detailed information about vehicle and fuel use in the transport sector is often disorganized or uncollected, making analysis and planning difficult. To address the significant gaps in transportation data across the region, extensive research and stakeholder collaboration are needed to fully assess the impacts of various transport options, including the large volume of air transport associated with the tourism industry.

1. **Coordinated data collection and analysis of transportation:** Designing and implementing effective national strategies to reduce energy use in the transportation sector will require that a more complete monitoring and evaluation of the current transportation sector be employed region wide. Large bodies of critical data are unavailable, including: *vehicle use and registration, fuel use, and availability and use of public transportation.*

2. **Updated sector plans and strategies:** The limited transportation sector data that is available, including information regarding upcoming plans or national strategies for reform, are often out-dated, inhibiting research and integrated planning.

2.4 Carbon Dioxide Emissions

2.4.1 Current Emissions Accounting

Although CARICOM accounts for only a very small share of global carbon dioxide emissions (0.24 percent in 2010), preliminary analysis of energy-related emissions indicates significant opportunities for improvement. Trinidad and Tobago has by far the highest overall CO_2 emissions from energy consumption, and its emissions have increased significantly over the past decade, in marked contrast to the other 14 member states. (See Figure 21.) This reflects not only the significance and size of that country's fossil fuel sector, but also recent rapid economic growth. CARICOM's second highest emitter, Jamaica, has seen its emissions decline in recent years; however, this is likely more a reflection of the shutdown of the country's mining sector in response to high electricity prices, as well as the effects of the global recession, than of an improvement in energy efficiency or fossil fuel consumption patterns.

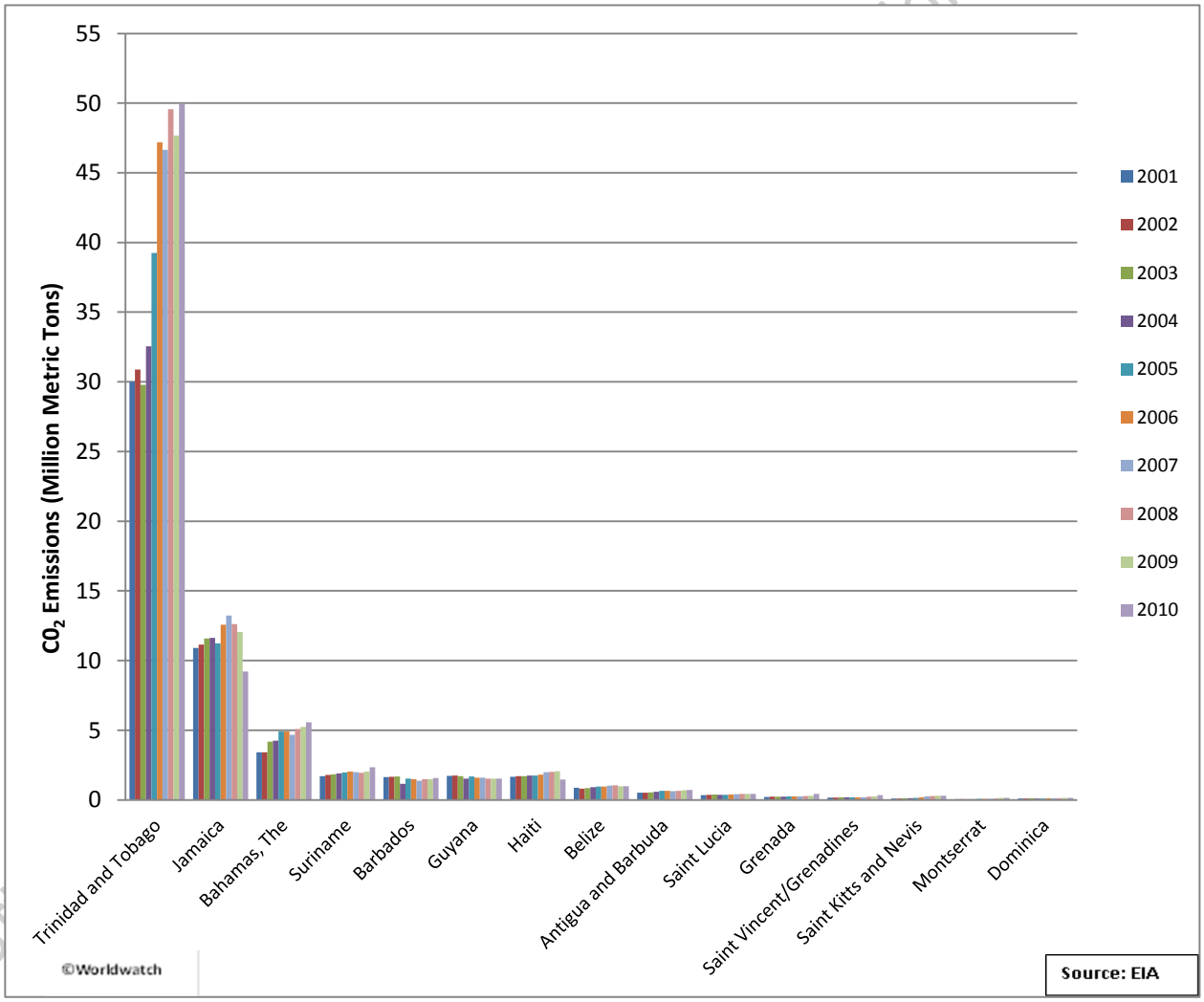


Figure 21. Carbon Dioxide Emissions from Energy Consumption in CARICOM Member States, 2000–10

Emissions per capita are generally low throughout the region compared to global figures. Unsurprisingly,

Trinidad and Tobago has the highest per capita emissions, followed by Montserrat, where high per capita figures reflect its complete dependence on temporary, inefficient diesel generators. (See Figure 22.)

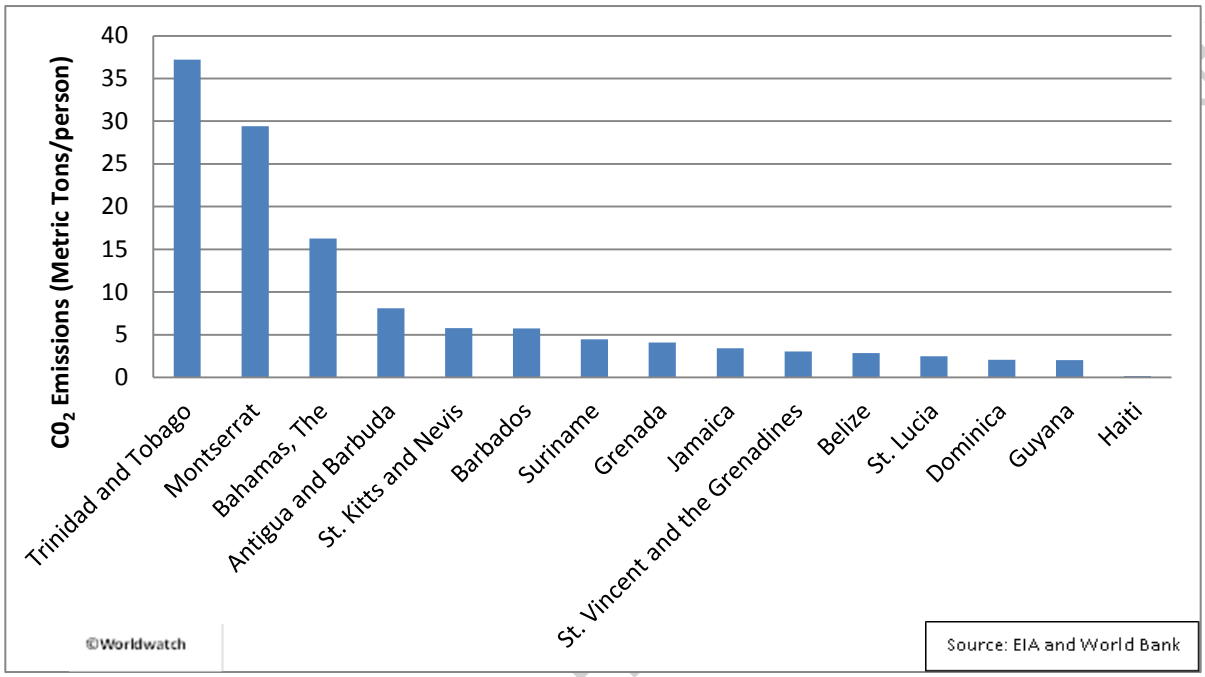


Figure 22. Per Capita Carbon Dioxide Emissions from Energy Consumption in CARICOM Member States, 2010

2.4.2 Future Projections of Emissions from the Power Sector (Business-as-Usual Scenario)

The power sector has an extensive carbon footprint. Globally, fossil fuel generation accounts for 90 percent of all CO_2 emissions and half of all human-caused greenhouse gas emissions.[60] In a business-as-usual scenario based on the region's existing generation mix, Worldwatch projects that power sector CO_2 emissions within CARICOM member states will increase significantly between 2012 and 2027, reflecting capacity additions and increased generation. (See Figure 23.)

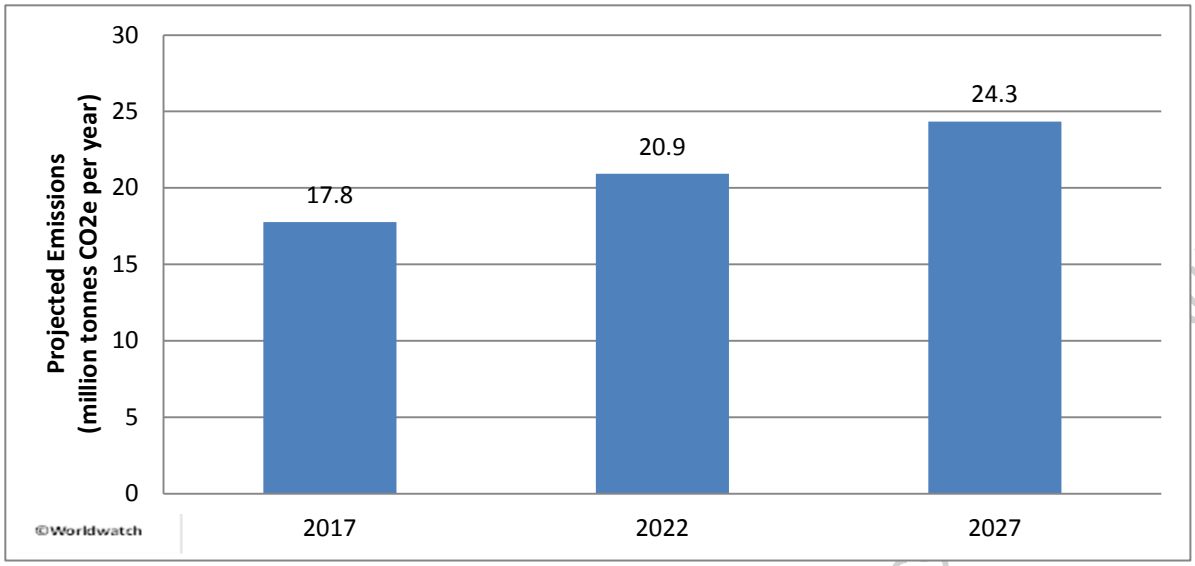


Figure 23. Projected Power Sector Emissions in the CARICOM Region, 2017, 2022, and 2027

2.4.3 Gap Analysis: Emissions

Given the region's negligible contribution to global emissions, this area remains a secondary priority, but significant data gaps remain:

1. **Updated emissions accounting:** Detailed emissions accounting is a necessary first step in any strategy to reduce emissions throughout CARICOM. Although member states participate in emissions reporting through the UNFCCC process, many of these official communications are significantly outdated and no longer reflect the regional situation. As policies and mechanisms are enacted and implemented to reduce emissions across the region, a detailed monitoring and evaluation system will further allow for policies to be assessed and updated based on observed data, thereby maximizing their effectiveness.

2. **Updated sector plans and strategies:** Available information regarding existing emissions reductions strategies, often linked to UNFCCC communications, are also often outdated.

3. **Sectoral emissions data:** The limited data currently available generally is not specific enough to assess and reform energy use within particular sectors. Collection and coordination of emissions in the major sectors (transportation, power, tourism, manufacturing, etc.) will help guide effective policymaking and the targeting of appropriate key sectors for emission reduction in each member state.

3 Renewable Energy and Energy Efficiency Potential

3.1 Renewable Energy Potentials

Based on existing assessments, every member of CARICOM exhibits significant potential for

development of renewable energy resources, including biomass, geothermal, hydropower, solar, and wind.[61] (See Table 6.)

Table 6. Renewable Energy Potentials in CARICOM Member States

	Hydro	Wind	Geothermal	Solar	Biomass/ Other
Antigua and Barbuda	None	400 MW[1]	None	27 MW[1]	Unknown
The Bahamas	None	229 MW[19]	None	58 MW[8]	1 MW[8]
Barbados	Unknown	40 MW[6]	None	39.7 MW[6]	23.5 MW[6]
Belize	70 MW[20]	Unknown	None	63,174,807 MWh/year[3]	Unknown
Dominica	17 MW[8]	30 MW[8]	1,390 MW[2]	45 MW[1]	Unknown
Grenada	500 kW[8]	20 MW[8]	1100 MW[2]	21 MW[1]	Unknown
Guyana	7,000 MW[7]	Unknown	None	575,822,086 MWh/year[3]	Unknown
Haiti	102 MW[4]	10 MW[4]	None[4]	1,654 MW[4]	5 MW (waste-to-energy)[4]
Jamaica	33.4 – 56.1 MW[5]	122 - 1313 MW[5]	None[5]	650 - 1876 MW[5]	192 MW[15];65 Waste-to-energy[16]
Montserrat	Unknown	Unknown	940 MW[2]	Unknown	Unknown
St. Kitts and Nevis	None	5 MW[8]	300–1,280 MW[2]	16 MW[8]	7[15] - 10 MW[13]
St. Lucia	150 kW[9]	40 MW[9]	170[9]–680[2] MW[2]	36 MW[8]	1.2 MW[15]
St. Vincent and the Grenadines	10 MW[12]	8 MW[12]	100[9]–890 MW[2]	23 MW[8]	0.9[15] - 4 MW[10]
Suriname	1,700 MW[17]	Unknown	Unknown	Unknown	Unknown
Trinidad and Tobago	Unknown	50 MW[18]	Unknown	308 MW[18]	Unknown
Regional Range	0–7,000 MW	Unknown–1313 MW	0–1,390 MW[2]	Unknown–1,876 MW	Unknown–157 MW

Source: See Endnote 61. © Worldwatch

Numerous assessments examining the potential for various specific technologies have been conducted throughout the years in several CARICOM states. These existing assessments, though often reliant on different methodologies and levels of detail, provide a **general overview** of renewable energy resources currently assumed available in each member state. Most technologies are already being used throughout the region, although far from their full potential. As discussed in Section 5.2, based on domestic conditions not all technologies can or should be developed to the full potential indicated in Table 6.

While hydro resources already are used widely in member states including Belize, Haiti and Suriname, the region's potential for resources like biomass, solar, and wind is extremely high, offering significant opportunities for development. Geothermal resources, available on several of CARICOM's small island states, could dramatically change the region by transforming certain member states into renewable energy exporters.

3.1.1 Modern biomass

Energy can be generated from a wide variety of biological materials, including agricultural crop residues, forestry wastes (woody biomass), and even municipal solid waste (MSW). Modern biomass can provide an easily accessible energy source to the region and is already a central part of renewable development strategies in some Caribbean countries, particularly those on the mainland. Belize has emerged as a leader in the use of bioenergy as a baseload energy source. Building on initial successes, the country has developed a strategy for future expansion of its bioenergy capacity. Among the bioenergy resources in use throughout the region are bagasse (residue from sugar cane processing, currently used in Belize, Barbados, Guyana, Haiti and Jamaica) and biogas systems (in place in Barbados, Haiti, Jamaica, St. Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago). A number of pilot projects are currently in place across the region, including in Antigua and Barbuda and Trinidad and Tobago.

Electricity generation from biomass sources has the advantage of providing reliable baseload renewable power and can offset some of the intermittency of wind and solar generation in an integrated electricity system. Both crop residue and woody biomass can be used for heat or electricity, or they can be gasified to have the same functionality as oil and natural gas, but with lower net carbon emissions. The strong agricultural sectors in many CARICOM member states provide opportunities to sustainably harness organic waste resources for use in the energy mix, with development of the necessary technologies. Potential sources of biomass feedstock in the Caribbean include agricultural crop residues such as sugarcane bagasse, sweet sorghum, coffee husk, rice straw, and coconut shells, as well as woody biomass. Like biomass energy, bio-based fuels (or biofuels) can be used for power generation as well, although they are most commonly used in the transportation sector. In particular, biodiesel derived from oilseed crops, such as the jatropha tree, can be used as a substitute for diesel to fuel thermal power plants.

It is important, however, to consider the wider, often negative impacts of biofuel and biomass production, which can include significant effects on local food prices, water use, and the overall energy intensity of fuel production. With the development of biomass resources, appropriate safeguards must be put in place to ensure that unsustainable practices do not occur. In Haiti, for example, an overreliance on traditional biomass coupled with a lack of environmental regulations has resulted in a 97 percent reduction of the country's forest cover, with disastrous implications for agriculture, rural livelihoods, and resilience to tropical storms.[62] Fuel crops also are vulnerable to the impacts of climate change, and outputs could be reduced as environmental conditions in the region change.

3.1.2 Geothermal

Geothermal energy can be used to generate electricity or to provide heating and cooling services. Currently, it plays a limited role in the global electricity sector, with only 11 GW installed in 24 countries worldwide.[63] Globally, the main technical limitation to producing electricity from geothermal energy is the need for reservoirs with very high temperatures near the Earth's surface. Such resources are rare, however, and most deep geothermal reservoirs are technologically or economically unfeasible to exploit. In many CARICOM members, however, these high-temperature reservoirs are located close to the Earth's surface, making them feasible to exploit and potentially economically viable.

Where adequate geothermal resources do exist, they can contribute significantly to a country or region's electricity portfolio. For example, geothermal accounts for 27 percent of electricity generation in the Philippines and 4.5 percent in California.[64] A major advantage of geothermal power compared to many other renewable sources is that it can be used as a baseload source of energy with plants

operating at an average capacity factor of 73 percent, higher than for any other renewable technology and rivaling fossil fuel and nuclear generation, and topping out at capacity factors at or above 90 percent in certain plants.[65]

The most common use of geothermal energy is for heating and cooling. Because these systems rely on reservoirs with much lower temperatures, viable locations are much more common; at least 78 countries use geothermal energy directly for heating.[66] Where strong potential exists, geothermal can supply nearly all of a nation's heat energy, such as in Iceland where it accounts for 90 percent of all heat.[67]

Many CARICOM member states, particularly the islands making up the volcanic arch of the Lesser Antilles, possess significant untapped high-temperature geothermal resources. Development of this resource in member states such as Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines could dramatically alter the energy balance not only of individual islands, but of the region as a whole by allowing for renewable energy export and increasing the economic viability of exploratory drilling.

There is currently no geothermal power capacity within CARICOM member nations, although exploratory drilling is under way in some countries. Within the broader Caribbean region, Guadeloupe is the only island to have developed geothermal power capacity as of 2011.[68] Geothermal power development's high upfront capital needs have been a significant barrier to deployment, but investment and development plans have increased in recent years. For those CARICOM member states with strong geothermal potential, the relatively small power demand of individual islands poses a challenge to the profitability of small-scale projects, and points to the significant potential benefits of regional interconnection, collaboration, and trade.[69]

3.1.3 Hydro

Large hydropower comprises the majority of global renewable power generation, both within CARICOM and globally, accounting for an estimated 16 percent of the world's electricity production.[70] In many parts of the Caribbean, hydropower represents an ideal option for power generation given the region's hilly topography and significant rainfall. Several member states, including Belize and Suriname, already have high installed hydro capacity and generate a large share of their electricity from hydro resources, while a number of others have significant potential that is yet to be harnessed. Development of large-scale hydropower facilities such as the 165 MW Amalia Falls project in Guyana stands to play a significant role in the changing energy mix. Like geothermal, hydropower presents opportunities to broaden and interconnect regional energy markets - particularly in mainland member states like Guyana and Suriname.

Large Hydro: Despite being a low-carbon, renewable energy source, large hydro often has serious environmental and socioeconomic impacts.[71] The damming of rivers required to create the large volume reservoirs needed for power generation can be harmful to both animal and human populations, and can harm natural ecosystems and biodiversity. In many global cases, large-scale hydropower projects have led to the displacement of local populations and adverse impacts on downstream water conditions, which affect the livelihoods of even those populations not displaced by the facilities themselves. Although hydropower generation itself produces comparatively low emissions, the construction of hydropower plants—including the destruction of forests and other carbon sinks to create reservoirs and the large amount of materials, including concrete, needed for construction—has heavy emissions

impacts.[72] Hydropower systems are also vulnerable to the impacts of climate change, as increasingly common drought conditions will reduce electricity output.

Small Hydro: Small hydro, on the other hand, has several advantages as an energy source, including the ability to provide cheap and clean electricity to communities that may not have access to other resources. Small hydropower is used around the world, especially in remote areas. Usually classified as hydropower that generates less than 10 MW of electricity, it can operate as "run-of-the-river" systems that divert water to channels leading to a waterwheel or turbine, avoiding many of the negative environmental implications of large-scale hydro. Despite these benefits, small hydro has relatively high upfront costs compared to conventional energy sources and requires certain specific site characteristics, including adequate stream flow, which precludes its development in several small-island CARICOM member states. Although low-volume, continuous-flow systems have made hydropower feasible in small streams, certain agricultural practices and methods of forest management have led to decreased flows in rivers and streams on many islands, making the resource uneconomical.[73] Consumers must also be close to the harvested hydro resource. In some rural areas, low consumer demand for electricity due to the lack of economically productive uses for power often makes attracting funding difficult. Issuing grants, setting up preferential financing schemes, and cultivating local small hydro manufacturing economies have proven crucial for initiating and maintaining small hydro projects.

3.1.4 Municipal Solid Waste

As with biomass sources from agriculture, municipal solid waste (MSW) or waste-to-energy technologies offer the opportunity to use previously discarded materials as a fuel source to provide both electricity and heat. This waste contains significant organic material, and, when burned, can drive a turbine like any other thermal power plant. In addition, landfill gas (primarily methane) can be captured and used to power a thermal power plant.

MSW is advantageous because it can be used as a baseload source of power. Because the waste would otherwise be discarded, it is also a cheap fuel source that requires little resource extraction or change in land use. Depending on whether it is incinerated or gasified, however, MSW can result in varying emissions levels, necessitating detailed research for viability in particular contexts or development plans. MSW has drawn some attention in the CARICOM region, although its viability is severely restricted in some member states where small populations do not generate the volumes of waste necessary to fuel waste-to-energy plants, or where waste collection capacity is limited.[74] In Haiti, however, MSW is estimated to be able to provide between 9.68 MW and 24.3 MW of power capacity, depending on the rate of waste collection.[75]

3.1.5 Ocean Energy

Ocean energy technologies including wave and tidal power generation, Ocean Thermal Energy Conversion (OTEC), and salinity gradient technologies, may offer significant opportunities for power generation and the use of deep sea cooling in the tourism sector. In fact, these technologies have been identified as a priority area for future focus under the Small Island Developing States (SIDS) Sustainable Energy Initiative (SIDS DOCK)[i] as they offer significant potential throughout the Caribbean region.

[i] SIDS DOCK is a sustainable energy initiative comprised of member countries of the Alliance of Small Island States (AOSIS) with a focus on achieving sustainable economic development through transformational change in the energy sector.

However, it is important to note that unlike most of the other renewable energy technologies examined in this chapter, marine energy technologies are far from commercial viability and still have prohibitively high costs. The costs of building and installing wave and tidal systems, including both the generation equipment and the underwater cables, are extremely high, and existing global capacity is almost exclusively in the form of pilot and demonstration projects. There also are many factors that need to be considered when it comes to developing marine energy projects, including corrosion of equipment in seawater, coexistence with other human uses of coastal waters such as fishing and recreation, grid connection obstacles, and potentially significant ecosystem disturbances.

Initial assessments demonstrate that the current potential might be adequate for off-grid solutions serving individual consumers, such as individual resorts. Although they remain largely immature and have not been deployed widely at a commercial scale, the continued development of these technologies may allow them to play a significant role in the future energy mix of CARICOM, as highlighted by a variety of pilot projects, including deep sea cooling in the tourism sector of The Bahamas.[76] As technologies mature and costs come down, wave and tidal generation could become cost competitive in the long-term in some coastal regions[77], though the long-term potential for OTEC in the region is restricted.

3.1.6 Solar

All CARICOM member states possess strong solar energy potential and many opportunities to use various solar technologies for power generation, heating, and cooling – making solar technology a crucial, but yet mostly unused regional sustainable energy solution. Today, a suite of relatively mature technologies is available to convert the sun's energy into electricity. These generally fit into one of two categories: photovoltaic (PV) modules that convert light directly into electricity, and concentrating solar power (CSP) systems that convert sunlight into heat energy that is later used to drive an engine. Solar power can operate at any scale, but whereas utility-scale CSP systems generally are considered viable only in very sunny climates with little-to-no cloud cover, PV technology is modular and can be scaled for use on a household rooftop, in medium-size settings such as resorts and industrial facilities, or as part of a large network of utility-scale PV farms. It is also a more flexible technology in that it captures both direct and diffuse irradiation. Solar PV, therefore, is better suited to the conditions observed in the Caribbean than CSP.

In addition to providing electricity, solar energy is commonly used as an alternative to electric or gas systems for heating water and spaces. Solar water heating can be active or passive, meaning that the systems either use pumps and controllers to move and regulate the water, or rely only on convection. Active systems are more efficient but also are more expensive and require significantly more maintenance. Passive systems have no moving parts and are valued for their simplicity. Solar hot water systems are broadly cost competitive globally, with payback periods under two years in many cases. By the end of 2011, global solar water and space heating capacity reached 232 gigawatts-thermal.[78] More than half of this is in China, and the vast majority is used for water heating.[79] For small-island states, the attractiveness of solar water heating is clear. Cyprus is the world's leader in installations per capita, and Barbados's experience is considered a Caribbean renewable energy success story.[80] Duty-free equipment imports and tax incentives in the country have created a thriving market, with 40,000 solar hot water systems installed on homes, businesses, and hotels as of 2008, as well as a market penetration of 33 percent for residential buildings.[81] The success of this project was cited explicitly by the Inter-American Development Bank (IDB) in announcing a multimillion-dollar loan to Barbados for continued renewable energy development.[82]

The high component costs that have traditionally plagued solar technologies have significantly declined, with solar PV module costs falling nearly 50 percent in 2011 alone, making solar cost-competitive with fossil fuels under certain conditions.[83]. Several CARICOM member states have already demonstrated enormous success using solar energy, including solar PV for rural electrification in Guyana and solar water heating in Barbados.

3.1.7 Wind

CARICOM member states exhibit high potential for wind power development. Outside of hydropower, wind has been by far the most successful renewable electricity source worldwide, with 238 GW installed globally by the end of 2011.[84] In some markets, the costs of wind power are estimated at 4–7 cents per kWh in attractive locations, making it fully competitive with fossil fuel technologies.[85] Although turbines come in many sizes, wind power is used mostly for centralized utility-scale generation, although innovations for smaller-scale generation make decentralized wind generation an increasingly viable option. Small-scale (50 to 100 kW) wind-diesel hybrid systems are growing in the Caribbean, and a U.S.-funded project in Dominica is aimed at demonstrating the viability of wind generation facilities under 250 kW in the region.[86] Wind turbines can provide on-site electricity generation for large electricity consumers such as a factory or farm. Unlike traditional on-site thermal generators, however, wind is intermittent and cannot be started up at will. Connecting these turbines to the grid can significantly increase the value of the electricity as landowners are able to sell excess power.

According to Nexant's 2010 report, wind has the potential to be the fastest-growing renewable energy technology in the region over the next two decades.[87] Certain member states have already begun to develop capacity to harness these resources. With the exception of Jamaica, however, which now boasts nearly 40 MW installed wind capacity, and St. Kitts and Nevis, which has 2 MW installed, few member states have developed utility-scale wind infrastructure.

3.1.8 Comparative Costs of Renewable Energy Technologies

Many renewable energy technologies can be employed at relatively low costs compared to current electricity generation in the region. Figure 24 compares the global range of generating costs for various renewable technologies (blue bars) to the range of residential electricity tariffs in CARICOM (between 4.5 and 38.2 US cents/kWh). For reference, it also notes current residential energy prices in CARICOM member states demonstrating strong potential for a given renewable energy source.

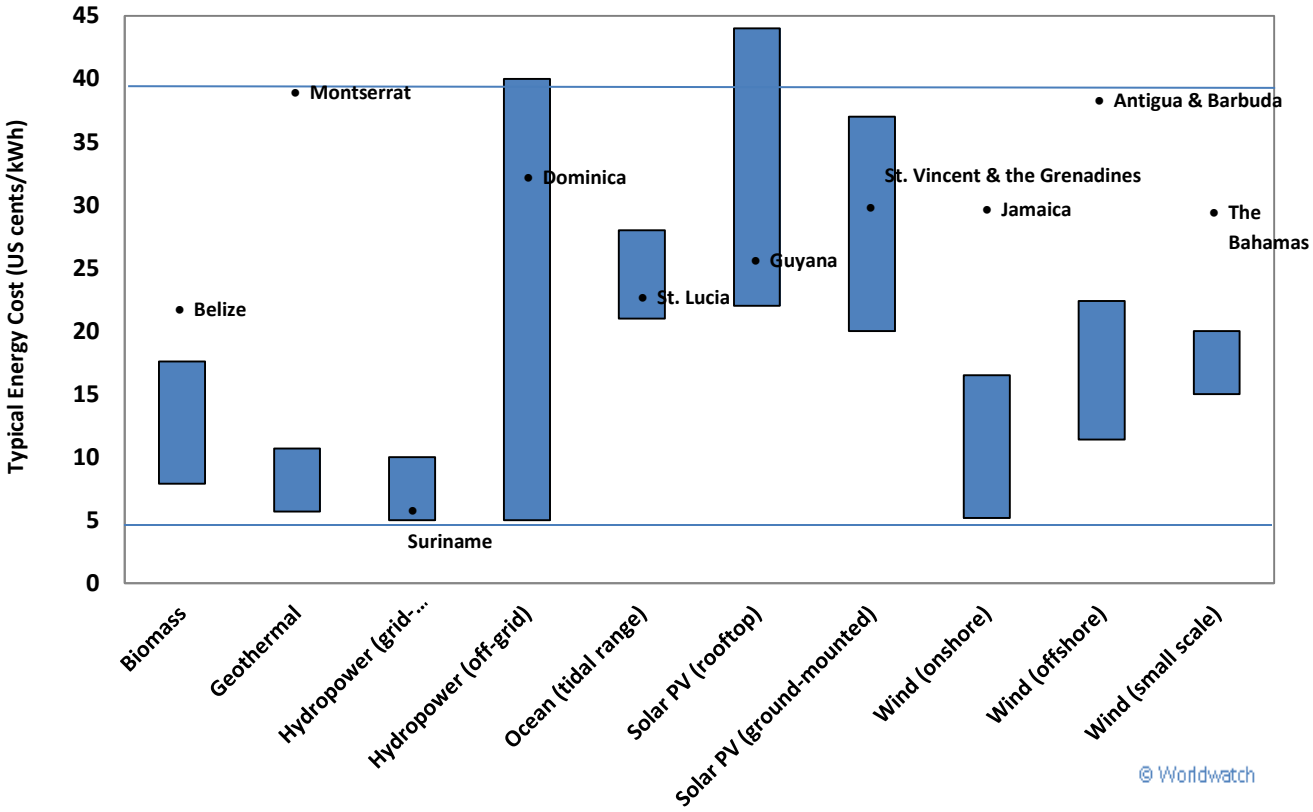


Figure 24. Global Power Generation Costs by Technology Compared to the Range of Electricity Tariffs in CARICOM

Note: Figure depicts the global range of generation costs for a number of renewable energy technologies, places them within the range of CARICOM electricity tariffs (4.5-38.2 U.S. cents/kWh) and provides example tariffs in select countries with strong potential for that particular resource.[88]

Although global generating costs and region-specific residential electricity tariffs are not directly comparable, they do indicate on a basic level the cost-effectiveness of renewable energy technologies, especially in the context of a region with such notoriously high electricity prices.

3.1.9 LCOE +

The cost-competitiveness of renewables in the Caribbean presents enormous opportunities for their expansion; however this will only be achieved if their real value is assessed and understood. Without detailed assessments of the costs associated with various generation options, as depicted in levelized cost of electricity (LCOE) analysis, it is impossible for policymakers to make fully informed decisions on which development pathway should be pursued. These types of assessments, however, are generally lacking across the region. Given their comparatively high upfront costs, renewable technologies often face barriers related to increased short-term costs for consumers. Over the entire life span of installed technologies, however, initial analysis in select parts of the Caribbean shows that certain renewable technologies are already cost competitive in the CARICOM region, with the cost of generation falling well below the price currently paid for electricity generated from fossil fuels once installation, operations and management, and fuel costs are included.

Despite the Caribbean's high electricity tariffs, pricing in the region (as in most of the rest of the world) continues to reflect only a fraction of the total costs to society resulting from a given generation system. Existing economic assessments all too often fail to take into account the numerous macroeconomic benefits of clean technologies, including job creation and expanded rural electrification, as well as the significant social costs of conventional power, including pollution's negative impacts on human health, and the costs of climate change and pollution. The wide-ranging electricity tariffs paid within CARICOM—from a low of roughly 4.5 U.S. cents/kWh charged by T&TEC in Trinidad and Tobago to the nearly 40 cents/kWh that APUA charged on the island of Antigua—do not internalize these significant costs.

Building on traditional LCOE analysis, a full assessment of socioeconomic impacts across the region, spearheaded by CARICOM, could lead to more balanced understanding of true societal costs of different power systems, correcting skewed market conditions and creating an environment that is more favorable for renewable energy development and deployment. By providing policymakers with this more detailed information, LCOE+ analysis integrating societal costs would play a central role in the enactment of long-term, integrated development scenarios that will benefit the region for years to come. Internalizing these costs would allow for more comprehensive decision making and a better understanding of the impacts that investments in specific technologies and fuels have on society as a whole. In many cases, deploying renewable power options could reduce the costs of generation compared to current systems. For CARICOM member states, simultaneously faced with high tariffs, vulnerability to international oil prices, and the impacts of climate change, it is critical that these factors be integrated into pricing models across the region. Doing so would create incentives for renewable energy deployment by creating a more transparent energy pricing structure.

The Model for Electricity Technology Assessment (META), developed by the World Bank's Energy Sector Management Assistance Program (ESMAP) and used extensively in Worldwatch's Sustainable Energy Roadmaps in the Caribbean, is an important tool that can be used to map the true cost of electricity. This flexible modeling tool internalizes factors such as local pollution and climate change to provide a more comprehensive picture of generation costs by technology—both renewable and non-renewable—that reflects the unique domestic conditions of each country.

3.2 Current Sustainable Energy Initiatives

A diverse array of sustainable energy initiatives technologies is being developed, explored, and implemented to harness the many available renewable resources in CARICOM member states. Many interesting case studies on renewable energy deployment and energy efficiency advancements exist throughout the region. Future research should focus on assessing these examples in order to replicate successes and learn from the challenges. Below are three examples to highlight the opportunities seen across the region.

<u>Solar Water Heaters in Barbados</u>

Barbados has emerged as a global leader in the deployment of solar water heaters. The solar water heater industry has been operating on the island since the 1970s and, to date, has installed upward of 50,000 individual units. Solar water heaters have an immense impact on reducing energy use, related emissions, and fuel import bills for energy import-dependent countries.

In Barbados, the installed systems contribute to estimated energy savings of 200 million kWh per year, and significant emissions reductions savings of 428 kilograms of CO_2 per system per year—equivalent to more than 5.5 percent of national carbon emissions.[89] The government of Barbados has played a key role in developing this important segment of the renewables market by introducing fiscal incentives into the national tax code to mitigate the cost barrier posed to citizens by the technology.

Geothermal in Dominica

Although geothermal resources have yet to be exploited within CARICOM, some member states are making significant strides. Dominica is a regional leader in taking concrete action to develop the sector, with contracts in place since 2011 to govern exploration of the island's geothermal potential. One of Dominica's most promising options for development is the Wotten Waven site, with the potential to support a 120 MW plant supplying 20 MW of power to meet Dominica's entire domestic demand and allowing for the export of 100 MW to neighbors Guadeloupe and Martinique.[90]

Recent reports indicate, however, that the project could be facing a major setback. Electricité de France (EDF), the world's largest utility company and one of the project's main partners, has reportedly withdrawn, prompting concerns about the project's future. Reports suggest that EDF based its decision on low profitability opportunities compared to those presented by investment in the Eastern Caribbean Gas Pipeline (ECGP), which would transport natural gas from Trinidad and Tobago to Barbados, St. Lucia, Guadeloupe, and Martinique.[91] Regardless of the specific reasons behind EDF's decision, it reflects a common pattern in the region. Several proposed geothermal developments have fallen through or been delayed due to investment concerns, reemphasizing the need for mechanisms to reduce the financial risks involved in geothermal development.

Wind Power in Jamaica

With an installed capacity of 38.7 MW, Wigton Wind Farm is the largest of Jamaica's two commercial-scale wind farms and the largest wind installation within CARICOM. Phase I of the Wigton facility was commissioned in 2004 with an initial capacity of 20.7 MW at a cost of US$26 million; the loan has since been refinanced through the Petrocaribe Development Fund.[92] Under the original 20-year agreement, Wigton sold electricity to the grid operator at a rate of 5.6 cents per kWh for the first five years, and 5.05 cents per kWh thereafter. These rates were too low for the wind farm to be profitable, however, and the terms were later renegotiated to reflect an updated avoided cost level averaging out to approximately 10 cents per kWh over the amortized life of the project's debt. Furthermore, rather than steady payments at the avoided cost level over time, the payments to Wigton under the new agreement are higher in the first few years—allowing the company to recover high upfront capital costs—and then lower in later years, averaging out to the avoided cost.

Phase II added 18 MW of capacity and began exporting electricity to the grid in December 2010 at a cost of $49 million, also financed by Jamaica's PetroCaribe Fund.[93] Since 2010, Wigton has envisioned further expansion, including an additional 24 MW that should have been under way by now. According to Wigton officials, the major barrier to new capacity has been the low avoided cost-based price for IPP wind generation at less than 11 cents per kWh—officials stated that a price of 13–14 cents per kWh would be necessary to make additional capacity viable at Wigton.[94] Since the Jamaican utility JPS currently sells electricity for 38 cents per kWh, a guaranteed price of 13-14 cents per kWh would be reasonable, and could spur significant wind power development.

These initiatives depict a sampling of the many sustainable energy programs and projects currently in development across the region. Unfortunately, renewable energy development and deployment across

CARICOM continues to be characterized by a lack of follow through on developed strategies and plans. Both the wind and geothermal sectors have fallen victim to this trend on numerous recent occasions. Gaps between project planning and project implementation remain one of the largest barriers to a sustainable energy transition. As highlighted by these success stories, government intervention should play a central role in working to bridge this gap.

3.3 Potential of Energy Efficiency in the Region

In tandem with renewable energy technologies, energy efficiency and energy conservation measures can be deployed across all economic sectors – including residential, commercial, and industrial - to reduce energy demand.[ii] Often referred to as "the fifth fuel," energy efficiency measures are often both the cheapest and fastest way to lessen the environmental and economic costs associated with a given energy system.

Energy efficiency is an important first step because of its compounding effects: when a user demands one less unit of energy because of efficiency measures, the system typically saves much more than one unit of energy because of avoided losses during generation, transmission, and distribution. Especially in countries like Haiti, where technical and non-technical losses are high, end-user efficiency savings can translate into much greater savings in generation. As a result, efficiency improvements can amplify the benefits of developing utility-scale renewable energy by increasing the impact of added renewable power capacity. As compared to centralized utility-scale power, distributed renewable technologies are often more efficient because they minimize the transmission losses associated with moving power over long distances.

The number of opportunities for energy efficiency that exist at the household level must be harnessed. Buildings themselves can be made significantly more efficient through proper insulation, white roofing, and smart architecture/landscaping. In-home products such as household appliances continue to consume comparatively large volumes of electricity, with their inefficiency exacerbated by reliance on outdated appliances and a lack of strong efficiency standards for new appliances. With growing economic development, a corresponding growth in energy demand from these types of appliances and other household products, such as air conditioning systems, will need to be managed through efficiency measures.

Energy efficiency measures also offer some of the most cost-effective tools for reducing CO_2 emissions. Especially in the many CARICOM member states where there are few, if any, energy efficiency measures in place, there are large gains to be made in this area. In many cases, energy efficiency measures actually save money due to reduced energy costs. A CO_2 abatement analysis for the Dominican Republic illustrates the cost and emission saving potential of energy efficiency measures in an upper-middle-income, fossil fuel-dependent small-island state similar to Jamaica.[95] (See Figure 25.) Similar analyses in other CARICOM member states could help to inform decision making by identifying priority action areas.

[ii] While energy efficiency, which results in the use of less energy to perform the same task, and energy conservation measures, which look to reduce overall energy use, differ, for the purposes of this analysis energy efficiency is used to describe both sets of energy reduction solutions.

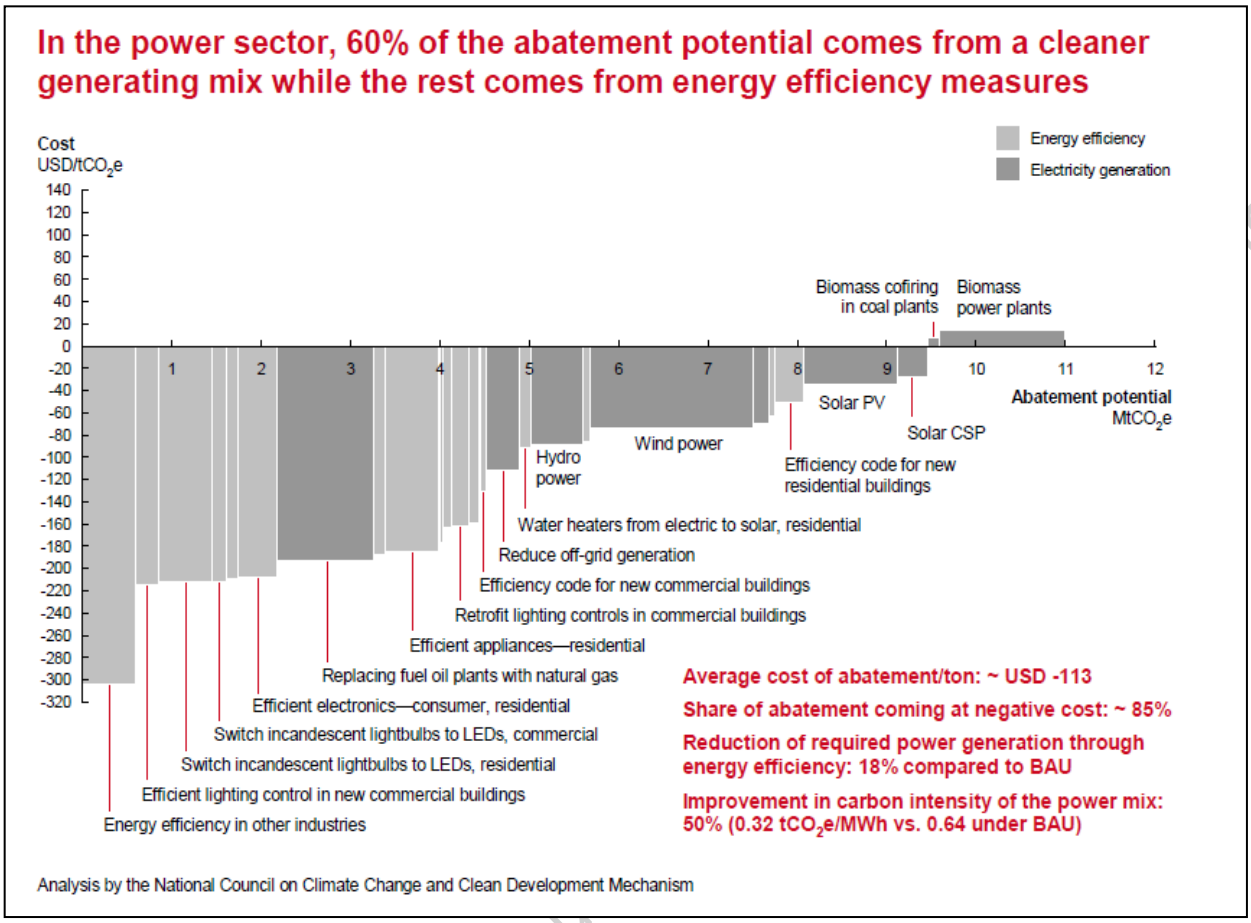


Figure 25. Carbon Abatement Cost Curve Analysis for the Dominican Republic

Although many CARICOM member states are relatively small, and therefore generate and consume comparatively little energy, an examination of energy intensity (primary energy consumption per dollar GDP) can indicate the efficiency of particular energy systems. Preliminary analysis of energy intensity throughout CARICOM highlights significant disparity among member states. (See Figure 26.) Not surprisingly, those member states with well-developed industrial sectors—particularly Trinidad and Tobago, Suriname, and Guyana, each of which has fairly extensive extractive industries—demonstrate the highest energy intensities, although Guyana's energy intensity has been declining steadily.

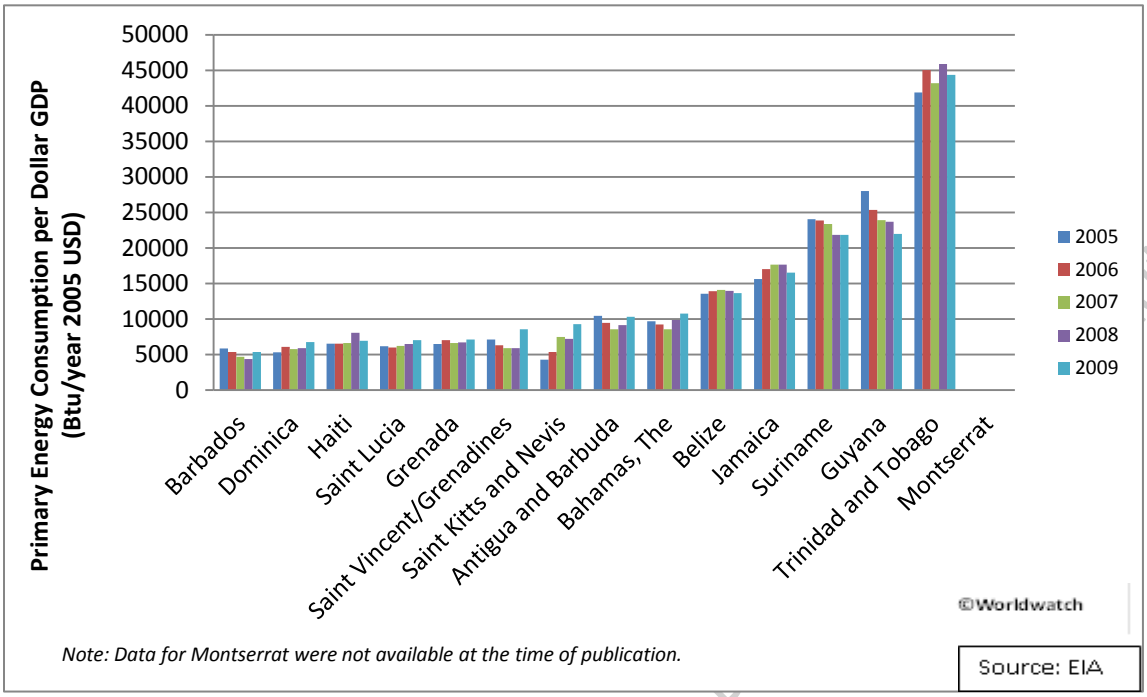


Figure 26. Energy Intensity of CARICOM Member States, 2005–09

Economic sectors that should be targeted for energy efficiency measures and technologies on a national level are those that: 1) account for a large share of the country's energy consumption; 2) are highly energy intensive or inefficient; or 3) are central to the economy. Across the CARICOM region, such sectors include: electricity generation, electricity transmission, hotels and tourism, mining, and the residential sector.

Despite the high energy costs for the tourism industry, hotels have been slow to introduce energy efficiency measures despite studies demonstrating that relatively small investments and practices can result in 20–30 percent energy savings.[96] A project of the U.S. Agency for International Development Energy Audits for Sustainable Tourism initiative, carried out between 1997 and 2002, reduced nightly energy use per guest by 12 percent in participating Jamaican hotels, reducing total energy consumption by more than 1.6 million kWh over the project period. The project resulted in efficiency savings of US$616,555 resulting from an investment of just US$175,000.[97]

3.4 Current Energy Efficiency Initiatives

CARICOM member states have expressed both a desire and a willingness to focus on improving energy efficiency, and several have begun implementing associated projects and policy measures. Many of the measures currently in place are tax incentives. For example, Trinidad and Tobago already provides a 150 percent tax allowance for companies that conduct energy audits and install energy saving equipment. Many other member states have suggested additional energy efficiency measures or are currently in the process of incorporating them into national plans. The Development Bank of Jamaica (DBJ) is financing ongoing energy efficiency and renewable energy pilot projects, including in two hotels, the Sunrise Club Hotel and Footprints on the Sands. Efficiency measures include energy management systems to shut off electricity use in unoccupied rooms and replacing old air conditioning systems with efficient inverter AC units.[98]

3.5 Renewables and the Grid

Integrated energy planning must look beyond deploying new technological solutions for energy generation and energy efficiency. Grid developments will play a central role in redesigning energy systems in the Caribbean, where existing infrastructure is largely out of date and often insufficient to meet the population's current and growing energy needs. This is evidenced by the region's high technical losses and, in select member states, a lack of reliable electricity access. Without further development, existing grid networks will be unable to successfully address the technical challenges associated with the increased use of renewable energy envisioned by CARICOM and its member states.

New grid infrastructure will be necessary to manage variability and to integrate complementary renewable energy sources into T&D networks to supply reliable power. New smart grid advancements can play a significant role in managing demand, shifting loads to off-peak hours, and better utilizing domestic renewable energy resources. The deployment of smart meters at the household level, combined with the appropriate policy mechanisms (e.g., feed-in tariffs, net metering/net billing) will allow customers to generate their own renewable power and sell back to the grid.

Grid investments are currently needed to reduce the high electricity losses of many CARICOM member states as well as to provide reliable electricity access to large portions of the population in states where grid expansion is the most viable option. This process will need to be driven in large part by national governments and the CARICOM Secretariat, because private investment into new grid infrastructure is slow to evolve.

As certain CARICOM member states look to integrate larger shares of variable renewable energy into grid networks, energy storage solutions will also need to be developed. Some feel storage solutions start to become necessary as the electricity system approaches a 20 percent renewable share.[99] While renewables such as geothermal and hydropower do not face these issues to the same degree, those islands that rely on more variable renewable sources such as wind and solar will need to invest in storage technologies. These issues already have begun to be addressed in certain member states, such as Antigua and Barbuda, where policymakers are assessing pumped storage hydropower as a component of wind development. The stand-alone diesel generators prevalent through much of the region may also serve to back up variable generation from new renewables. This approach is prevalent in Guyana's Hinterland Electrification Strategy.[100]

3.6 Regional Interconnection Potential

There has been much discussion within CARICOM and the broader Caribbean region about the potential benefits of some degree of electrical integration and/or regional energy trade. In particular, the development of abundant renewable energy resources such as geothermal would make export via interconnection increasingly viable and perhaps even necessary to make the significant investments that are required economical.

There are many potential benefits of electricity interconnection in the Caribbean. Given the prevalence of small-island economies within CARICOM, many of which struggle to take advantage of economies of scale due to their limited market size and investment capacity, interconnection presents opportunities to reduce operating costs and stimulate increased investment. Interconnection, particularly in the context of a renewable energy resource such as geothermal, which requires significant initial capital investment, can make development much more profitable by enabling it to be exported.[101]

Already, some CARICOM member states use submarine interconnection cables to link individual islands within a country. These include two 33 kV lines between Trinidad and Tobago, short-distance cables in the Bahamas that supply electricity to several small islands and cays, and a 34.5 kV submarine cable linking mainland Belize with San Pedro.[102] St. Kitts and Nevis is working with a private developer to build a geothermal generation facility capable of providing sufficient renewable energy baseload to serve the entire 8–9 MW peak load on Nevis and deliver the excess to St Kitts. The developer is considering a generation capacity of either 14 MW or 20 MW for the initial stage and 35 MW for the eventual second stage.

A pre-feasibility study conducted by the Energy and Climate Partnership for the Americas (ECPA) on a potential interconnection between St. Kitts and Nevis and Puerto Rico concluded that such an interconnection could simultaneously reduce oil and natural gas use on the islands and promote geothermal development.[103] In addition, as of July 2012, three wells had been drilled in the Wotton Waven area of Dominica to assess the feasibility of geothermal development and submarine transmission to Martinique and Guadeloupe.

Several studies on the feasibility and implications of electricity interconnection in the Caribbean have already been done. A 2010 preliminary study conducted by Nexant concludes that the following six interconnection scenarios involving CARICOM member states would be both economically viable and technically feasible: Nevis-St Kitts; Dominica-Martinique; Dominica-Guadeloupe; Nevis-Puerto Rico; Nevis-U.S. Virgin Islands; and the Dominican Republic-Haiti land interconnection. A 2009 study by St. Vincent Electricity Services Limited (VINLEC) concluded that although connecting the small grids of the Grenadine Islands was not cost effective, interconnection for energy exports could become feasible following significant geothermal development.[104] A project funded by the IDB is currently performing pre-feasibility studies to evaluate the political, institutional, regulatory, technical, economic, environmental, and social implications of electrical interconnection in the "Northern Arc" countries (i.e., Suriname, Guyana, French Guinea, and two northern states in Brazil).

Regional pipelines for natural gas have also been considered and their potential assessed as part of the development of a regional energy strategy. Construction of the Eastern Caribbean Gas pipeline is slated to commence in 2014.[105] At this time, however, some experts tend to agree that the construction of regional gas pipelines is not economically viable for the region due in part to high material and construction costs. Electricity interconnections therefore appear to be the most promising option for regional energy interconnection.

3.7 Gap Analysis

The completion and communication of technical assessments for renewable energy, energy efficiency, and grid and storage solutions is the backbone of integrated energy planning. Unfortunately, this is often lacking in CARICOM. Even in areas where the necessary assessments have been completed, the results are often not communicated and the assessments themselves unavailable. Moving forward with the C-SERMS initiative will require ongoing and thorough analysis of renewable energy and energy efficiency potential, as well as a more coordinated approach to compiling and sharing existing data throughout the region. Priority gaps that, if addressed, would facilitate rapid forward progress include:

1. **Lack of widespread calculation, understanding and communication of renewable energy's cost-effectiveness:** Despite the cost-effectiveness of renewable technologies in the Caribbean region, they continue to be perceived by many regional stakeholders as prohibitively expensive. This poses a significant barrier to development in a region already

facing high electricity prices. A thorough assessment of levelized cost of electricity (LCOE) in each CARICOM state—comparing the costs of various generation sources and including the "true costs" typically excluded from conventional cost analyses—will identify and communicate the economic feasibility of renewable development, as well as the societal benefits that stem from its increased deployment.

2. **Unavailability of renewable energy assessments and technology feasibility studies:** Although many member states have conducted initial assessments of resource potential for a number of technologies, much more detailed resource identification will be needed before projects can be implemented. Where detailed resource assessments have not been conducted, they should be carried out. Where assessments have already been conducted, they should be made publicly available and easily accessible to potential investors, project developers, and other key stakeholders. Compiling all completed assessments in a central location, open to all energy stakeholders, would facilitate knowledge sharing and avoid duplication of effort.

3. **Higher resolution assessments for priority geographic locations not conducted and/or communicated:** National-level assessments provide a valuable overview of available resources and can play a crucial role in indicating promising areas for deployment of specific technologies. In order for project development to move forward, however, assessments must be conducted on a higher resolution. Priority areas for more detailed assessment include those with the best resources and those near population centers.

4. **Analysis of opportunities for resource complementarity in integrated energy planning not conducted and/or communicated:** Many opportunities exist to deploy certain renewable energy technologies in tandem, taking advantage of seasonal and diurnal variation to overcome some of the challenges typically posed by the variability of renewable resources like solar and wind. Assessments of complementarity potential will facilitate smarter and more integrated energy planning, and will indicate opportunities for the most efficient and most cost-effective renewable deployment.

4 Existing Policy Framework

Despite the strong potential for energy efficiency and renewable energy observed in all CARICOM member states, the development of sustainable energy systems will not occur organically. The success of sustainable energy development in CARICOM will depend largely on the effectiveness of policy and regulatory structures. Regional and national governing bodies must be proactive in implementing enabling policy frameworks that facilitate development and promote the investments needed to encourage energy efficiency improvements and allow renewable energy projects to take hold.

Worldwide, renewable energy and energy efficiency support policies have been critical drivers of increased renewable generation in recent years, and the implementation of such measures is increasing rapidly. The number of countries with support policies in place for renewable power generation, for example, increased from 48 in 2005 to 109 by early 2012.[106] Developing countries and emerging economies are taking the lead in supporting renewables via policy frameworks, accounting for the majority of countries with concrete support mechanisms in place today.

No single policy mechanism can successfully transform a nation's entire energy sector. Instead, policymakers must design and implement an appropriate **policy mix** that matches unique domestic

conditions. International experience shows that countries which have successfully promoted renewable energy and energy efficiency score high on three essential building blocks: 1) a **long-term vision** that includes goals and targets; 2) **concrete policies and measures** to achieve these goals and targets; and 3) **effective administrative processes and governance structures** for implementing and revising these mechanisms.[iii]

Although recent years have seen an increase in the number of policies designed to incentivize renewable energy and energy efficiency in CARICOM member states, overall these efforts remain disjointed and incomplete. In the absence of a coherent long-term vision, well-designed policy mechanisms and effective governance frameworks, a variety of technical, financial, institutional, and capacity barriers will continue to impede the shift to sustainable energy production, consumption, and trade in the Caribbean.

4.1 Existing National Energy Plans and Long-Term Visions in CARICOM

Establishing an official long-term vision for sustainable energy development that lays out clear goals and priorities and commits all government stakeholders to a common and cohesive strategic agenda represents a crucial component of effective sustainable energy planning. CARICOM has taken a significant step forward by finalizing its Energy Policy. In addition to this regional vision, all 15 CARICOM member states now have a national energy strategy in some stage of development or implementation, a significant shift from when work began on the CARICOM Regional Energy Policy a decade ago.[107] (See Table 7.) To facilitate development of a sustainable energy system for the region as a whole, it is essential that these plans encourage the deployment of renewable energy and energy efficiency technologies. A preliminary review of these documents by the CARICOM Secretariat concluded that they generally align with the CARICOM Regional Energy Policy.[108]

Table 7. Existing National Energy Plans in CARICOM Member States

	National Energy Policy	Name of Policy Document
Antigua and Barbuda	In Draft (Feb. 2012)	Final National Energy Policy
Bahamas	Proposed (Sep. 2010)	Second Report of the National Energy Policy Committee
Barbados	Submitted (Dec. 2006) Proposed (June 2010)	The National Energy Policy of Barbados Sustainable Energy Framework for Barbados
Belize	In Draft (Nov. 2011) Submitted (Sep. 2012)	Draft National Energy Policy Framework MESTPU Strategic Plan 2012-2017
Dominica	In Draft (Dec. 2011)	Draft Sustainable Energy Plan of the Commonwealth of Dominica
Grenada	Approved (June 2011)	The National Energy Policy of Grenada
Guyana	Approved (May 2010)	National Low Carbon Development Strategy
Haiti	In Draft (Feb. 2011)	National Energy Sector Development Plan
Jamaica	Approved (Oct. 2009)	Jamaica's National Energy Policy 2009-2030
Montserrat	Approved (Sep. 2008)	Montserrat Energy Policy, 2008-2027
St. Kitts and Nevis	In Draft (Apr. 2011)	Draft National Energy Policy
St. Lucia	Approved (Jan. 2010)	Saint Lucia National Energy Policy
St. Vincent & the Grenadines	Approved (Mar. 2009)	National Energy Policy

[iii] For more information on these three essential components of sustainable energy planning, see the Worldwatch Institute's work on Sustainable Energy Roadmaps, in Alexander Ochs and Shakuntala Makhijani, *Sustainable Energy Roadmaps: Guiding the Global Shift to Domestic Renewables* (Washington, DC: Worldwatch Institute, 2012).

Suriname	Submitted (Nov. 2010)	Renewable Energy Policy of Suriname
Trinidad and Tobago	In Draft (Jan. 2011)	Framework for Development of a Renewable Energy Policy for Trinidad and Tobago

Source: See Endnote 107. © Worldwatch

Setting appropriately ambitious targets for energy sector development is a critical piece of designing and implementing an effective climate-compatible development strategy. Targets, if well-designed and adhered to, help to articulate a long-term vision that can transcend changes in leadership, commit all necessary actors and stakeholders to a common goal, and provide key investors with the signs of long-term stability that they need to commit to crucial project financing. In the context of CARICOM, regional targets can also unite individual member states around a common goal and help to ensure that their respective national action plans and policies work as part of a cohesive whole.

Many CARICOM member states have set specific targets for sustainable energy development across several categories, including renewable energy penetration in the national energy mix, renewable power, energy efficiency improvements, and—in fewer cases—carbon emissions reductions. Because these targets were set at the national level, the forms they take vary widely. Although this presents certain challenges in terms of developing regional targets, CARICOM's targets should—wherever possible—build on what individual member states have already achieved and on the national targets already set, providing a common, cohesive guiding vision to the region as a whole.

4.1.1 Existing Renewable Energy Targets

Many CARICOM member states have set ambitious renewable energy goals that are comparable to targets being adopted globally. For example, three countries—Dominica, Grenada, and Guyana—are targeting more than 90 percent renewable power in the coming decades. (See Table 8.)

Table 8. Overview of Renewable Energy Targets in CARICOM Member States

	Renewable Energy Supply	Electricity from Renewables	Transport
Antigua and Barbuda		5% by 2015 10% by 2020 15% by 2030	Improve transport efficiency 40% in 15 years
The Bahamas		15% by 2020 30% by 2030	Achieve fuel economy of 30–35 mpg for 70% of vehicles in 5–10 years
Barbados	10% by 2012 20% by 2026	29% increase by 2029	
Belize	Reduce fossil fuel dependence 50% by 2020		
Dominica		25% by 2010 100% through the addition of geothermal by 2020	
Grenada	20% by 2020	10% by 2013 (Grenada) 20% by 2017 (Grenada) 40% by 2011 (Carriacou and Petite Martinique) 100% by 2030 (no date given)	
Guyana		90% through hydro development Install 15,000 solar home systems (no date given)	
Haiti			
Jamaica	30% by 2030	15% by 2020	

		20% by 2030	
Montserrat			
St. Lucia	20% by 2020	5% by 2013 15% by 2015 30% by 2020	
St. Kitts and Nevis		20% by 2015	Reduce fossil fuel consumption 15% by 2015
St. Vincent and the Grenadines		30% by 2015 60% by 2020	Reduce fossil fuel consumption 10% by 2015 and 15% by 2020
Suriname			
Trinidad and Tobago		5% of peak demand (or 60 MW) by 2020	Convert 20% of all 500,000 vehicles to CNG by 2015 Reduce the sector's CO_2 emissions by 10–15% (no date given)

4.1.2 Existing Energy Efficiency Targets

As of April 2013, seven CARICOM member states had either implemented or were considering national targets for energy efficiency improvements. (See Table 9.)

Table 9. Overview of National Energy Efficiency Targets in CARICOM Member States

Country	Energy Efficiency
Antigua and Barbuda	Improve energy efficiency by 30% over 15 years
The Bahamas	None
Barbados	Reduce electricity consumption 22% compared to business-as-usual by 2029
Belize	Improve energy efficiency and conservation by at least 30% by 2033 (suggested)
Dominica	None
Grenada	None
Guyana	None
Haiti	None
Jamaica	Reduce energy intensity from 21,152 to 6,000 Btus/$GDP by 2030
Montserrat	None
St. Lucia	Reduce electricity consumption in the public sector by 20% by 2020
St. Kitts and Nevis	Reduce projected electricity demand 20% by 2015 (resulting in peak demand of 45.7 MW)
St. Vincent and the Grenadines	Reduce projected increase in peak demand 5% by 2015 and 10% by 2020 Reduce power losses to 7% by 2015 and 5% by 2020 Reduce electricity generation 15% by 2020
Suriname	None
Trinidad and Tobago	No target currently exists; however, a 150% tax allowance is granted to commercial and industrial enterprises that achieve a target % of energy efficiency improvement (target currently being determined)

4.1.3 Existing Emissions Reductions Targets

As of April 2013, only two CARICOM member states had national targets for emissions reductions in place. Dominica has set a goal of becoming "carbon negative" by 2020 by exporting geothermal to the

neighboring countries of Guadeloupe and Martinique, and Grenada has set a target of reducing greenhouse gas emissions 20 percent below business-as-usual projections by 2020.

4.2 Existing Concrete Policies and Mechanisms

Once the vision has been established, direct support mechanisms for renewable energy and energy efficiency are necessary to support the development and deployment of these technologies and to meet overarching targets. Although such measures have been widely implemented across the region, there remains a significant need for policy evaluation and implementation of additional measures. Because sustainable energy markets are policy driven, governments within CARICOM can take a number of steps to mitigate the technical and non-technical barriers obstructing development and deployment of both renewable energy technologies and energy efficiency solutions. Already, some member states have implemented a variety of regulatory reform measures, fiscal incentives, and public financing mechanisms.[109] (See Table 10.)

4.2.1 Existing Renewable Energy Support Policies

Most CARICOM member states have implemented some form of renewable energy support policy, whether in the form of regulation, fiscal incentive, or public financing mechanism.

Regulatory Measures

Feed-in tariffs (FITs), which provide a fixed, guaranteed price per unit of energy produced and sold into the grid, are the most widely adopted policy in the global power sector, currently used in more than 60 countries worldwide—more than half of which are categorized as developing nations.[110] Although FITs have been suggested in several CARICOM member states, none have been implemented. Several member states have implemented **net metering** or **net billing** schemes, which allow small-scale electricity consumers to generate their own electricity and feed it into the grid, creating a two-way flow of electricity whereby the customer is billed or credited/paid based on the ratio of power consumed to power generated.[111] Currently, only a small group of CARICOM member states offer incentives for producers of renewable power to sell directly back to the grid. In Jamaica, a recent renegotiation of the utility's electricity license resulted in a net billing provision allowing small-scale renewable energy producers to deduct the electricity they produce themselves from their bill, and to sell any excess electricity that they do not consume to the grid. Net metering and net billing schemes have also been introduced in Barbados (pilot), Grenada, and St. Lucia (pilot) with limited success. As of September 2011, only a combined 65 customers had been connected under all four programs.[112] International experience has shown that to create effective incentives for generation, the tariffs set in such programs must be well designed and appropriate. In Jamaica, for example, the tariffs offered under the net billing scheme do not reflect the current electricity market and are still significantly lower than the price that the utility charges for electricity, therefore failing to provide the kind of cost incentive required to develop renewable energy. Although these four countries have taken a significant step forward in implementing these schemes, it is important that these initiatives be improved and scaled up to support larger additions of renewable capacity across the region.

Given the region's long history of monopoly control over electricity generation, transmission, and distribution, IPPs have struggled to gain a foothold in many member states. A successful transition to renewable energy sources will require the increased presence and participation of independent generators, both large and small and on- and off-grid. Recognizing this, a number of member states currently **permit IPPs** to operate, although with varying degrees of administrative and regulatory

burden. In the case of Antigua and Barbuda and St. Vincent and the Grenadines, independent production is allowed only if approved by the utility. In those states where IPPs are currently not permitted, national laws and regulations should be amended to allow them. Many CARICOM member states already have high levels of self-generation, mostly by private businesses, as a result of unreliable grid power supply and/or the absence of legal authority to access grid infrastructure. Where this is not yet the case, however, significant regulatory changes must take place to open markets to independent generators.

Fiscal Incentives and Public Financing

Another generation incentive is the **production tax credit** model, which provides a long-term guaranteed tax incentive based on units of energy produced; this mechanism has been identified as one of the major drivers of wind power development in the United States. Several member states have implemented **tax reductions or exemptions** to provide incentives for renewable energy deployment, or are in the process of doing so. In his May 2013 budget address, "An Agenda for Economic Growth and Fiscal Sustainability," the Prime Minister of St. Lucia announced that his administration will implement a range of renewable energy tax incentives including income tax deductions for installed renewable energy systems and import duty exemptions for renewable energy technology components. **Tenders**, or auctions, are also being used to encourage renewable energy deployment. Certain countries, such as South Africa, are now turning to this market-based mechanism in place of traditional policies such as FITs. Tenders are quickly becoming one of the primary mechanisms for supporting renewable energy in Central America and, within CARICOM, already play an important role in Jamaica.

Table 10. Renewable Energy Support Policies in CARICOM Member States

	Regulatory Policies				Fiscal Incentives and Public Financing			
	Feed-in Tariff	Net Metering/ Billing	Renewable Portfolio Standard/ Quota	IPPs Permitted	Tax Credits	Tax Reduction/ Exemption	Public Loans/ Grants	Green Public Procurement
Antigua and Barbuda		Suggested		X				
The Bahamas	Suggested	Suggested						
Barbados	In develop-ment	X		X	X	X	X	
Belize								
Dominica				X				
Grenada		X	Suggested	X	Suggested	X	Suggested	
Guyana		Suggested				X		
Haiti								
Jamaica		X		X	X	X		
Montserrat					Suggested	Suggested		
St. Kitts and Nevis				X*				
St. Lucia		X		X	Suggested	X		
St. Vincent and the Grenadines		Suggested		X	Suggested	Suggested		
Suriname	Suggested	Suggested		X		Suggested		
Trinidad and Tobago	Suggested			Suggested				

* Note that only self-generation from wind and solar PV is permitted through NEVLEC. © Worldwatch
Note: "Suggested" indicates that the measure has been cited or discussed in some official state capacity (including in an official planning document or in public remarks) but has not yet been implemented.
Source: See Endnote 109.

4.2.2 Existing Energy Efficiency Support Policies

As with renewable energy, energy efficiency solutions can be promoted effectively through direct government regulations and fiscal incentives, as well as initiatives aimed at raising public awareness about efficient conservation.[113] (See Table 11.) Guyana has made significant efforts to promote energy efficiency through a combination of **tax exemptions**, **public demonstrations**, and **incentives** for efficient lighting. Trinidad and Tobago will grant a 150 percent tax allowance to commercial and industrial enterprises that achieve a target share of energy efficiency improvement, although the specific target is still being determined.

National building codes are commonly used to great effect to ensure that new construction incorporates modern, energy-saving technologies. A number of countries worldwide have implemented mandates requiring new construction to include solar hot water heating, a technology that has already taken hold in Barbados. The promotion of **energy labeling** for consumer goods such as household appliances can have a significant impact on reducing energy use and further encouraging the purchase of less energy-intensive products. In combination with labeling, **appliance efficiency standards** can be adopted to enforce the use of products above a mandated energy efficiency threshold. Incentives

encouraging businesses and individuals to perform **energy audits**, such as those already in place in Trinidad and Tobago, can have a significant impact. Encouraging consumers to critically examine the ways in which they use energy can make them aware of the enormous and relatively easy opportunities that exist for improvement and significant savings.

Table 11. Energy Efficiency Support Policies in CARICOM Member States

	National Energy Efficiency Standards	Tax Credits	Tax Reduction/ Exemption	Public Demon-stration	Prohibited Use/ Import of Incandescent Bulbs	Appliance Labeling Standards
Antigua and Barbuda	Suggested					
The Bahamas						
Barbados		X	X			
Belize						
Dominica	Suggested	Suggested		Suggested		
Grenada						
Guyana			X	X	X	
Haiti						
Jamaica	In Draft		X			X
Montserrat						
St. Kitts and Nevis						
St. Lucia			Suggested			
St. Vincent and the Grenadines			Suggested			
Suriname	Suggested				Suggested	
Trinidad and Tobago	Suggested		X	Suggested	Suggested	Suggested

Note: "Suggested" indicates that the measure has been cited or discussed in some official state capacity (including in an official planning document or in public remarks) but has not yet been implemented.
Source: See Endnote 113.

Although energy efficiency mechanisms are gaining prevalence in regional policy discussions, they have yet to be enacted as widely as renewable energy support policies; however, because efficiency improvements often present the fastest, least-expensive opportunities to decrease energy consumption and associated emissions, they should be considered to a greater extent throughout CARICOM. Strategies for doing are discussed in the *Summary and Recommendations for Policymakers* report.

4.2.3 Existing Support Policies for Sustainable Transportation

Given the importance of transportation in regional energy consumption, some governments have implemented mechanisms specifically targeting improvements in that sector. A combination of direct regulation, including **biofuel blend mandates** and **fuel efficiency standards**, as well as **fiscal supports** has been used to promote decreased dependence on fossil fuels in the transportation sector. (See Table 12.)

Table 12. Transportation Policies in CARICOM Member States

	Blend Mandate	Import Tax Exemption/ Reduction	Fuel Efficiency Standards
Antigua and Barbuda	Suggested		Suggested
The Bahamas			
Barbados	Suggested	X	
Belize			
Dominica			
Grenada			
Guyana			
Haiti			
Jamaica	X		
Montserrat			
St. Kitts and Nevis			
St. Lucia		Suggested	
St. Vincent and the Grenadines		Suggested	
Suriname		Suggested	
Trinidad and Tobago		X	

Note: "Suggested" indicates that the measure has been cited or discussed in some official state capacity (including in an official planning document or in public remarks) but has not yet been implemented.

In Trinidad and Tobago, Finance Act No. 13 of 2010 includes provisions that **remove import duties** on conversion kits and cylinders required to convert vehicles from gasoline to compressed natural gas (CNG), and apply a zero-rated value-added tax (VAT) to private or commercial vehicles manufactured to use CNG.[114] Although the use of natural gas in transport is not a viable option for all CARICOM member states, these mechanisms demonstrate the kinds of incentives that can be used to encourage reform. In St. Lucia, the government intends to implement a duty and excise tax exemption on the importation of all vehicles operating on 'sustainable fuels', as well as on the equipment required to convert conventional vehicles.

Market incentives designed to overcome the cost barriers associated with electric vehicles, such as the preferential standing under the tax code observed in Barbados, could be a valuable tool for encouraging the development of domestic markets for these vehicles. Governments can set a strong example and have a powerful impact on encouraging change in the transportation sector by transitioning their own fleets to alternative fuel vehicles. In Trinidad and Tobago, 100 new CNG-powered buses are scheduled to be added to the fleet in 2013, and some 300 more will be converted from diesel. Although CNG may not be the appropriate choice for all CARICOM member states, when purchasing new vehicles for their public fleets governments throughout the region should look to invest in electric vehicles or other alternative-fuel vehicles where possible, and support the initial development of charging and refueling stations.

4.2.4 Policy Effectiveness

Although a policy may officially exist, its impact depends on its design and the way in which it is implemented. The failure to implement enacted policies, to apply them universally, or to honor the terms of existing policy measures may result in impacts directly opposed to what was originally intended. Renewables are already seen by many as a risky investment; if this is combined with a lack of long-term certainty and trust in the policy environment of a specific country, it is highly likely that investors and project developers will look to alternative markets that present more-secure policy and

market conditions. This is not an issue unique to CARICOM. In Europe, cuts to FITs and other incentives, the most damaging of which are being applied retroactively, are proving costly to numerous companies and have the potential to erode confidence in what has been one of the most established renewable energy markets worldwide.

4.3 Existing Governance and Administrative Structures

There are numerous examples across the CARICOM region and around the world of cases in which renewable energy support policies, although well designed, failed because they were not supported by effective governance and administrative structures. These can be either an important enabler to the increased deployment of sustainable energy or a critical barrier to its growth. Unfortunately, the latter is often the case. International experience suggests that governance and administrative reforms must play a central role in the development of any nation's energy sector. The CARICOM region is currently characterized by a vast array of agencies and structures responsible for various aspects of energy sector governance. (See Table 13.)

A variety of institutional challenges persist in CARICOM. Although crucial government agencies often compete for limited public resources, the energy sectors in many CARICOM member states could benefit substantially from additional resources provided at the national level. Because energy issues affect such a broad range of sectors, a multitude of government agencies with overlapping (and sometimes opposing) mandates and priorities are typically involved in various aspects of energy planning and regulation. Likewise, due to their wide-ranging and cross-sectoral responsibilities, many government officials lack the detailed knowledge of renewable energy technologies and support mechanisms required to identify and design the most effective policy mix.

Few CARICOM member states have significant capacity dedicated exclusively to energy issues, often making it difficult to coordinate with other government officials and to provide the updated information necessary for renewable energy planning. Given the extensive and continuous monitoring required to keep all national regulations up to date and most efficient, this can pose a significant barrier to renewable energy policy development. In other cases, dedicated ministries and committees lack the capacity to fulfill their mandate, rendering the institutional structure that exists on paper largely meaningless. Given their small size and in some cases limited institutional and financial capacity, several CARICOM member states struggle to collect and track important data sets. Even in cases where data and information are collected and made publicly available, they can be challenging to access. Few ministries responsible for energy issues have a Web presence, making it difficult for stakeholders and researchers to access critical information. Responsibility for identifying, tracking, and analyzing key data and trends related to the Caribbean energy sector is often fragmented or undefined, resulting in widespread gaps in the knowledge base required to assess, develop, and revise components of national energy planning and to attract private developers. CIPORE was developed to collect and provide information on regional renewable energy development, but it faces ongoing challenges related to limited financial resources and capacity.

The governance of electricity services remains a significant challenge as well. Most CARICOM member states have a single utility with monopoly control over electricity transmission and distribution, and sometimes generation. This presents many potential issues for consumers, including higher electricity prices, and hinders the deployment of renewable technologies by contributing to utility resistance against measures allowing consumers to connect distributed renewable energy systems and sell power

to the grid. Such challenges are further compounded in member states without an independent regulatory agency.

Table 13. Institutional and Governance Structure of the Energy Sector in CARICOM Member States

	Ministry	Designated Institution for Renewable Energy	Regulator	Utility	State-Owned	Privately Owned
Antigua and Barbuda	Ministry of Public Works and the Environment	Energy Desk, Office of the Prime Minister		APUA		
The Bahamas	Ministry of the Environment		Utilities Regulation and Competition Authority	Bahamas Electricity Corp. and Grand Bahama Power Corp.	X (BEC)	X (GBPC)
Barbados	Ministry of Finance, Economic Affairs, and Energy	Renewable Energy and Energy Conservation Unit within the responsible Ministry	Fair Trading Commission	Barbados Light and Power		X
Belize	Ministry of Energy, Science & Technology, and Public Utilities		Public Utilities Commission	Belize Electricity Ltd.	X	
Dominica	Ministry of Public Utilities, Energy, Ports, and the Public Service	Energy Unit within the responsible Ministry	Independent Regulatory Commission	DOMLEC		X
Grenada	Ministry of Finance, Planning, Economy, Energy & Cooperatives			GRENLEC		X
Guyana	Ministry of Natural Resources and the Environment	Guyana Energy Agency	Public Utilities Commission	Guyana Power and Light	X	
Haiti	Ministry of Energy			EDH	X	
Jamaica	Ministry of Science, Technology, Energy and Mining (MSTEM)	Centre of Excellence for Sustainable Energy Developments (CESED)	Office of Utilities Regulation	JPS		X
Montserrat	Ministry of Communication, Works and Labor (Energy Development Committee)			Montserrat Utilities Ltd.		
St. Kitts and Nevis	Ministry of Public Works, Housing, Energy and Utilities (St. Kitts) \ Ministry of Communications, Utilities, Posts, Planning, Natural Resources and Environment (Nevis)		Public Utilities Commission	SKELEC & NEVLEC	X	
St. Lucia	Ministry of Sustainable Development, Energy, Science and Technology	Energy Policy Advisory Committee	Ministry of Public Utilities	LUCELEC	X (public/ private)	
St. Vincent and the Grenadines	Ministry of Energy	Energy Unit		VINLEC	X	
Suriname	Ministry of Natural Resources	Energy Unit of the Ministry of Natural Resources		Energie Bedrijven Suriname (EBS)	X	
Trinidad and Tobago	Ministry of Energy and Energy Affairs; Ministry of Public Utilities	Renewable Energy Committee	Regulated Industries Comm.	T&TEC	X	

Energy governance throughout the region is also commonly characterized by excessive permitting and regulatory requirements. Although regulation and permitting are critical for ensuring successful implementation while minimizing any negative impacts associated with project deployment, overly onerous processes often create disincentives for renewable energy project development, even in places with strong resource potential and favorable market conditions. Long and complicated permitting processes lengthen project lead time and add additional soft costs to project implementation. An example from one CARICOM member state illustrates problems typical throughout the region. in the country's National Energy Policy, the Ministry cites time-consuming administrative procedures as a major barrier to renewable energy project development.[115] Complex permitting requirements for small hydro capacity additions, for example, burden renewable energy project developers in the country, resulting in significant risk and expense, and discouraging developers and investors from undertaking renewable energy projects.[116] (See Figure 27.)

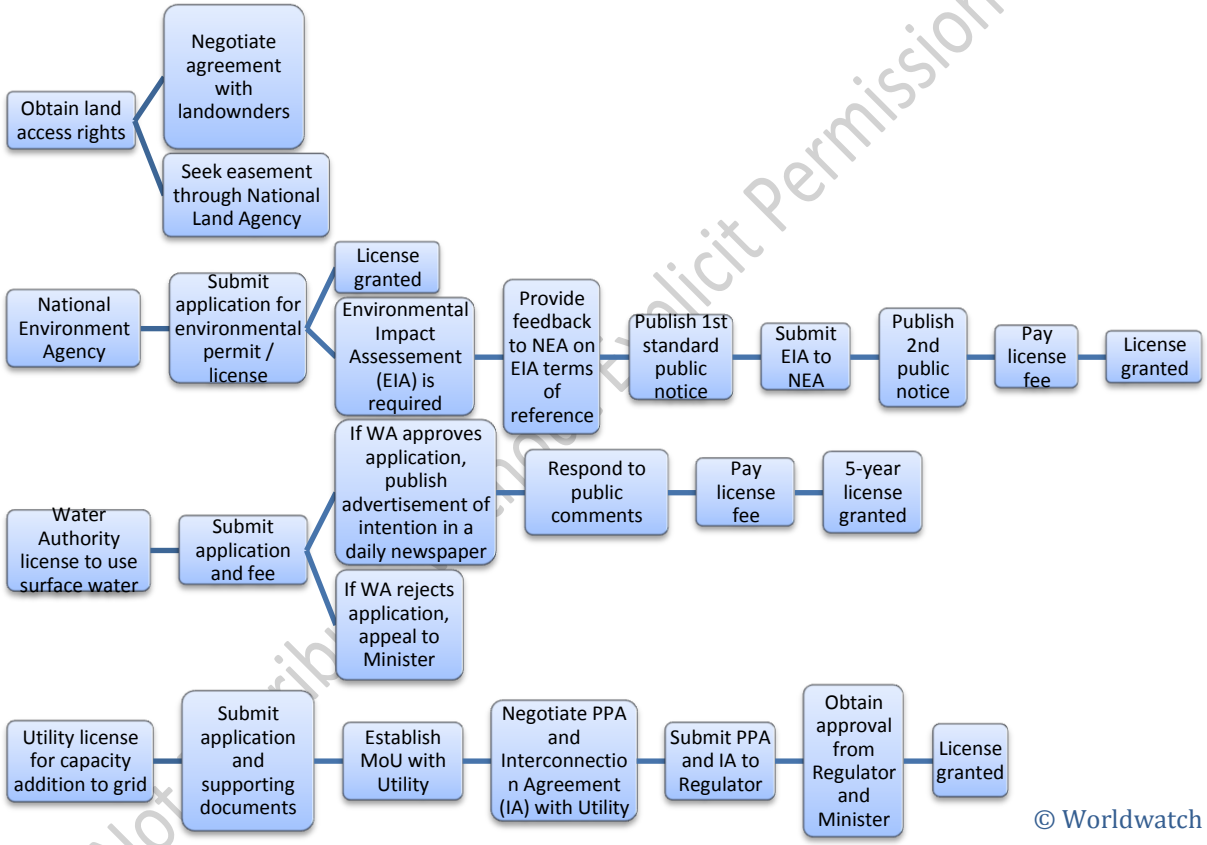


Figure 27. Observed Permitting Processes for Adding Small Hydro Capacity (100 kW to 25 MW) in a CARICOM Member State

Effective governance is further complicated by the number of actors involved in regional energy issues. Many disparate national, regional and international initiatives have operated or are currently active in the Caribbean. Key players including GIZ/CREDP, SIDS DOCK, Carbon War Room, OLADE, and ECLAC have ongoing energy sector initiatives across the region, while other organizations, such as the Clinton Foundation, continue to support key projects in specific countries. The number of projects and initiatives operating across all 15 member states makes coordination difficult, and can result in needless duplication of effort. To ensure the most effective and efficient use of limited resources and the sharing

of critical knowledge, the CARICOM Secretariat should play a key role in organizing, supporting, and coordinating this ongoing work. Lessons learned in these initiatives can contribute significantly to the further development of regional and national energy strategies and concrete policy mechanisms.

5 Setting CARICOM Targets for Renewable Energy, Energy Efficiency and Emissions Reductions

5.1 Setting Regional Energy Targets Worldwide

Global studies have used a wide range of scenarios to estimate the potential future contributions of renewable energy to the energy mix.[117] (See Table 14.) Despite their differences, these scenarios underscore the potential for renewable energy technologies to have a significant impact on a number of critical sectors over the coming decades.

Table 14. Global Renewable Energy Scenarios

Potential	Organization	Source
100% by 2050	WWF/Ecofys	*The Energy Report*
By 2035: • 48% of electricity generation • 19% of heat demand • 14% of transport	IEA	*World Energy Outlook 2012* (450 Scenario)
Electricity • 37% by 2020, 61% by 2030, 94% by 2050 **Heat** • 50% by 2030 90% by 2050	Greenpeace/GWEC/EREC	*Energy [R]evolution 2012*
50% of primary energy by 2030	Worldwatch/REEEP	*Renewable Revolution: Low-Carbon Energy by 2030*

Worldwide, several initiatives and regional organizations have developed targets for renewable energy and energy efficiency. The United Nations' Sustainable Energy for All Initiative (SE4All) has pledged to work toward three critical goals related to energy access, energy efficiency, and the share of renewables.[118] The European Union has set a region-wide target of 20 percent renewables by 2020, to be met through binding country-specific commitments ranging from Sweden's target of 50 percent by 2020 to Malta's target of 10 percent by 2020.[119] In West Africa, the 15- member Economic Community of West African States (ECOWAS) has committed to a Renewable Energy Policy (EREP) that includes targets for both on- and off-grid renewable energy applications and renewable fuels used as a substitute for gasoline, diesel, and fuel oil.[120] And SIDS DOCK, which has particular relevance for CARICOM member states, has set a variety of targets for small-island states.[121] (See Table 15.)

Table 15. Renewable Energy and Energy Efficiency Targets of Regional Associations and Organizations Worldwide

Organization	Target/Goal	Countries Covered
Sustainable Energy for All	• Ensure universal access to modern energy services; • Double the global rate of improvement in energy efficiency; • Double the share of renewables in the global energy mix	Global
SIDS DOCK	• Obtain 50% of power generation from low-carbon sources by 2033; • Reduce petroleum use in transportation 20–30% by 2033; • Increase energy efficiency 25% by 2033	30 small-island states
European Union	• Obtain 20% of final energy consumption from renewables by 2020; • Increase energy efficiency 20% by 2020; • Use 10% biofuels in transportation by 2020	EU-27
Economic Community of West African States (ECOWAS)	**Grid-connected** • Share of peak load in capacity (excluding medium and large hydro): 10% by 2020, 19% by 2030 • Share of peak load in capacity (including medium and large hydro): 35% by 2020, 48% by 2030 • Share of generation (excluding medium and large hydro): 5% by 2020, 12% by 2030 • Share of generation (including medium and large hydro): 23% by 2020, 31% by 2030 **Off-grid applications** • Share of rural population served from renewable energy: 22% by 2020, 25% by 2030 **Biofuels** • Ethanol as share of gasoline consumption: 5% by 2020, 15% by 2030 • Biodiesel as share of diesel and fuel-oil consumption: 5% by 2020, 10% by 2030	Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo

5.2 Recommended Renewable Power Targets for CARICOM

5.2.1 Renewable Power Targets Agreed Upon by COTED

On March 1, 2013, at the 41st Special Meeting of the Council on Trade and Economic Development (COTED) on Energy in Port-of-Spain, Trinidad and Tobago, CARICOM member states took a critical step forward in defining their common vision for renewable energy development. In addition to passing the CARICOM Draft Energy Policy, energy ministers of the CARICOM member states adopted regional targets for the share of renewables in CARICOM's electricity mix by 2017, 2022, and 2027.

5.2.2 Methodology

CARICOM member states exhibit enormous potential for rapid and extensive development of renewable energy resources including biomass, geothermal, hydro, solar, and wind. In many member states, if these resources were developed to their full potentials, renewables could account for 100 percent of both current and projected power production within a relatively short timeframe. Given the role of targets in establishing a vision of what is possible and the fact that specific countries have varying capacities to develop certain energy resources, regional renewable power targets for CARICOM should be based largely on assessments of renewable energy potential in each member state.

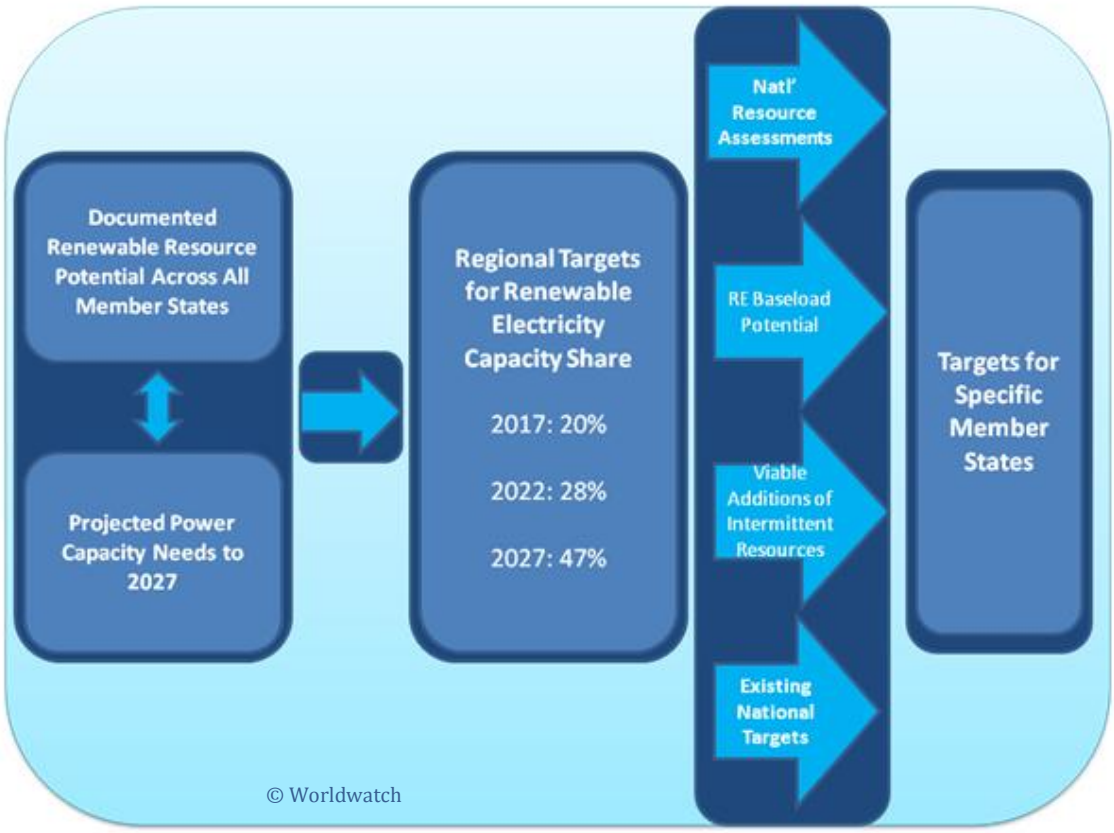


Figure 28. Methodology for Recommending Renewable Power Capacity Targets

To advise CARICOM on developing renewable energy targets, the Worldwatch Institute has developed a methodology that sets an overall regional target based on the available documented technical resource potential in member states. It then works backward to assign individual shares of that regional target to specific member states based on a combination of country-specific resource assessments and existing renewable energy targets. Based on a cumulative assessment of region-wide renewable energy potential, the analysis concludes that CARICOM may set overall regional goals of **28 percent** renewable power capacity by 2022 and **47 percent** by 2027. (See Table 16.)

Table 16. Proposed Renewable Energy Targets for the CARICOM Region

Horizon	Target Year	CARICOM Targets (Contribution of renewable energy to overall installed generating capacity)
Short Term (5 years)	2017	20%
Medium Term (10 years)	2022	28%
Long Term (15 years)	2027	47%
Base Year 2012: Share of renewable energy in electricity generation is 7.6%		

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In this methodology, the regional targets are based on estimates of national renewable energy potential, taken from a variety of sources and studies and compared to projected capacity needs calculated to 2030.[122] Because the characteristics of a given renewable technology determine the ways it

can be used, the Worldwatch methodology distinguishes between baseload and intermittent renewable energy sources.

- **Baseload renewable energy sources:** Within CARICOM, renewable energy sources that can provide baseload generation include biomass, biogas, geothermal, and hydro.[iv] Baseload power stations typically operate relatively continuously at high capacity factors. It is generally more economical to operate these generators at constant levels than to adjust production to match consumption, and generally the facilities are shut down only for planned or forced maintenance periods.

- **Intermittent renewable energy sources:** By contrast, intermittent renewable energy sources such as wind and solar PV produce power more variably and operate at significantly lower capacity factors. These sources can be used in decentralized generation, or by injecting power into the grid. As the share of intermittent supply increases, however, so do the cost and complexity of managing supply and maintaining stability.

Targets are based on energy balance projections developed under a business-as-usual scenario to assess the total energy and installed capacity needs of the region in the given years. (See Annex A.) Given the relatively short timeframe granted for the 2017 targets, they assume that renewable energy projects currently in the pipeline and scheduled to be completed before 2017 are brought online as scheduled. Those capacity additions are then added to existing capacity, and calculated as a share of the total. The 2022 targets assume some degree of progression toward the final 2027 target, based on the specifics of the particular renewable energy resource being used, as well as what share renewables already comprise of the country's installed capacity. Targets for 2027 represent an increase over business-as-usual scenarios for each country within the region. These targets represent a more ambitious strategy to make use of the tremendous exploitable renewable energy resources available.

5.2.3 Suggesting Country-Specific Targets

Based on the selected regional targets of **28 percent by 2022** and **48 percent by 2027**, Worldwatch then developed **preliminary member state-specific targets** for renewable penetration, reflecting a combined analysis of individual assessments of available renewable energy baseload potential, viable additions of intermittent renewable energy resources, and existing country goals. (See Table 17.) **It is expected, however, that member state-specific targets will be discussed and assessed within CARICOM, and that final national efforts will reflect this internal debate.**

To achieve these targets, each CARICOM state will need to make significant gains in renewable penetration. For many states, this will require strengthening existing national targets and striving to integrate a greater share of renewables into the energy mix. Although existing national targets and CARICOM regional targets are not directly comparable due to methodological differences, the existing targets do provide a general picture of the ambition that many CARICOM states have shown in renewable energy planning at the national level.

[iv] The initial targets presented to COTED counted only geothermal and hydro as baseload renewable energy sources. This can be adjusted according to feedback received from member states.

Table 17. Redefining National Renewable Energy Targets in CARICOM Member States

Country	Existing Renewable Electricity Targets	Estimated National Renewable Share of Installed Capacity to Meet Regional Target of 48% by 2027	Estimated Renewable Energy Share of Generation in 2027 (based on installed capacity target)
Antigua and Barbuda	5% by 2015 10% by 2020 15% by 2030	51%	64%
The Bahamas	15% by 2020 30% by 2030	55%	53%
Barbados	29% increase by 2029	67%	55%
Belize		76%	85%
Dominica	25% by 2010 100% through the addition of geothermal	56%	100%
Grenada	10% by 2013 (Grenada) 20% by 2017 (Grenada) 40% by 2011 (Carriacou and Petite Martinique) 100% by 2030	70%	100%
Guyana	90% through hydro development Install 15,000 solar home systems	84%	90%
Haiti		46%	52%
Jamaica	20% by 2030	40%	
Montserrat		34%	100%
St. Kitts and Nevis[v]		St. Kitts: 57% Nevis: 67%	St Kitts: 100% Nevis: 100%
St. Lucia	5% by 2013 15% by 2015 30% by 2020	69%	100%
St. Vincent and the Grenadines	30% by 2015 60% by 2020	59%	81%
Suriname		52%	60%
Trinidad and Tobago	5% of peak demand (or 60 MW) by 2020	52%	29%

The developed scenarios would necessitate an expansion of total power and total renewable power capacity over the given years. Based on Worldwatch calculations, by 2027, these cumulative figures would be 11,693 MW and 5,613 MW, respectively.

5.2.4 Advantages

This approach results in bold overall targets that would make CARICOM one of the most ambitious regions worldwide in sustainable energy development, especially in the long term (by 2027). Such targets produce a powerful long-term vision that makes significant renewable energy capacity a central pillar of energy planning and overall development strategy in each member state, and in the region as a whole. Renewable energy technologies often face resistance from those who believe that available

[v] St. Kitts installed capacity and generation figures included imported geothermal power from Nevis

renewable resources are inadequate to supply the demands of an entire country. This approach clearly demonstrates that, in fact, given the ample biomass, geothermal, hydro, solar, and wind resources of the Caribbean, renewable energy technologies are capable of providing 100 percent (or nearly 100 percent) of regional power needs relatively soon.

Those member states with abundant biomass, geothermal and hydro resources can develop significant baseload renewable energy, enabling intermittent renewable technologies such as wind and solar to contribute additional power. Countries like Belize and Suriname have already achieved a renewable power share of approximately 50 percent, with significant additional resource potential available. Member states with higher potential shares of intermittent resources will need to strategically integrate these solutions, and may have to invest both in the development of renewable energy technologies and in the modernization of their transmission and distribution capacities. Although small market size, minimal power demand, and relatively minor installed capacity can present certain obstacles to scaling up renewable energy development in small-island states, these factors also present an opportunity to reach a 100 percent renewables share in a relatively short period of time.

In many cases, the suggested targets are significantly higher than what might be expected based on current levels of renewable energy penetration and historic technology growth rates. These indicative targets, however, seek to provide an ambitious vision for harnessing the resources prevalent in each member state. Across the region, historic deployment has struggled to match the tremendous resource potential available for a number of renewable technologies. These targets seek to strengthen and expand existing efforts, where applicable, and to generate the new initiatives and efforts needed to better promote the deployment of renewable energy technologies across CARICOM.

5.2.5 Challenges

Basing these assessments on projections of future demand and/or capacity could result in inaccuracies because these forecasts may be subject to change—and in fact *should* change—as CARICOM and individual member states move to implement efficiency measures. Already, some member states have indicated that they could likely surpass their suggested national commitment to meeting the regional targets. As states make more ambitious domestic plans, these should be reflected in increased commitments at the regional level.

Due to time and information restraints, certain other factors and assumptions were not considered in the scope of this analysis, but should be studied and taken into account as the regional process moves forward. These factors include electricity grid and storage improvements, grid interconnections with other CARICOM and non-CARICOM states, unforeseen technological developments, land use constraints, and the changing economic viability of deploying various renewable technologies, including price fluctuations of renewable and non-renewable generation options.

This approach was also not able to account for the full spectrum of potential technical, political, economic, or financial constraints in the region. For example, the potentially limited availability of developable land in certain resource rich zones may limit the possibility of deploying renewable technologies to their documented potential. Such detailed analysis, however, falls beyond the scope of this report. In addition, this approach does not consider a time table for decommissioning conventional power plants currently in operation. It is important to note, however, that even if renewables achieve a 100 percent share, fossil fuel generation will likely be maintained to some degree for emergency situations. The fact that most CARICOM member states currently rely heavily on diesel generators

means that the backup power already exists to facilitate intermittent renewable energy technologies, making a quick transition technical feasible and less costly.

In addition, several of the resource assessments relied on for these preliminary calculations are limited and likely do not reflect member states' full potential. The assessments used for the Bahamas, for example, consider economic feasibility and were completed two years ago. Since then, solar costs have decreased significantly and will likely continue to do so, changing what is economically and politically feasible. Furthermore, the resource assessment statistics used to make these calculations were pulled from a variety of studies, and the generation capacity potentials of various renewable energy sources were simply summed, without assessing their complementarity. Some resource estimates cite studies focused on very specific locations, suggesting that the full resource potential of the country may in fact be much higher.

Finally, the enormous potential benefit of regional interconnection and trade were not factored into these calculations. The role of CARICOM in promoting regional interconnection as a potential game changer for the Caribbean energy sector and establishing the political will necessary to encourage development is discussed in Chapter 3 and outlined in the *Summary and Recommendations for Policymakers* report.

5.2.6 Recommendations for Moving Forward

Adopt and extend targets

Setting initial targets is only the first step in developing a regional energy vision. Senior energy officials within CARICOM have already indicated their intent to go beyond these initial goals and set more ambitious targets. Although not formally accepted at the COTED, delegates there expressed a willingness to set an additional target of 50 percent renewable energy share in the power sector by 2030. All efforts should be made to ensure that the targets approved at the COTED are formally accepted by the member states, and that any additional targets be integrated into regional energy planning.

Assess and compare regional and country-specific targets

Targets based on renewable energy capacity were selected as a starting point for the region based on the data available and on CARICOM's ambition to move forward as quickly as possible. This is certainly not the only metric that could be used, as many other methodologies have been employed within the region and around the world. Using capacity is a potentially imperfect measure as it does not account for a variety of aspects, such as the differing capacity factors of various renewable and non-renewable power generation technologies as well as the significant energy resources used outside of electricity production. Within the power sector, more detailed resource assessments and power plant performance data would enable development of generation-based targets that could provide additional guidance to CARICOM member states. Based on currently available data, initial modeling has produced estimates for the potential generation share of each theoretical national capacity target (See Table 9). Overall, filling significant data gaps in respect to energy statistics in other sectors, most notably transportation, would facilitate regional and national target setting for renewable energy shares of total energy use. Future research aimed at improving energy policymaking and strengthening CARICOM's regional targets could compare the methodologies used by individual CARICOM member states in setting their national-level targets.

5.3 Recommended Energy Efficiency Targets for CARICOM

Energy efficiency is often cited as the quickest and most effective way to reduce costs in the energy sector. It also can be a critical factor in enabling countries that are struggling to provide continuous, reliable energy access to do so more effectively. Worldwide, however, the pace at which energy intensity is declining slowed to 0.5 percent annually between 2000 and 2010, down from more than 1 percent annually over the preceding two decades.[123] CARICOM and its 15 member states should seek to take advantage of opportunities for efficiency improvements wherever possible by adopting a long-term energy efficiency strategy.

Setting a regional target for energy efficiency will drive this process forward and provide the guidance necessary to adopt efficiency measures in all critical areas, including generation, transformation, distribution, and final energy consumption. Seven CARICOM member states have already set national-level energy efficiency targets (see Table 9.), although this is far fewer than the number that has adopted renewable energy targets. CARCOM's regional targets for energy efficiency should build on these national efforts in order to establish a guiding vision for the region as a whole to maximize energy use.

Unfortunately, energy efficiency is often difficult to measure and various metrics are used to measure how efficiently energy is being used within a specific region, country, or sector. This is reflected in the diverse formats that energy efficiency targets have taken worldwide. In some cases, targets have been applied across an entire economy, while in others they have been applied to specific sectors. A sampling of energy efficiency targets adopted around the world includes measures aimed at reducing energy intensity; decreasing energy consumption; incorporating fuel-efficient vehicles into the national vehicle mix; and reducing electricity demand.[124]

Regardless of how it is measured, energy efficiency is playing an increasingly important role in energy system reform and development worldwide. Countries across Asia and Europe have taken the lead in adopting ambitious strategies to curb their energy use. At the regional level, the EU is a leader in setting a guiding vision, targeting a 20 percent reduction in primary energy consumption against projected energy use by 2020.[125] At the national level, Denmark is relying on energy efficiency improvements to help meet its long-term renewable energy target, one of the most ambitious in the world. Denmark's national development strategy identifies energy efficiency measures as a key factor allowing the country to attain 100 percent renewable energy in the national energy supply by 2050.[126] China, in the midst of continuing rapid economic development, has implemented new legislation targeting a 16 percent reduction in energy intensity by 2016.[127] And Japan has passed energy efficiency measures targeting specific sectors with the aim of reducing electricity demand by 10 percent by 2030.[128]

Choosing the appropriate metrics by which energy efficiency should be measured in CARICOM is of paramount importance. Worldwatch suggests that CARICOM establish regional energy efficiency targets based on **energy intensity**. This metric has already been used to measure energy efficiency improvements at the regional level in the Asia-Pacific Economic Cooperation (APEC) countries, which are targeting a 45 percent reduction from 2005 levels by 2035, and at the national level for Jamaica's energy efficiency target.[129]

Energy intensity measures the productivity of energy use by assessing unit of energy inputs per unit of economic output, typically measured in GDP. Although not the same as energy efficiency, measurements of energy intensity can serve as an effective proxy for assessing energy efficiency improvements.[130] This approach also directly correlates with CARICOM's goals to decrease energy use

where possible and to encourage regional economic growth. Energy intensity is also a metric better suited to the unique characteristics of the region's energy sector. For a number of member states including Belize, Guyana, and Haiti, the urgent need to add new power capacity and increase generation to meet the needs of their citizens makes an approach to energy efficiency based on reducing generation and/or consumption inappropriate and perhaps even counterproductive in some cases.

Articulating and measuring energy efficiency goals in terms of energy intensity has certain disadvantages that must be addressed. Certain energy intensive industries such as energy production and mining may skew the comparative rankings regardless of the true efficiency of their operation.[131] Within CARICOM, a significant gap in energy intensity exists between the service-oriented islands that have comparatively low energy needs and member states that have comparatively energy-intense industries, such as Trinidad and Tobago. Even if Trinidad and Tobago makes extensive energy efficiency improvements, the country will still have comparatively high energy intensity without a wholesale shift in domestic industry. As improvements are made, however, this metric will allow for changes to be assessed and benchmarked in member states categorized by low and high energy demand. In this sense, energy intensity can be very effective in establishing patterns of reduced energy use coming as a result of energy efficiency improvements within individual member states.

Based on observed global trends, Worldwatch suggests that a regional CARICOM target of a 33 percent reduction in energy intensity by 2027 be applied evenly across all member states. This goal is in line with both domestic and international energy intensity projections and targets over similar time periods. The IEA projects that a moderate adoption of energy efficiency measures could result in an annual decrease in global energy intensity of 1.8 percent per year between 2010 and 2035, while the enactment of a full slate of policies to take advantage of all economically viable energy efficiency technologies would result in 2.4 percent annual decrease over the same period.[132] These estimates support CARICOM's ambitions for the renewable energy sector, as they result in demand for both coal and oil peaking by 2020, while encouraging an ever-increasing demand for renewables and natural gas over the specified time frame.

Two CARICOM member states—Antigua and Barbuda, and Belize—have already enacted domestic measures targeting energy efficiency improvements of roughly 30 percent. (See Table 9.) A 33 percent reduction in energy intensity across the region would make CARICOM a global leader and would have a transformative effect on domestic energy sectors and the economies of member states. Targeting ambitious improvements in energy efficiency will benefit all member states by reducing strain on existing power systems, reducing the need to add new and expensive generation capacity, and increasing long-term economic productivity by reducing production costs.

While regionally appropriate based on international metrics, the feasibility of this preliminary regional target should be assessed at the national level in each member state by thoroughly examining opportunities for energy efficiency improvements in the context of each member's unique economic structure. Certain key industries or sectors may possess greater potential than others for significant improvements. The pace of adoption of energy efficiency initiatives in the region also varies widely, which may initially constrain deployment in certain member states. Where potential for improvements in energy efficiency exceed 33 percent, all efforts should be made to maximize efficiency through the adoption of national policies.

To facilitate this process and shape the development of effective energy efficiency measures, the CARICOM Secretariat and member states should attempt to fill all critical information gaps and develop a more detailed overview of sectoral energy use across the region. Currently this data is often lacking or

not publicly available. Additional national level assessments of energy use at the sectoral level can guide the future development of CARICOM energy efficiency strategies. Short- to mid-term energy efficiency targets and additional long-term targets beyond 2027 may be necessary to match the region's full ambitions. Collectively, these actions will facilitate the development of national strategies that identify the highest priority impact areas in which energy is being used least efficiently and where the most significant improvements can be made.

5.4 Recommended Emissions Reduction Targets for CARICOM

A regional target for CO_2 emissions reductions in CARICOM should form a third pillar of the regional vision being put forward by C-SERMS. While the aggregate emissions of all 15 member states are negligible in comparison to total global CO_2 emissions, an ambitious CARICOM target for emissions reductions will encourage member states to make crucial improvements and will set a strong precedent for international action in this critical area. Significant emissions reductions can be achieved through the C-SERMS initiative.

Worldwide, emissions from the energy sector represent one of the leading contributors to climate change, with fossil fuel combustion currently accounting for nearly 70 percent of all CO_2 emissions. This trend has not improved in recent years, despite the constraints imposed by the global economic crisis and the uptake in climate-compatible development strategies being implemented in many leading countries. CO_2 emissions from traditional fossil fuels reached a new all-time high of 31.6 gigatonnes (Gt) in 2011.[133]

The increased deployment of renewable energy will play a central role in mitigating climate change by reducing CO_2 emissions, an issue critical to the future development of small-island states. Investments in and deployment of renewable energy technologies today are an important factor in reducing current emissions and ensuring that the world is not locked in to climate damaging technologies for decades to come. Even global temperature increases well below 2 degrees Celsius—the international threshold below which catastrophic climate impacts may be avoided—will have an enormous impact on Earth's ecosystems and human civilizations, with the world's poorest populations standing to bear 75 to 80 percent of climate change-related costs.[134]

For low-lying, small-island states, the threat of climate change is immense. Sea-level rise, reduced food security, increased water scarcity, and the growth in frequency and strength of severe storms are all tied directly to climate change and gravely threaten the region's long-term security. Within CARICOM, these threats can be magnified. These factors, combined with acute poverty and limited adaptive capacity, have led to Haiti being recognized as the world's most vulnerable nation to climate change.[135]

To mitigate this threat, countries must make a concerted effort to limit harmful CO_2 emissions. Global emissions reductions are a hotly contested subject, however, as illustrated by the slow and often contentious annual negotiations of the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP). With global negotiations at a standstill, national and regional organizations are again taking the lead in transitioning to climate-compatible development strategies by adopting emissions reduction targets.

The EU once again stands out as a primary example of combined commitments made at the regional level, mandating a 20 percent reduction in greenhouse gas emissions by 2020 from all 27 member states.[136] At the national level, many small-island states have already established ambitious goals for emissions reductions, expressed recently in coordinated action through the Barbados Declaration.

Within CARICOM, Dominica is seeking to become carbon negative through renewable energy exports and Grenada aims to reduce greenhouse gases 20 percent below business-as-usual projections by 2020. Other targets included in the Barbados Declaration include the Marshall Islands' goal of reducing CO_2 levels 40 percent below 2009 levels by 2020.[137]

A variety of metrics and methodologies can be used to set emissions reduction targets for CARICOM, each with its own unique strengths and weaknesses. Based on observed intentional experiences and regional information and data gathering, Worldwatch recommends three targets for CO_2 emission reductions within the power sector against business-as-usual projections. (See Table 18.) The proposed emissions reduction targets are based on emission projections resulting from the modeled generation mix designed for each member state to meet the adopted regional renewable energy targets (See Table 15, 16, and Annex A)

Table 18. Proposed Power Sector Carbon Dioxide Emissions Reduction Targets for the CARICOM Region

Horizon	Target Year	CARICOM Targets (CO_2 emissions reduction in the power sector against business-as-usual)
Short Term (5 years)	2017	18%
Medium Term (10 years)	2022	32%
Long Term (15 years)	2027	46%

Given the region's ambitious commitment to transforming its regional energy sector, these goals are achievable over the given time frame. In order for them to be met, however, each CARICOM member state must make a significant commitment to reducing domestic emissions. Estimates for these national commitments for the final target year (2027) are outlined in Table 19.

Table 19. Proposed National Power Sector Carbon Dioxide Emissions Reduction Targets for 2027 for CARICOM Member States

Country	Estimated CO_2 Emissions Reduction (against business-as-usual in 2027)
Antigua and Barbuda	62%
Bahamas	53%
Barbados	61%
Belize	62%
Dominica	100%
Grenada	100%
Guyana	82%
Haiti	44%
Jamaica	51%
Montserrat	100%
St. Kitts and Nevis	100%
St. Lucia	100%
St. Vincent and the Grenadines	78%
Suriname	43%

Trinidad and Tobago	29%

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Emissions reduction targets for CARICOM's power sector would benefit greatly from additional research quantifying potential emissions reductions from other key sectors. To facilitate this process and fully inform the development of effective emissions reduction measures, efforts should be made to fill all critical information gaps and to develop a more detailed overview of sectoral energy use and associated emissions across the region. Currently, this level of data is often lacking or not publicly available, making it impossible to assess the full potential for emissions reductions in all energy sub-sectors.

Further national level assessments of emissions impacts at the sectoral level can provide guidance on the future development of emission reduction strategies to be implemented within CARICOM and, potentially, pledged at the international level. This more-detailed assessment will support the development of short- to mid-term emissions reduction targets and additional long-term targets beyond 2027, establishing CARICOM as a current and future leader in the implementation of climate-compatible development strategies. Further research should highlight high-priority sectors for emissions reductions and help identify technologies available to maximize emissions reductions within CARICOM while limiting the cost to national governments. Effective monitoring and continued benchmarking must be done to ensure that member states are on track to meet their emissions reduction commitments.

6 Looking Forward: Designing and Implementing a Strategy to Achieve Regional Targets

Achieving the regional targets recommended in Chapter 5 and the commitments made under the CARICOM Energy Policy will require coordinated and strategic action on the part of both CARICOM and individual member states. Analysis across key sectors reveals critical gaps that must be filled in order for a regional Roadmap & Strategy to be developed beyond the First Phase.

Electricity

- Updated power sector generation capacity plans and strategies
- Deatiled data on power plants in operation
- Analysis of electricity end users
- Grid and storage assessments and expansion plans

Tranportation

- Updated tranportation sector plans and strategies
- Energy statistics in the transportation sector
  - Fuel use
  - Vehicle registration database

Emissions

- Updated emissions reduction plans and strategies
- Updated GHG inventories
- Sectoral emissions data

Renewable Energy and Energy Efficiency Potentials

- LCOE+
- Centralized database for RE assesments
- Assessments at higher resolutions for priority areas
- Analysis of opportunities for complementarity
- Energy Audits

Policy and Finanace

- Review of governance and administration effectiveness
- Review of policy effectiveness
- Identification of financial barriers to renewable energy within each member state

Figure 29. Regional Gap Analysis

Filling these gaps will allow for the formulation and implementation of various strategies towards achieving CARICOM's targets and will require coordinated efforts on both the regional and national levels (See Figure 17.) On the national level, individual member states must **implement domestic policy mechanisms** and **enact needed reforms** to meet their contribution to the regional target. At the same time, CARICOM can play a crucial in **coordinating these national efforts**, ensuring that the progress of individual member states is **monitored and verified**, and **providing critical support** to member states.

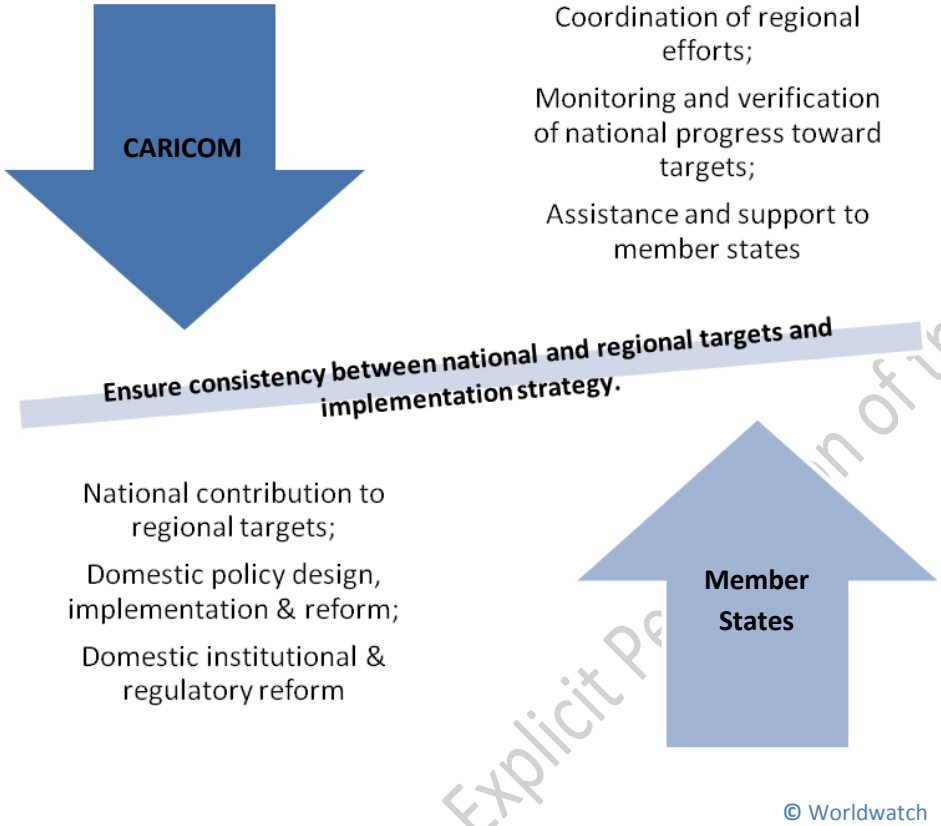


Figure 30. Achieving targets through coordinated regional and national efforts

Recommendations for Moving Forward: An outline for Regional and National Action

Based on available data regarding the region's current energy situation and the identified gaps, a number of targeted strategies could have a significant impact in mitigating existing barriers to the expansion, development and deployment of renewable energy and energy efficiency across CARICOM. The Caribbean Renewable Energy Development Programme (CREDP) aims to remove such barriers by achieving four major goals:

1. **Information:** Improve the region's energy information network by strengthening existing information systems and building awareness of renewable energy;
2. **Finance:** Identify innovative financing mechanisms for renewable energy projects, including regional loan structures and technical assistance to banks;
3. **Policy:** Support the implementation of regulatory frameworks that enable renewable energy development;
4. **Capacity:** Build technical capacity among players in the renewable energy field including project developers, financiers, engineers and technicians, policymakers and planners;

Worldwatch, using CREDP's four major goals as an organizing framework, identifies key elements of a strategic work program by which barriers could be mitigated and targets achieved. This work program

recommends priority initiatives, policies, projects and activities to be undertaken on both the regional and national levels, and indicates a preliminary timeline on which each could be achieved.

Though items across all four categories are presented individually here, in practice many rely on the successful completion of a number of complimentary actions. While successful completion of individual projects would have a significant positive impact on the region, completion of the full slate of potential activities described below would allow CARICOM to meet and likely exceed its regional sustainable energy goals. The regional approach embodied by the C-SERMS initiative ensures that no member state must take this path alone, but will instead be supported by a network of actors and institutions united under a common vision for the region's energy sector.

Table 20 Priority Initiatives, Policies, Projects and Activities (PIPPA) for CARICOM

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Reg./Nat'l/Both
	INFORMATION																
1	**Conduct and Communicate Key Resource and Technical Assessments**																
1.1.1	*Identify renewable resource assessment needs in member states*	●	●														B
1.1.2	*Commission any renewable resource assessments necessary to fill identified gaps*	●	●	●	●	●											B
1.1.3	*Assess renewable technology uses (generation, solar cooling, solar water heating, etc.)*	●	●	●	●	●	●										B
1.1.4	*Communicate key findings*	●	●	●	●	●	●	●	●								B
1.2.1	*Identify priority sectors for energy efficiency assessments (e.g., industry, households, transportation)*	●	●														B
1.2.2	*Conduct energy audits of identified target areas*	●	●	●	●												B
1.2.3	*Communicate key findings*	●	●	●	●	●	●										B
1.3.1	*Assess current grid and storage: infrastructure capabilities*	●	●	●													B
1.3.2	*Identify solutions to bridge gap between existing (1.3.1) and projected (2.3) grid and storage needs*	●	●	●	●	●	●										B
1.3.3	*Grid and storage: Communicate key findings*	●	●	●	●	●	●	●									B
2	**Conduct and Communicate Electricity System Modeling**																
2.1	*Facilitate country-specific LCOE+ modeling of all-inclusive electricity generation scenarios (incl. renewable energy, fossil fuels)*	●	●	●													B

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	R/N/B
2.2	*Calculate electricity generation scenarios examining various generation mixes (e.g., BAU,30% renewables, 50% renewables, 80% renewables) and associated socioeconomic impacts (e.g., jobs)*	●	●	●													B
2.3	*Conduct load profile analysis for overlay with modeled scenarios to determine grid and storage transition needs*	●	●	●	●												B
3	**Conduct On-Site Feasibility Studies (Community Impact, Economic Cost, Environmental Footprint, etc.) for Priority Resources Identified**																
3.1	*Assess feasibility of resources with regional potential (e.g., geothermal, offshore wind, maritime power)*	●	●	●	●	●	●	●									R
3.2	*Assess feasibility of priority resources at national level*	●	●	●	●												N
4	**Coordinate Information Gathering and Communication**																
4.1	*Identify set of key energy indicators*	●	●														R
4.2	*In cooperation with existing initiatives (CEIS, CIPORE, OLADE), fill identified energy system data gaps*	●	●	●	●	●											R
4.3	*Provide open and user-friendly access to regularly updated data*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	B
4.4	*Create (or reform) national data collection and tracking systems*	●	●	●	●												N
5	**Conduct Regional Assessment of Technological Lessons Learned**																
5.1	*Facilitate and regularly update compilation of regional experience with energy efficiency and renewable energy deployment, financing, and use*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	R
5.2	*Disseminate information to facilitate knowledge sharing*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	B

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	R/N/B
6	**Facilitate communication and outreach to the general public**																
6.1	*Implement options for more-effective communication (educational programs, energy competitions, road shows, etc.)*	●	●	●	●	●											B
	FINANCE																
7	**Coordinate International Finance**																
7.1	*Establish and maintain regional institutional structure to match key regional needs to available sources of climate finance (e.g., coordinate and bundle projects, develop NAMAs, etc.)*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	R
7.2	*Serve as regional representative and voice in international climate negotiations*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	R
8	**Develop Innovative Financing Mechanisms for Renewable Energy Projects**																
8.1	*Design and develop a regional strategy to promote financing of small- and medium-scale renewable energy enterprises*	●	●	●													R
8.2	*Design a model financing window to be implemented in commercial banks*	●	●	●													R
8.3	*Establish a dedicated renewable energy revolving fund*	●	●	●	●	●											R
9	**Develop Targeted Financing Tools to Support Key High Impact Areas**																
9.1	*Develop a Geothermal Risk Mitigation Fund for the CARICOM region*	●	●	●	●	●	●	●									R
9.2	*Support financing of new infrastructure development by conducting financial assessments for regional development needs (smart grid development, energy storage, electric vehicle charging, etc.)*	●	●	●	●	●	●										B
9.3	*Support financing for distributed renewables by designing and establishing financial mechanisms targeting the sector*	●	●	●	●	●											B

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	R/N/B
9.4	*Identify and communicate sources of funding for regional research, development, and innovation (RDI) in sustainable energy*	●	●	●	●												B
11	**Utilize Government Resources to Promote Renewable Energy**																
11.1	*Identify and implement high-impact opportunities for public procurement for renewable power generation and energy efficiency*	●	●	●													N
11.2	*Identify and implement high-impact opportunities for public procurement for sustainable transport options*	●	●	●	●	●	●	●	●	●							N
11.3	*Establish publicly backed demonstration projects*	●	●	●	●	●	●	●	●	●							N
11.4	*Support the development of public-private partnerships*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	B
	POLICY																
12	**De-Monopolize Grid Access and Encourage IPP Generation**																
12.1	*Facilitate dialogue among key stakeholders (e.g., policymakers, utilities, end-users) to identify action plan for enacting reform*	●	●	●													R
12.2	*Follow CARICOM action plan to: 1) Provide IPPs with guaranteed and priority access to electricity grids; 2) Establish independent regulatory bodies with capacity to design and enforce PPAs*	●	●	●	●	●											N
13	**Set Regional Standards**																
13.1	*Identify priority areas where regional standards can be set (e.g., building codes, technology standards, fuel efficiency standards, R&D, etc.)*	●	●														R
13.2	*Design and enact regional standards in collaboration with member states*	●	●	●													R
13.3	*Ensure that domestic policy reflects and enforces regional standards*	●	●	●	●												N

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	R/N/B
14	**Incentivize Renewable Generation Through Regulatory Reform**																
14.1	*Develop template for member states to systematically identify the most effective policy mix*	●	●	●													R
14.2	*Develop model legislation*	●	●														R
14.3	*Promote the adoption of net billing as agreed at COTED*	●	●														R
14.4	*Identify and implement renewable energy support policies. (Options to design the appropriate policy mix: Establish feed-in tariff, adopt production tax credit, establish net metering/net billing, utilize auctions/tendering, develop dedicated rural electrification programs focused on renewable power)*	●	●	●	●												N
14.5	*Identify and implement policy mechanisms specifically targeting areas/populations with limited access to electricity*	●	●	●	●												N
15	**Support Energy Efficiency Through Targeted Legislation**																
15.1	*Identify key sectors for efficiency improvements*	●	●														R
15.2	*Identify opportunities and strategies for demand-side management*	●	●														B
15.3	*Develop and enforce national building codes that promote energy efficiency*	●	●	●	●												N
15.4	*Mandate appliance labeling and efficiency standards*	●	●	●													N
15.5	*Offer fiscal incentives (e.g., rebates, tax exemptions) for energy audits and purchasing of energy efficient products*	●	●														N

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	R/N/B
16	**Implement Policies to Support the Growth of Renewable Energy in the Transportation Sector**																
16.1	*Develop standards for inter-member state transport (e.g., shipping and air travel)*	●	●	●													R
16.2	*Conduct feasibility studies for alternative transportation systems*	●	●	●													R
16.3	*Coordinate the creation of a regional biofuel market*	●	●	●	●												R
16.4	*Establish support for public transportation*	●	●	●	●												N
16.5	*Create mandates and market incentives to promote fuel-efficient and alternative-fuel vehicles*	●	●	●	●	●	●										N
17	**Ensure Policy Effectiveness**																
17.1	*Identify key policy effectiveness indicators*	●	●														R
17.2	*Track, assess, and communicate effectiveness of policy framework across member states*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	R
17.3	*Track effectiveness of domestic policy implementation*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	N
17.4	*Ensure consistent policy implementation*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	N
	CAPACITY																
18	**Coordinate International Initiatives in the Region**																
18.1	*Compile past and ongoing international studies and projects across member states*	●	●														R
18.2	*Identify areas of duplicated effort and critical gaps*	●	●	●													R
18.3	*Work with outside actors (GIZ/CREDP, IRENA, etc.) to ensure that key needs are being met within the region*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	R
19	**Build Capacities with Key Supporting Stakeholders**																
19.1	*Assess current human, institutional, and education/ training/research capacity within CARICOM to identify key capacity gaps*	●	●	●													R

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	R/N/B
19.2	*Create shared database of existing regional training materials, available training tools and curricula, education programs, etc.*	●	●														R
19.3	*Encourage development of regional professional networks including a database of trained renewable energy and energy efficiency professionals*	●	●														R
19.4	*Facilitate training and education programs for key stakeholder groups including: policymakers, financial institutions, job force, private sector*	●	●	●	●												R
19.5	*Establish renewable energy and energy efficiency technology centers throughout CARICOM (locations based on national resource potential and technological experience)*	●	●	●	●	●	●										B
20	**Improve Institutional Effectiveness**																
20.1	*Develop guiding framework for appropriate energy institution structure and operation*	●	●														R
20.2	*Assess effectiveness of existing energy institutions*	●	●	●													N
20.3	*Improve structure and operation of existing energy institutions based on regional recommendations and national assessments*	●	●	●	●	●	●										N
21	**Support and Manage Regional Electricity Interconnection**																
21.1	*Conduct feasibility studies examining interconnection scenarios*	●	●	●	●												R
21.2	*Establish enabling regulatory framework: Develop standards to coordinate electricity sector planning and operation of pooled electric systems; create mechanism for enforcing compliance with mandatory standards*	●	●	●	●	●	●	●	●								R
22	**Mainstream Renewable Energy**																
22.1	*Integrate renewable energy and energy efficiency across government planning processes*	●	●	●													N
22.2	*Ensure the participation and coordination of all government branches and departments*	●	●	●													N

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	R/N/B
22.3	*Establish an effective platform for inter-ministerial dialogue*	●	●														N
23	**Simplify Regulatory Compliance**																
23.1	*Survey regional project developers to identify onerous regulatory barriers*	●	●														R
23.2	*Assess efficiency of existing regulations*	●	●	●													N
23.3	*Enact regulatory reform that prioritizes efficiency and simplicity (e.g., establish a one-stop shop for renewable energy project development)*	●	●	●	●	●	●										N
23.4	*Communicate regulations to project developers and stakeholders*	●	●	●	●	●	●										N
24	**Maximize Societal Benefits of Sustainable Energy**																
24.1	*Identify opportunities for mutually beneficial partnerships between cultural industries and the renewable energy sector*	●	●	●													B
24.2	*Develop programs to ensure that women benefit from sustainable energy and can participate fully in energy transition*	●	●	●													B
25	**Promote Capacity in Research, Development, and Innovation (RDI)**																
25.1	*Create platform for Science, Technology, and Innovation (STI) associations (institutions, researchers, public and private sector agencies, tertiary institutions, etc.) engaged in sustainable energy to encourage communication and build constructive partnerships across countries and relevant disciplines*	●	●	●													R
25.2	*Develop R&D training programs in collaboration with regional STI associations*	●	●	●	●												R

Recommendations identifying regional and national actions that will have the greatest impact across CARICOM are not always equally applicable to each of the 15 member states. In fact, a number of member states have already begun to distinguish themselves as leaders with respect to many of the categories outlined above. Based on a detailed assessment of unique local conditions, policy development should therefore focus on the most critical areas within each member state (See Table 21).

Table 21. Priority Action Areas for CARICOM Member States

	Concrete Policies and Mechanisms				
	IPP Reform	Generation Incentives	Incentive for Rural Renewables	Maximizing Energy Efficiency	Renewable Energy in Transportation
Antigua and Barbuda	■	■		■	■
The Bahamas	■	■		■	■
Barbados				■	
Belize	■	■	■	■	■
Dominica		■		■	■
Grenada				■	■
Guyana	■	■	■	■	■
Haiti	■	■	■	■	■
Jamaica	■			■	
Montserrat	■	■		■	■
St. Kitts and Nevis		■		■	■
St. Lucia				■	■
St. Vincent and the Grenadines		■		■	■
Suriname		■	■	■	■
Trinidad and Tobago	■	■		■	

Overview of Important Products from Existing Regional Sustainable Energy Initiatives

The information and recommendations contained in this report are based on an analysis of the numerous sustainable energy development activities already underway within CARICOM. Moving forward, it is crucial that these existing initiatives and the knowledge they have generated be integrated and expanded as the next slate of relevant projects, initiatives, policies and activities are developed and implemented under C-SERMS. In the ongoing effort to maximize resources and build on existing regional knowledge and capacity to achieve the vision established by the CARICOM Energy Policy, these initiatives may serve as a valuable point of departure.

The Caribbean Renewable Energy Development Programme (CREDP), which commenced in 2004,[vi] is a cornerstone example of sustainable energy initiatives in the region. Since its inception CREDP has served as an important catalyst for advancing renewable energy in CARICOM. Arising from the CREDP project and subsequent regional level initiatives—such as the Caribbean Renewable Energy Capacity Support (CRECS) project executed by the CARICOM Secretariat, the Caribbean Sustainable Energy Programme (CSEP) executed by OAS, etc—a number of important products have been produced to support

[vi] The UNDP component of CREDP ended in 2009 while the GIZ component extended until 2013

renewable energy development. To help establish a baseline of relevant work being done throughout the region, a summary of important outputs from various initiatives over the past decade is shown in Table 22.

Table 22. Overview of Important Products from Existing Regional Sustainable Energy Initiatives

INITIATIVE/PROJECT	IMPLEMENTING BODY	RELEVANT OUTPUT	COMMENTS
CARICOM Energy Programme/ C-SERMS	CARICOM Secretariat	1. Quarterly regional coordination meetings among relevant sustainable energy partners/projects/initiatives 2. CARICOM Energy Week 3. Framework Document for Research, Development & Innovation in Sustainable Energy in CARICOM 4. C-SERMS Platform	Where relevant, will be made available on www.cc-energyprogramme.org
	CREDP/UNDP/GIZ	1. Caribbean Information Portal on Renewable Energy (CIPORE) 2. *Baseline Study of Energy Policies and Legislation in Selected Caribbean Countries* 3. Standards and assessment instruments for Technical Vocational Education and Training (TVET) assessors and trainers for Solar Water Heating installation and maintenance 4. Energy Week in the Caribbean – A Guide for Organizers	www.cipore.org Will be made available on www.cc-energyprogramme.org www.credp-giz.org
Eastern Caribbean Energy Labeling Project (ECELP)	CREDP/GIZ	1. Customer's Guide – Energy Efficiency of Household Appliances 2. Retailer's Guide - Energy Efficiency Labels for Household Appliances 3. Flyers on energy efficiency standards and labels for appliances, labels and illuminants	www.ecelp.org www.ecelp.org www.ecelp.org
Caribbean Renewable Energy Capacity Support (CRECS)	CARICOM Secretariat	1. Model electricity and energy sector laws and primary and secondary laws at national level with renewable energy focus 2. MSc. RE Programmes at UWI 3. Communication strategy development for energy-related programme in the Caribbean - Guidelines for Implementers 4. Model Caribbean sustainable energy public awareness	Will be made available on www.cc-energyprogramme.org Will be made available on www.cc-energyprogramme.org Will be made available

INITIATIVE/PROJECT	IMPLEMENTING BODY	RELEVANT OUTPUT	COMMENTS
		programme 5. Network of R&D Institutions to Support RE 6. Strategy for the promotion of Solar Water Heating in CARICOM Member States	on www.cc-energyprogramme.org Will be made available on www.cc-energyprogramme.org
Caribbean Sustainable Energy Programme (CSEP)	CARICOM Secretariat/OAS	1. Caribbean Educator's Guide to Sustainable Energy Education and Awareness 2. Teachers' Resource Booklet for Integrated Instruction in Sustainable Energy 3. Learn and Save Booklet 4. Financiers' Guide to Sustainable Energy Lending in the Caribbean 5. Energy Efficiency Guidelines for Office Buildings in Tropical Climates	All documents will be made available on www.oas.org/dsd
Caribbean Policy Research Institute (CaPRI) Renewable Energy Project	CaPRI	1. Country-specific database for potential investors on technology options, costs, and performance characteristics of typical RE systems 2. Country profiles related to the RE-investment environment, including databases on RE-related policies, regulation, incentives, availability and suitability of financing 3. Cost-benefit analysis tool to identify viable/ near viable technologies and analyze the impact of financing conditions on viability, to raise awareness amongst financiers and potential adopters of RE technologies 4. Tool for policymakers to analyze the impact of alternative policy options on RE project viability	Work in progress Work in progress Work in progress Work in progress
CARILEC Energy Efficiency and Renewable Energy Project	CARILEC/IDB	1. Model Power Purchase Agreement	www.carilec.com
UN ECLAC Renewable Energy Project		1. Identification of fiscal and regulatory barriers in selected Caribbean countries: Bahamas, Guyana and Suriname	
SIDS DOCK	SIDS DOCK	1. Strategy Paper for Policy Harmonization	Work in progress –

INITIATIVE/PROJECT	IMPLEMENTING BODY	RELEVANT OUTPUT	COMMENTS
		2. National Financing Mechanism Guidebook 3. SIDS Appropriate Sustainable Energy Technology Assessment 4. SIDS Public Education and Awareness Program	will be available at www.sidsdock.org
Sustainable Energy Technical Assistance (SETA)	OECS/CDB	1. OECS Sub-regional Energy Efficiency Strategy complemented by National Energy Efficiency Strategies and Action Plans 2. Model legislation including regulations and rules for energy management	Work in progress Work in progress will be available at www.oecs.org

Note: List of compiled activities based on communication with the CARICOM Secretariat

Looking Ahead: Immediate Next Steps in the Sustainable Energy Transition for CARICOM

The ambition demonstrated by CARICOM's 15 member states in adopting the CARICOM Energy Policy and committing to regional renewable energy targets forecasts a bright future for the Caribbean. As demonstrated, however, a great deal of work remains to be done. The projects, policies and initiatives recommended and outlined here represent a strategic program for making this vision a reality. Each member state, with the support of CARICOM, must now begin the process of translating their ambitious regional commitments into **tangible action** at the regional and national level.

The success of the CARICOM Energy Policy and the realization of the energy transformation it embodies will rely on all 15 member states making sustained, collaborative progress over the coming years. CARICOM can play a key role in ensuring that this process is cohesive and effective by developing and implementing a systematic and transparent process for facilitating and monitoring action.

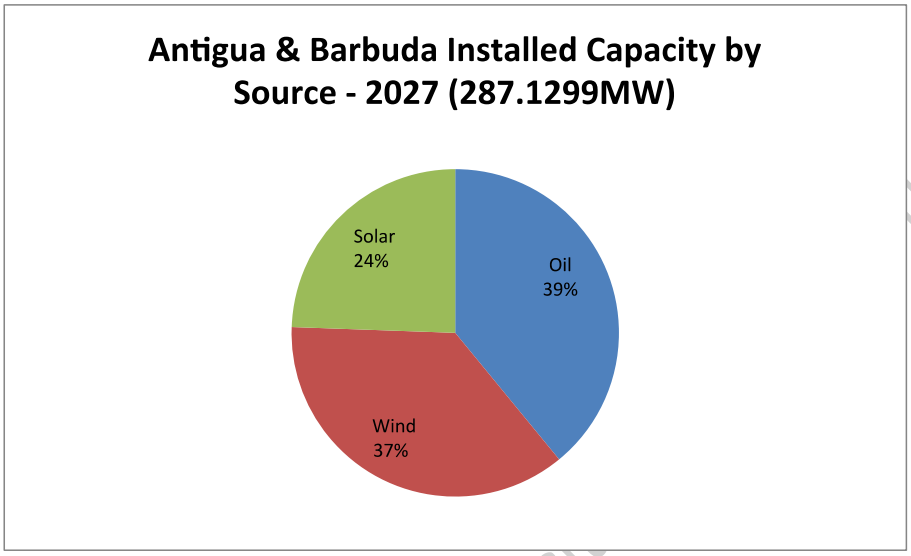
To do this, international best practice suggests the development of National Implementation Plans and a systematic monitoring and evaluation framework to standardize renewable energy and energy efficiency development and deployment across the region (See Table 23). Worldwatch recommends three priority steps for CARICOM: 1) **develop and communicate a standardized framework methodology for** developing implementation plans to be applied across the region, 2) **support the development of national implementation plans**, and 3) **devise and implement a transparent system for monitoring and supporting national actions.** Together, these three things will help ensure that as national, regional and international actors embark on the priority projects and initiatives outlined in this report, efforts across the region are coordinated and consistent – and that member states can access the support they need to contribute to regional goals.

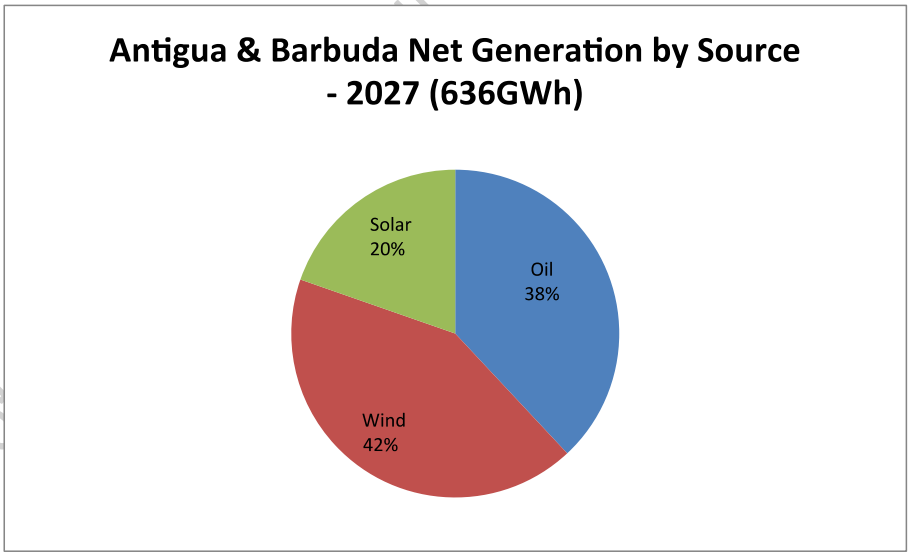
Table 23. Immediate Next Steps in Facilitating the Transition to Sustainable Energy in CARICOM

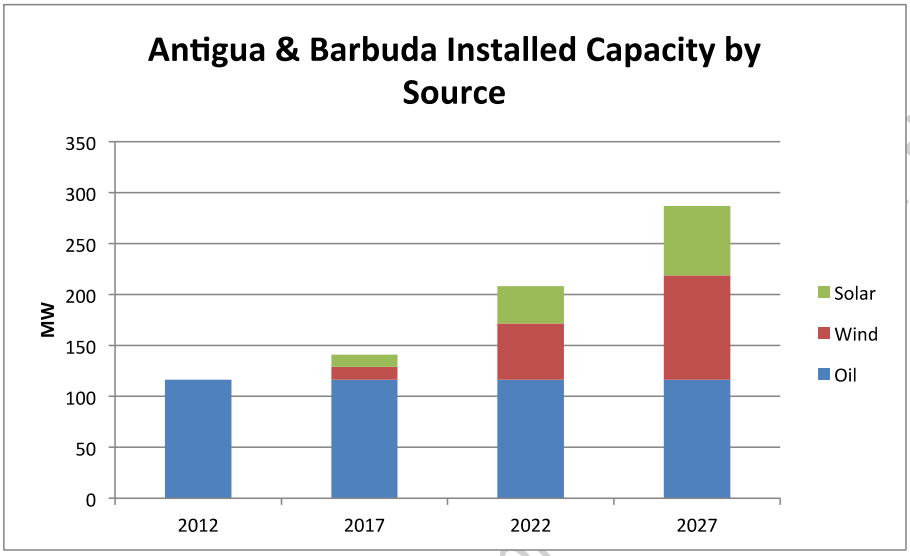
Goals/Objectives and Specific Measures to Implement	Schedule															Reg./Nat'l/Both
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	
Develop Frameworks for National Implementation Plans																
Ensure coordinated progress towards achieving CARICOM Energy Policy goals by developing a standardized template for member states to enact new national implementation plans where none exist, or update existing plans to meet regional goals	○	○														R
Facilitate process by which regional targets are translated into national targets	○	○														R
Communicate and train national policymakers on using the developed framework methodology		○														R
Support the Development of National Implementation Plans																
Develop national implementation plans under the framework provided by CARICOM, including nationally appropriate targets and strategies to ensure coherence between national policy and CARICOM energy goals		○	○	○												B
Monitor and Support National Actions to Meet Regional Energy Policy Goals																
Design a systematic process for tracking progress toward regional goals, including: setting major benchmarks and identifying key energy sector indicators	○	○														R
Identify appropriate platform for collaborative MRV by CARICOM and individual member states	○	○														
Develop and implement a systematic process for tracking and assessing national progress		○	○													B

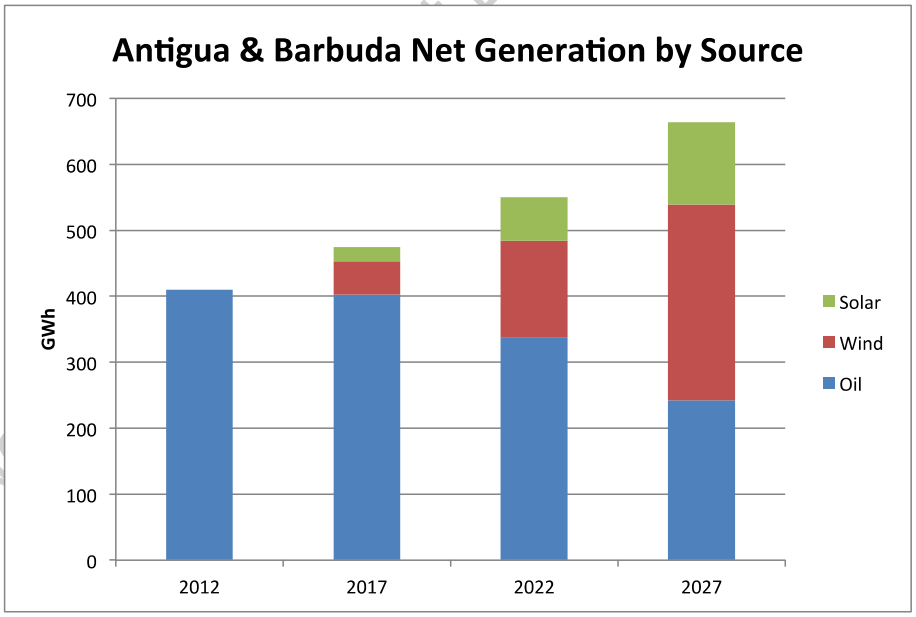
Although sustainable energy solutions have made great strides in the Caribbean, many significant gaps and barriers remain. In the coming decades, however, **these barriers - to energy access as well as renewable energy, energy efficiency, and reliable grid development and deployment - can be overcome**.

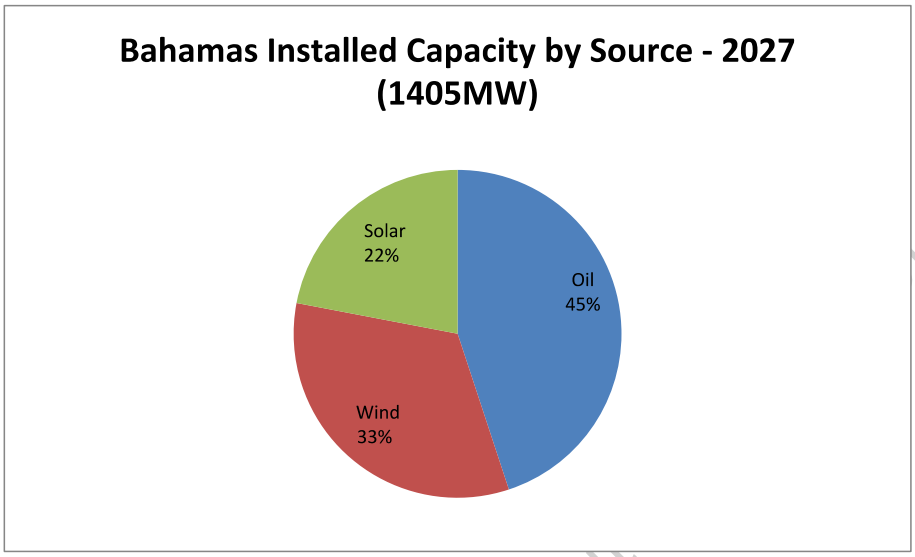
Through a cohesive regional effort coordinated and led by CARICOM and fully supported by each of its 15 member states, the region can sure that no member state will have to do this alone but will instead be supported by a network of actors united under a common vision for the Caribbean energy sector. While the full transformation of CARICOM's energy sector will be a long-term process, the priority areas identified in this *C-SERMS I* report simultaneously represent urgent needs and opportunities for rapid progress. If implemented, the matrix of projects, policies, and initiatives listed here will result in effective and efficient sustainable energy development, making CARICOM a global sustainable energy leader.

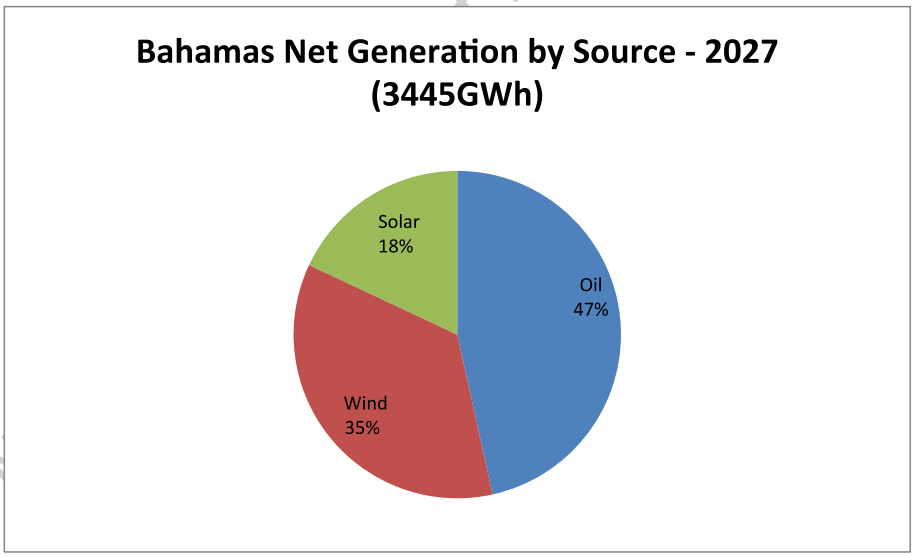


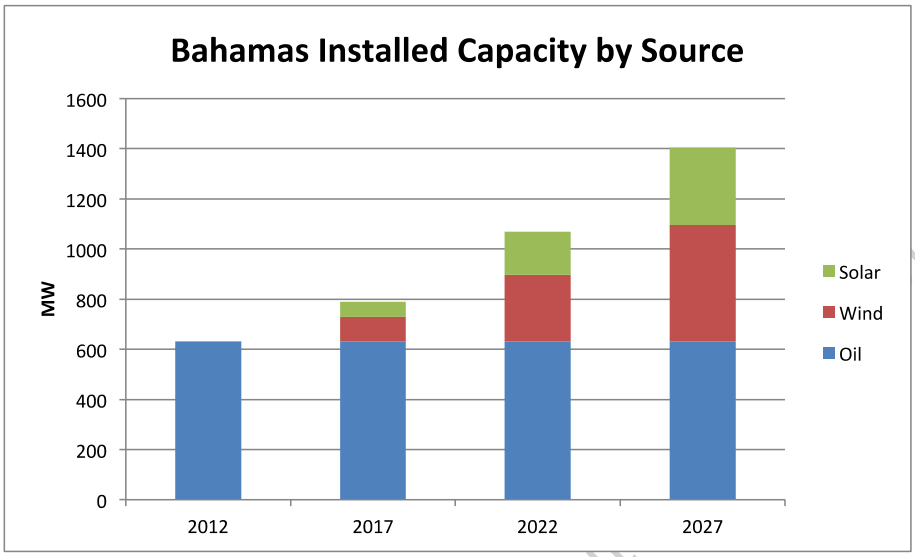


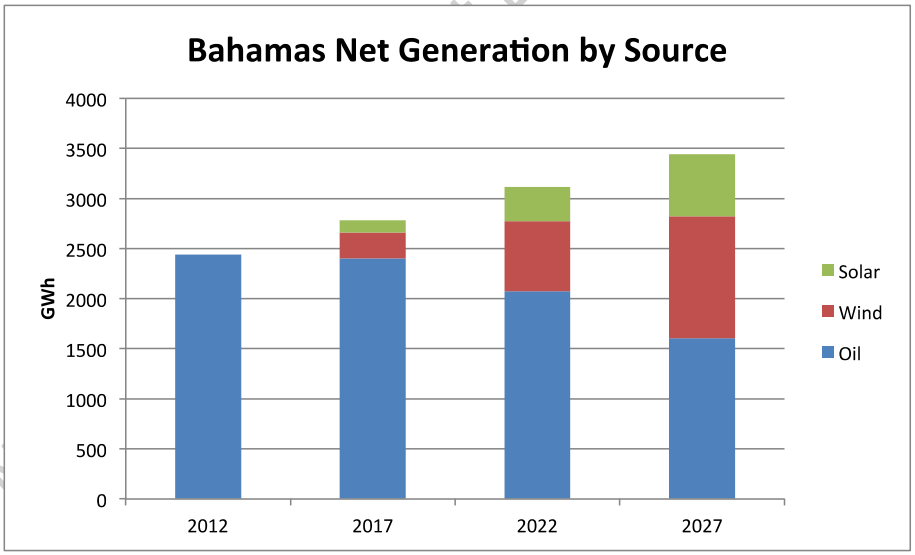


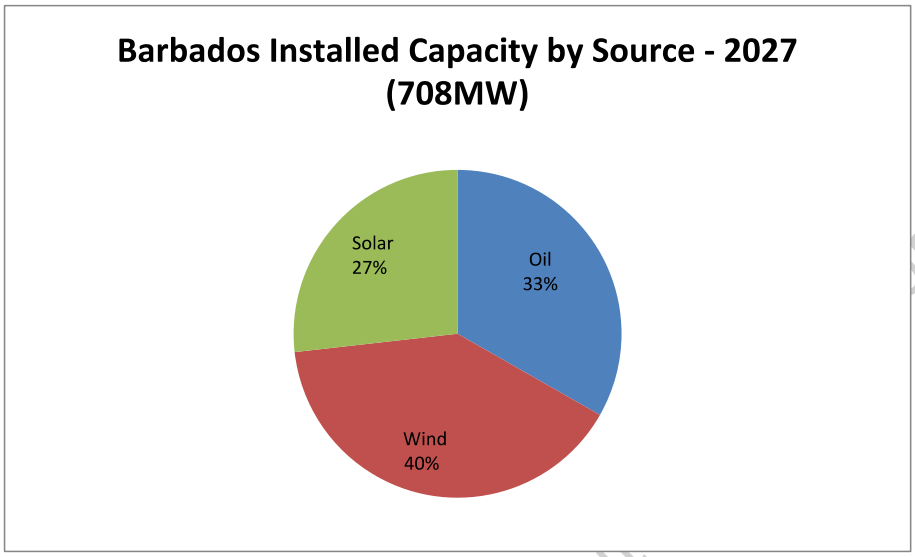


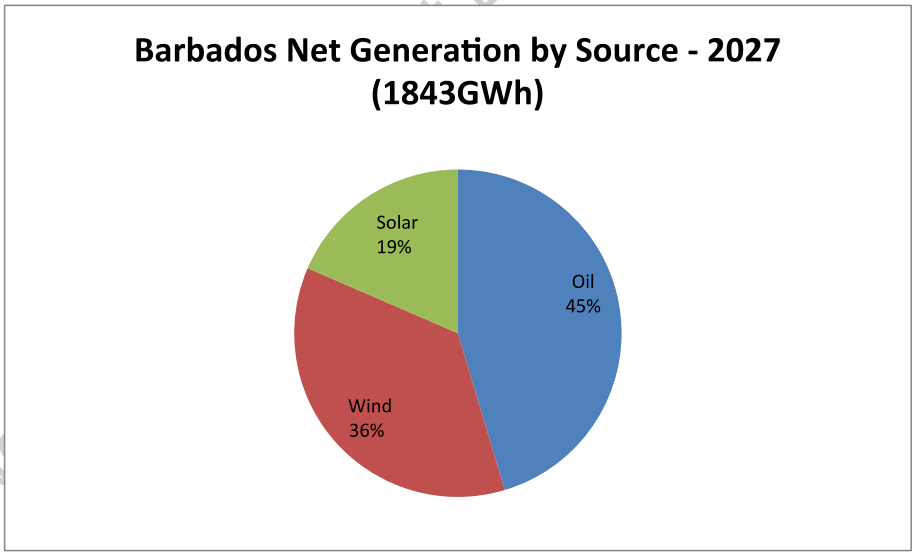


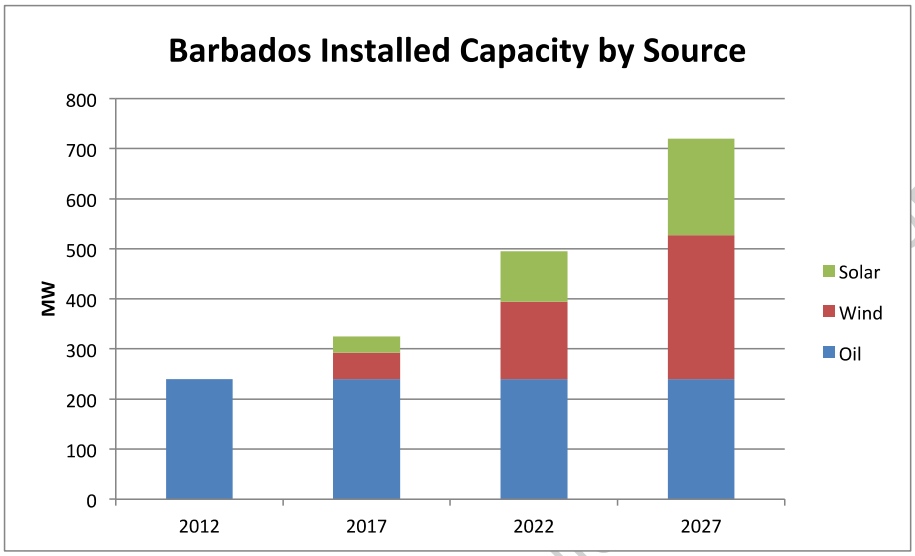


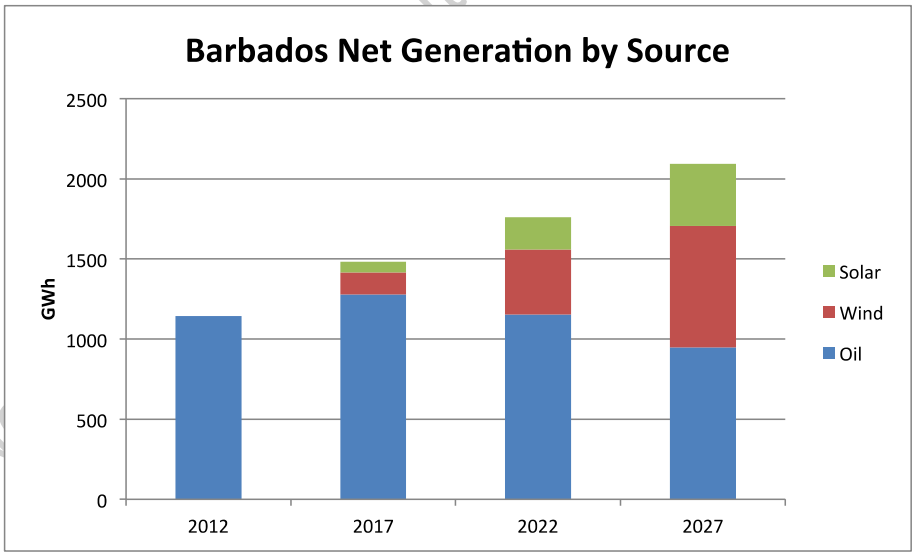


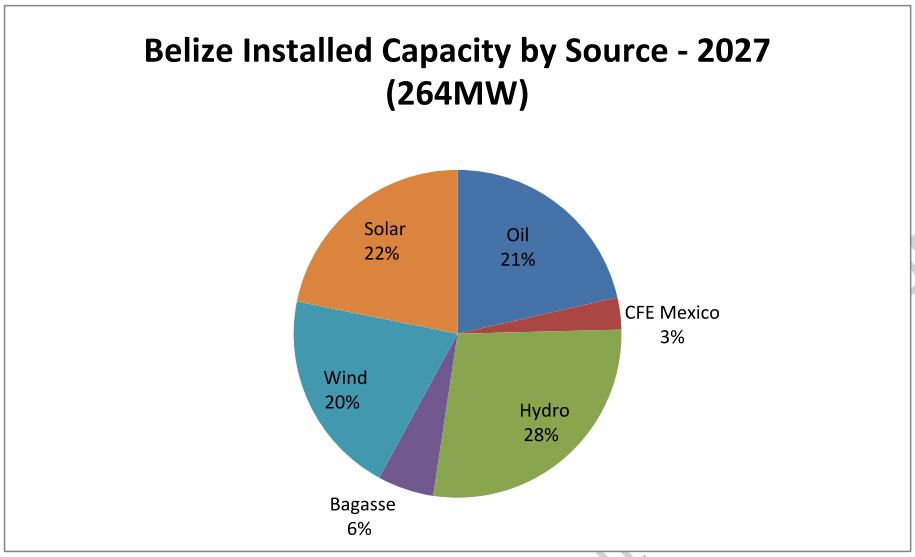


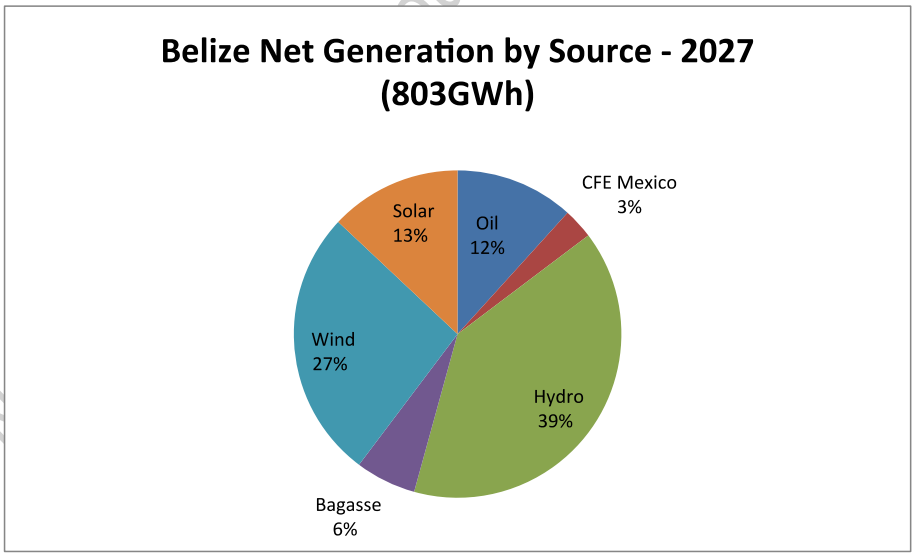


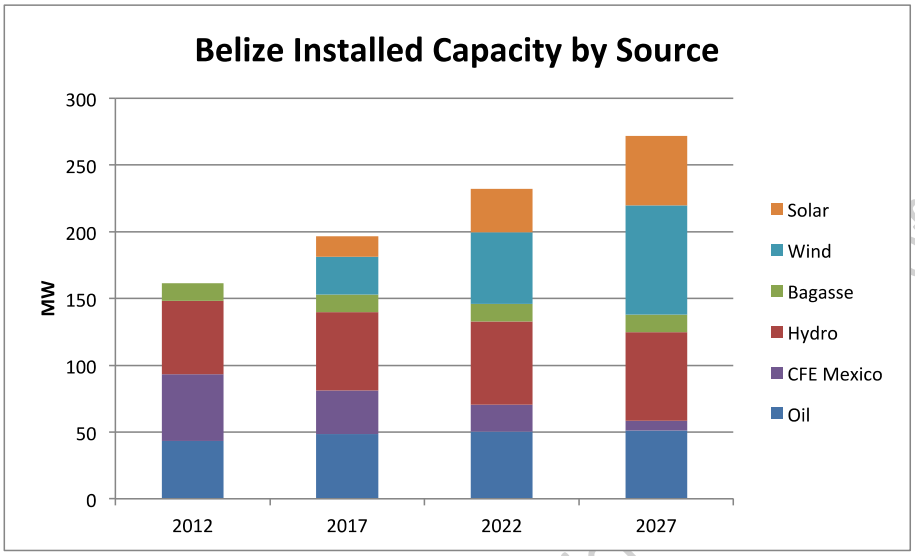


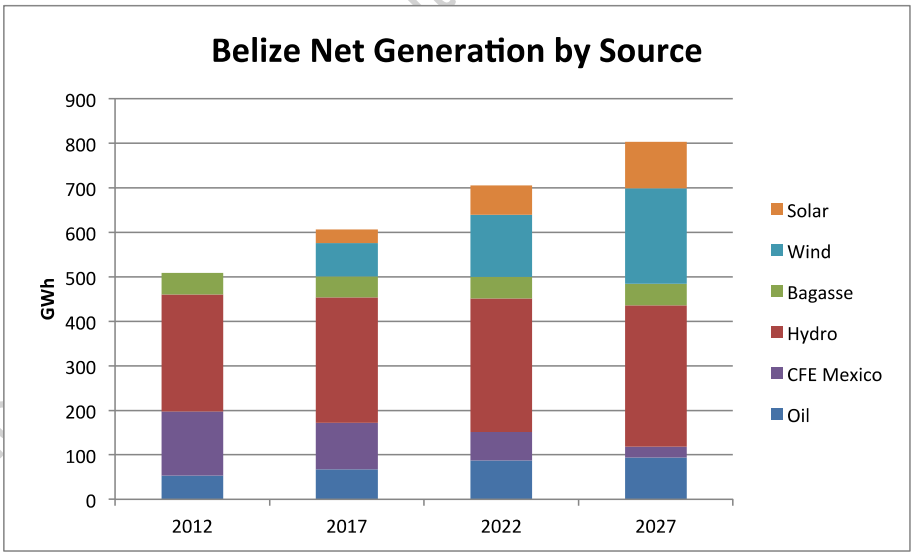


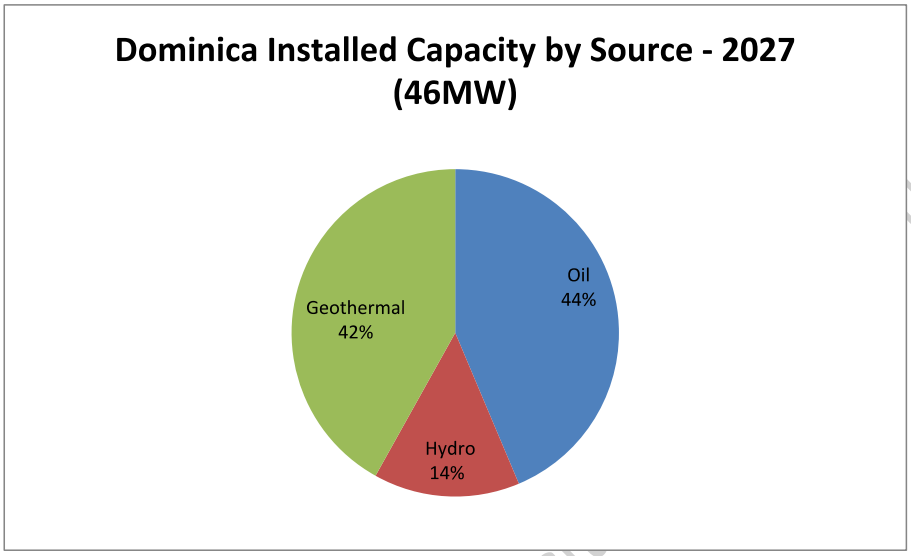


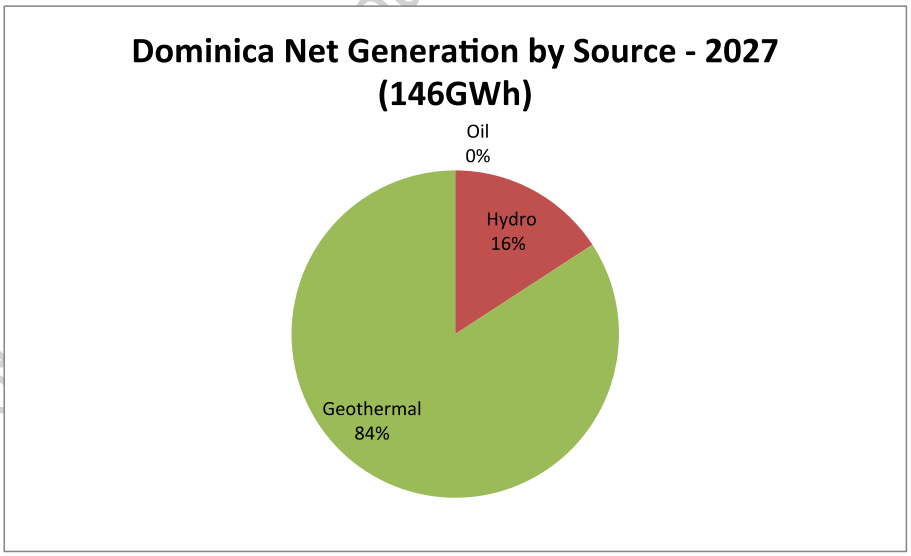


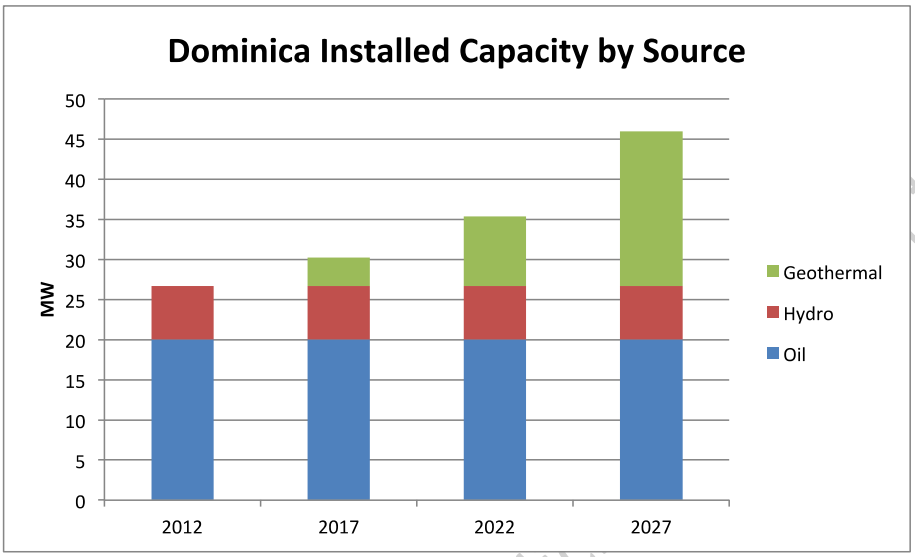


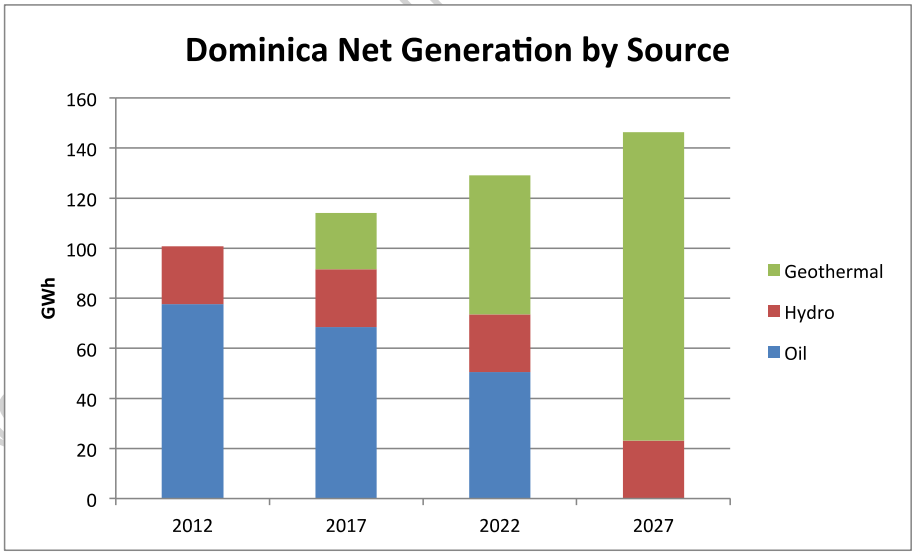


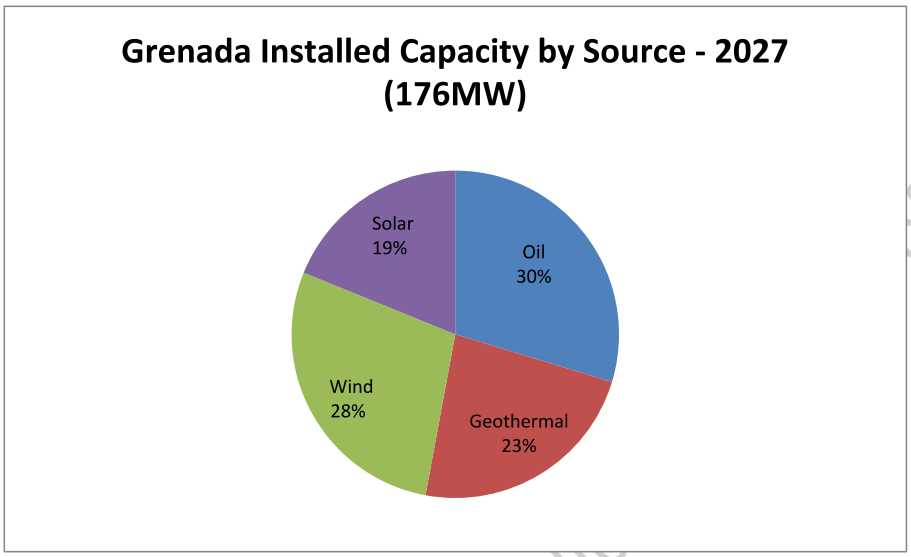


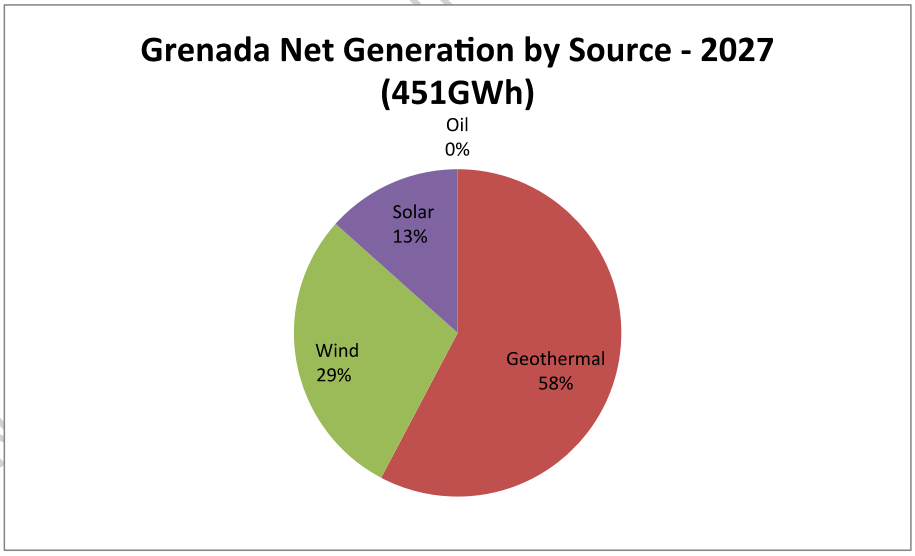


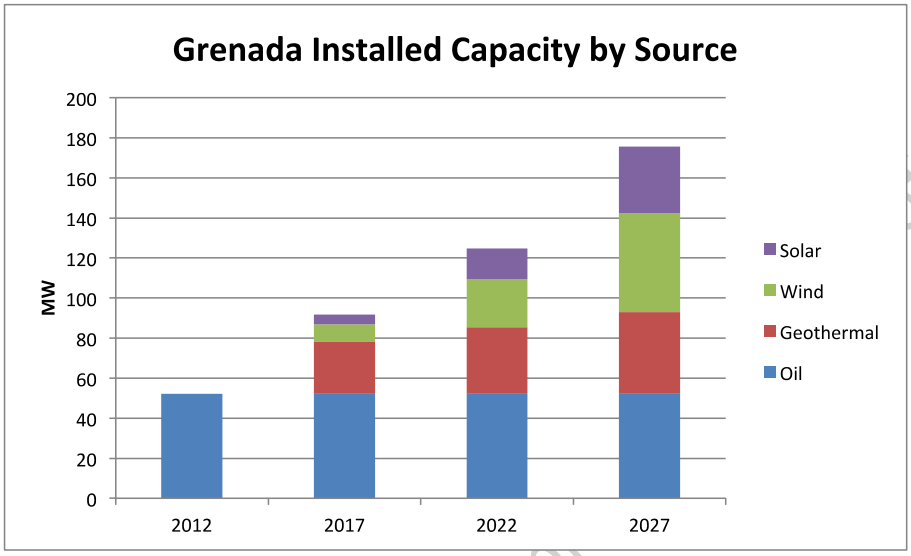


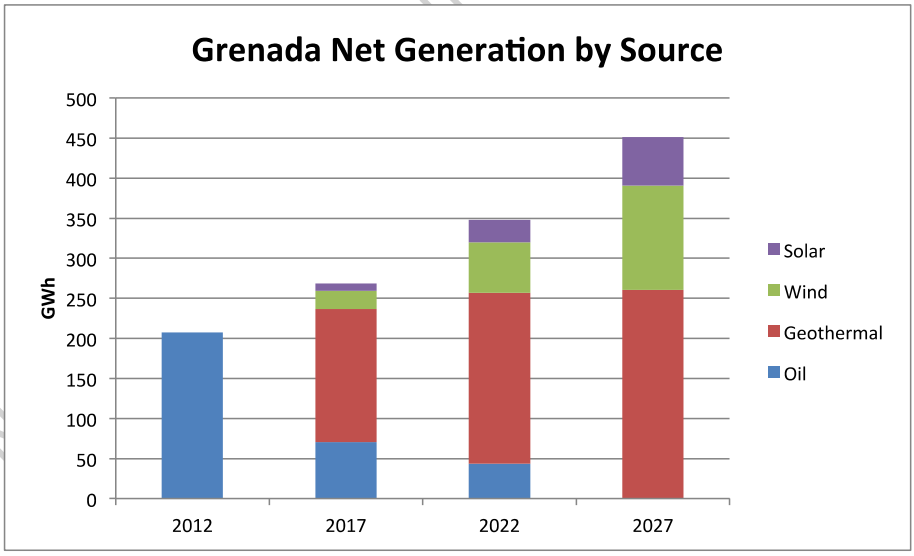


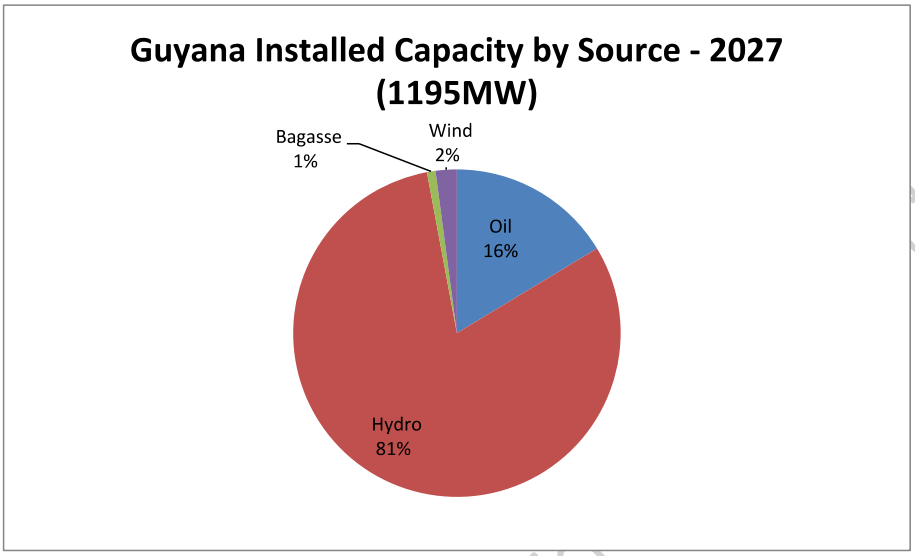


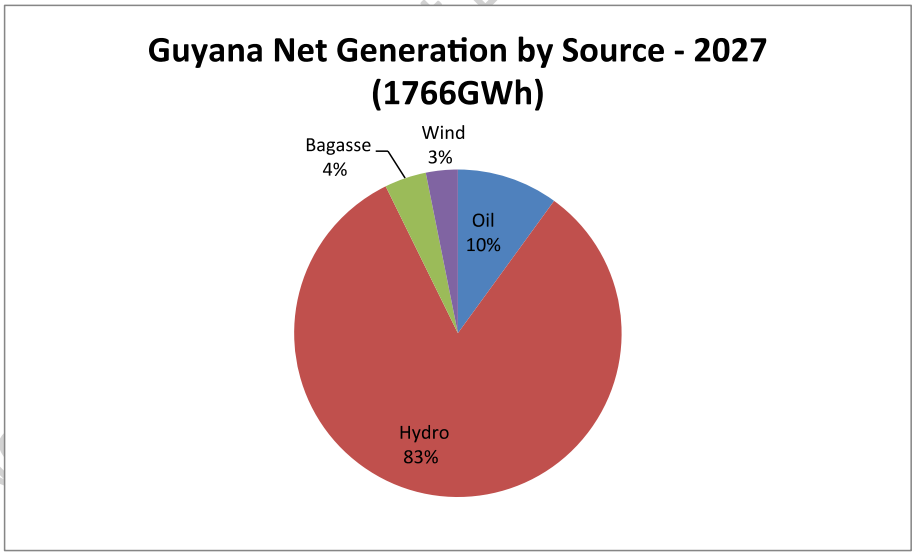


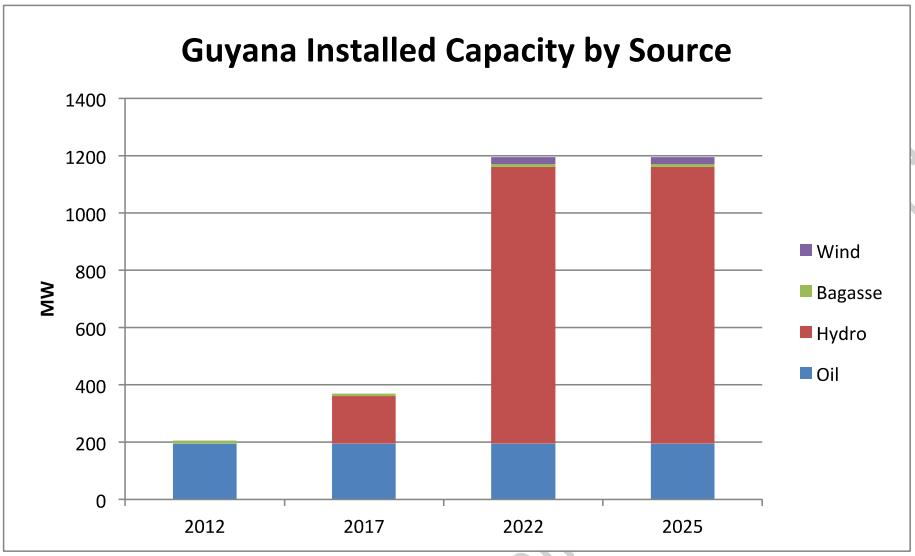


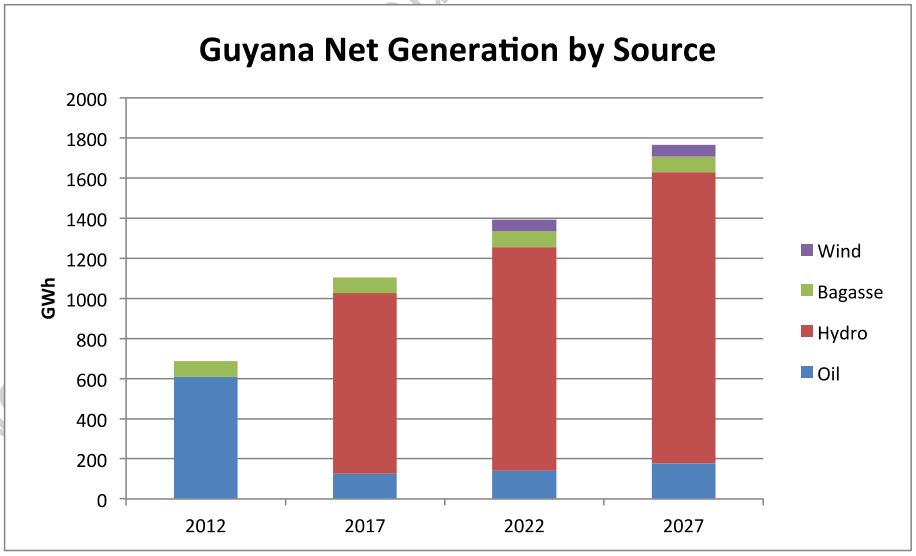


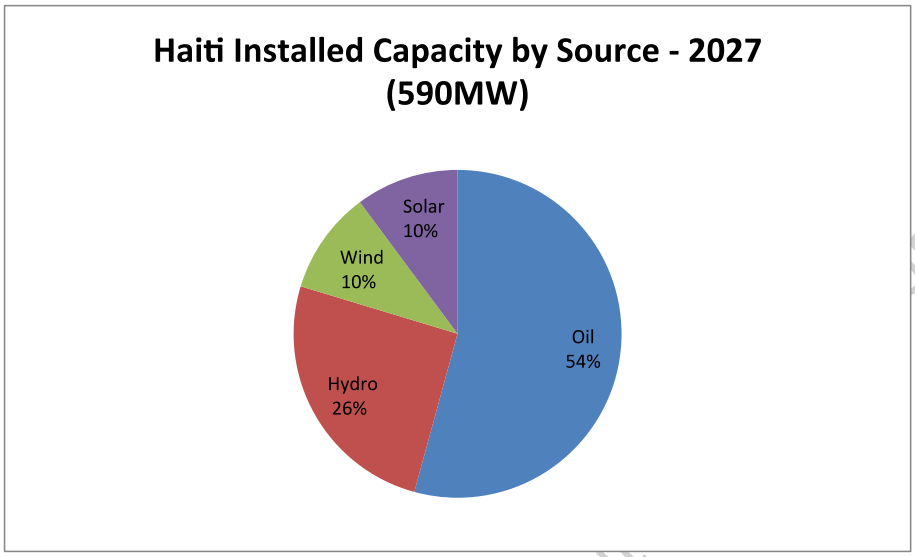


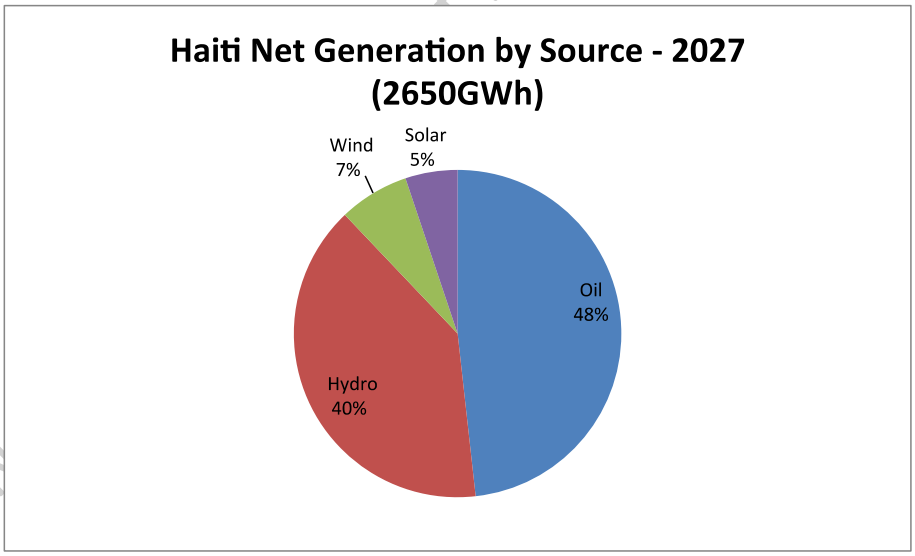


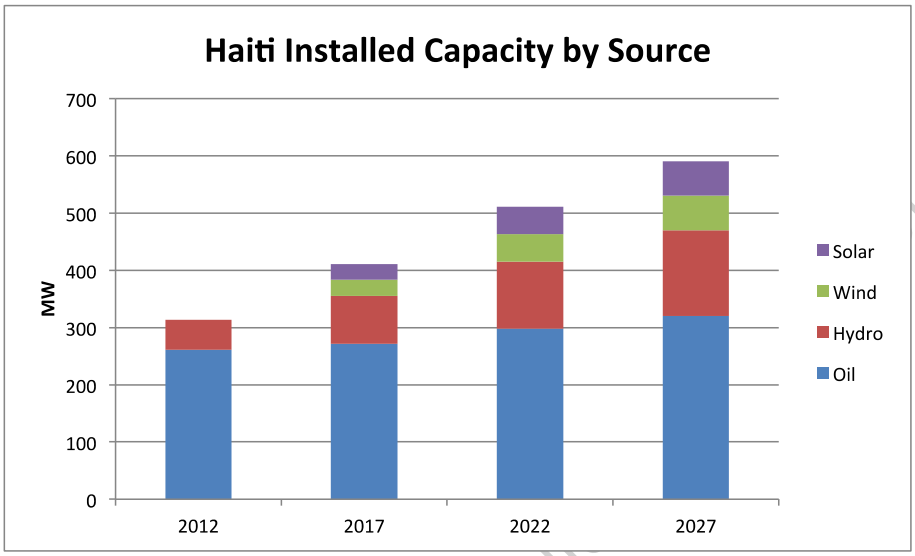


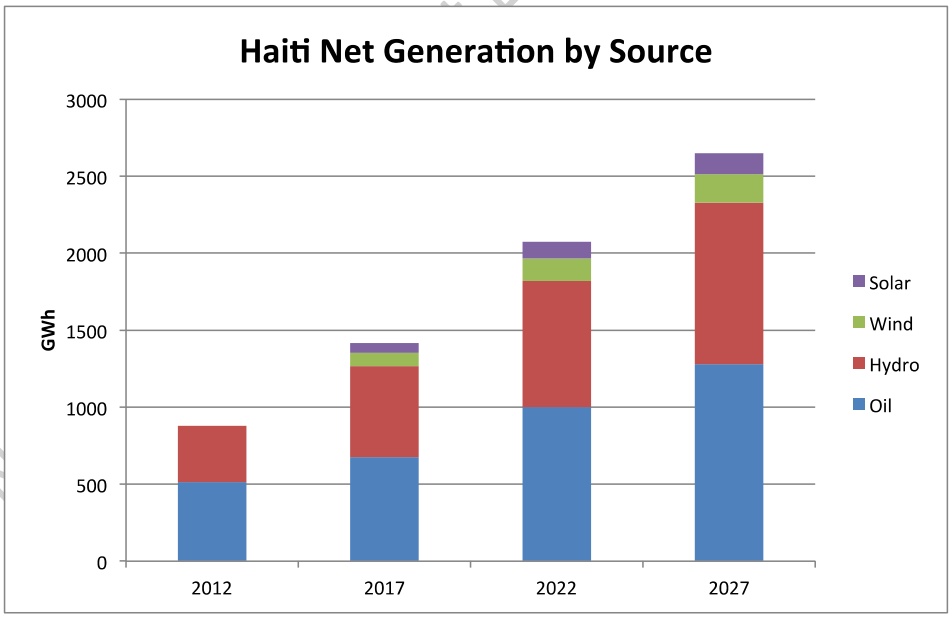


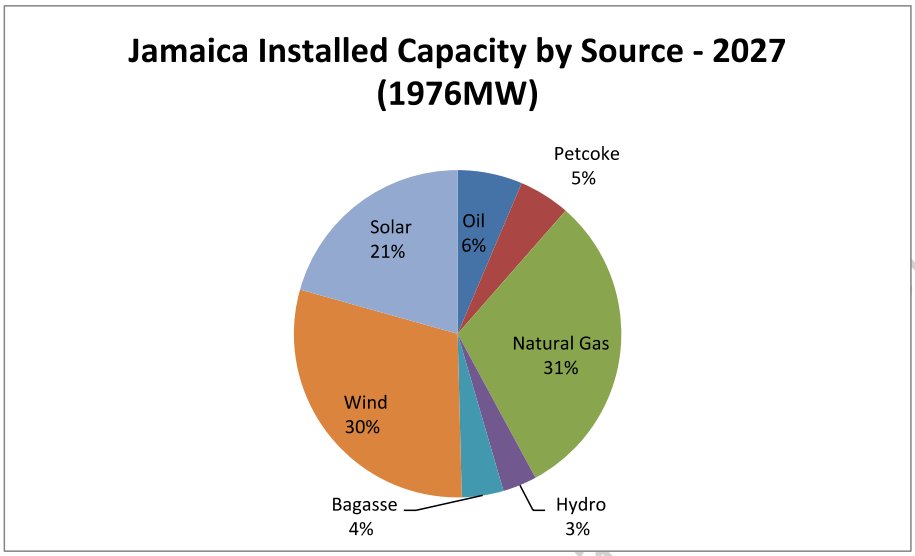


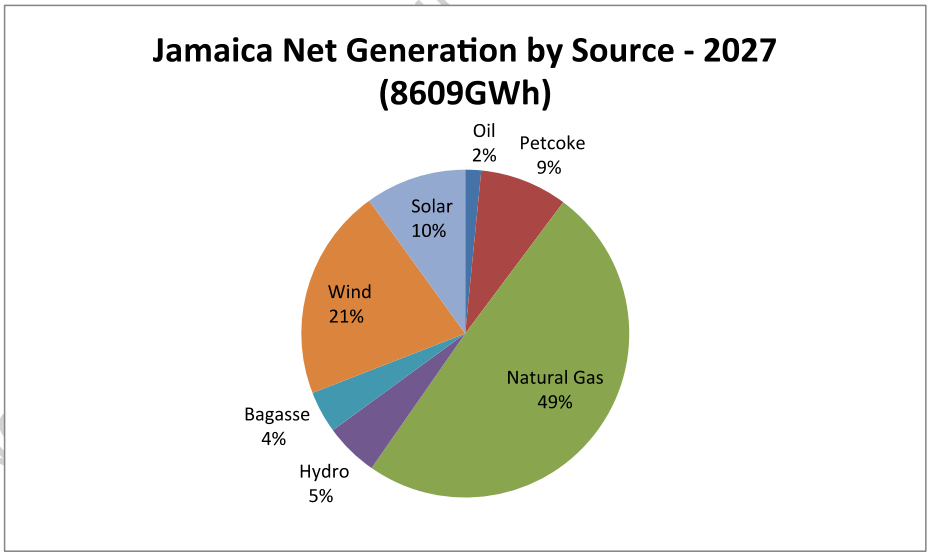


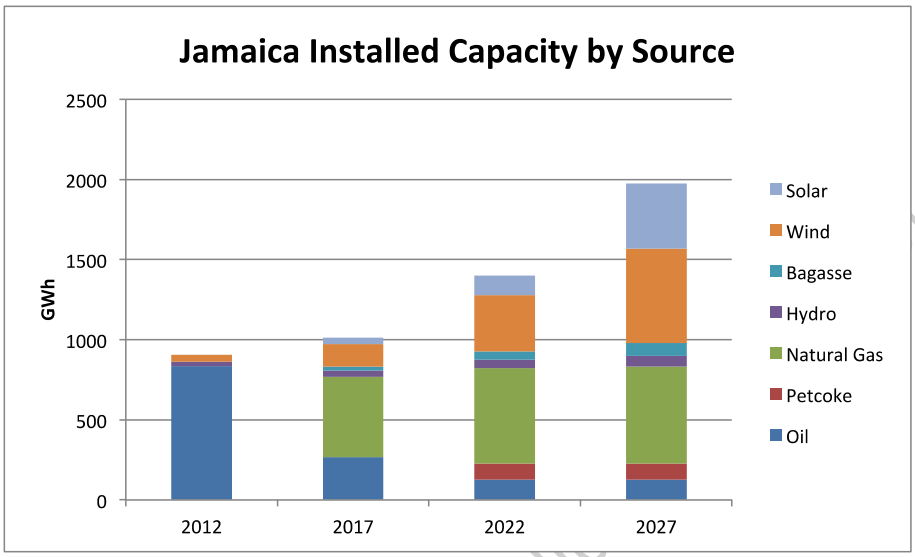


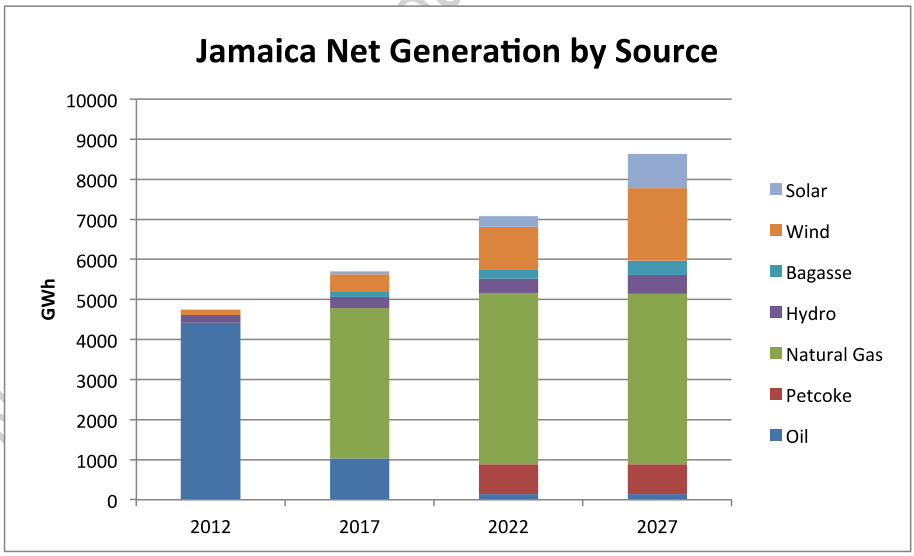


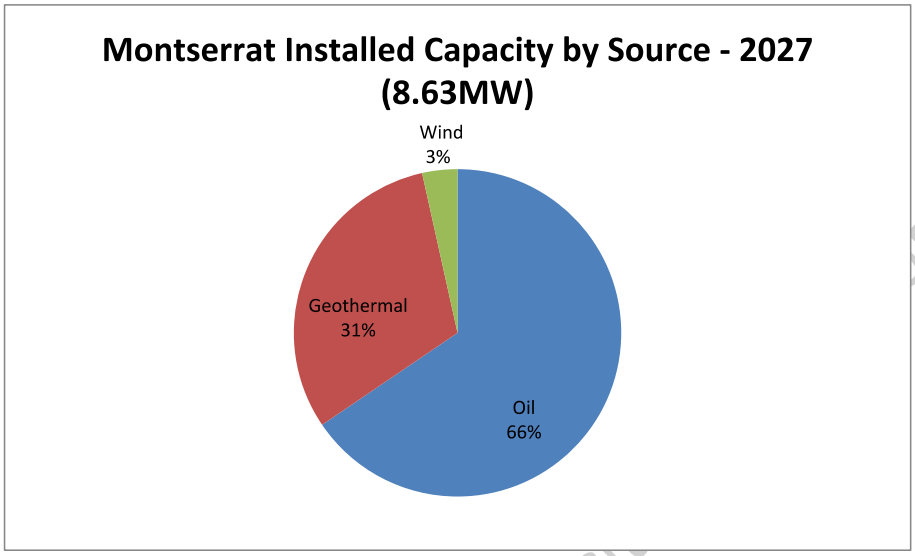


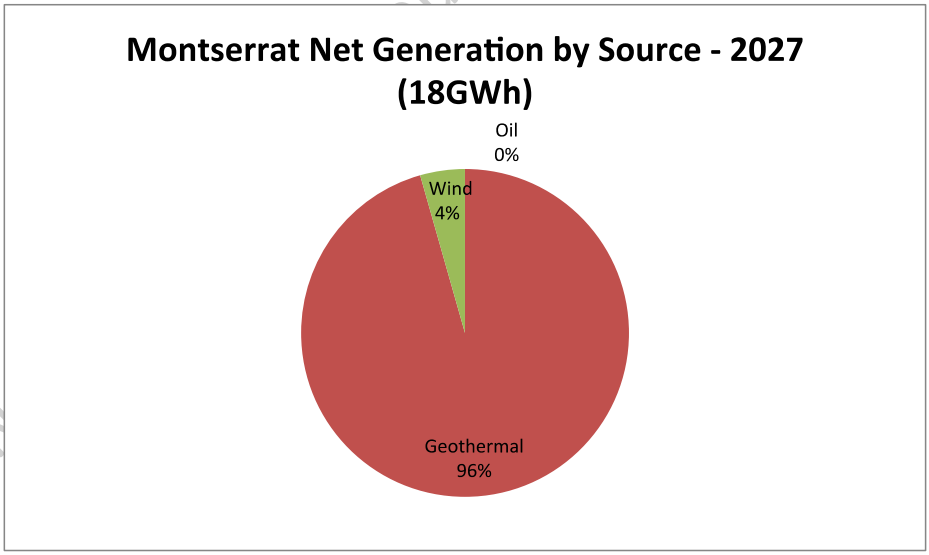


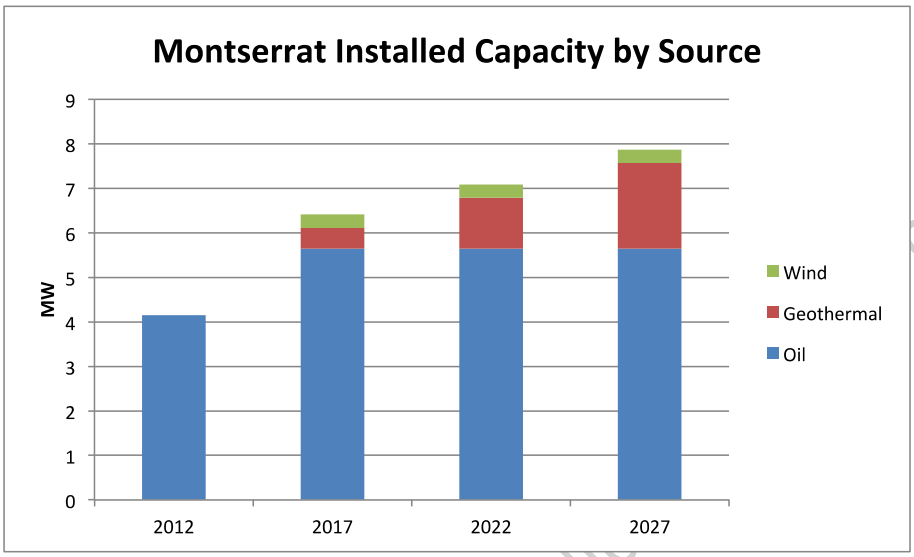


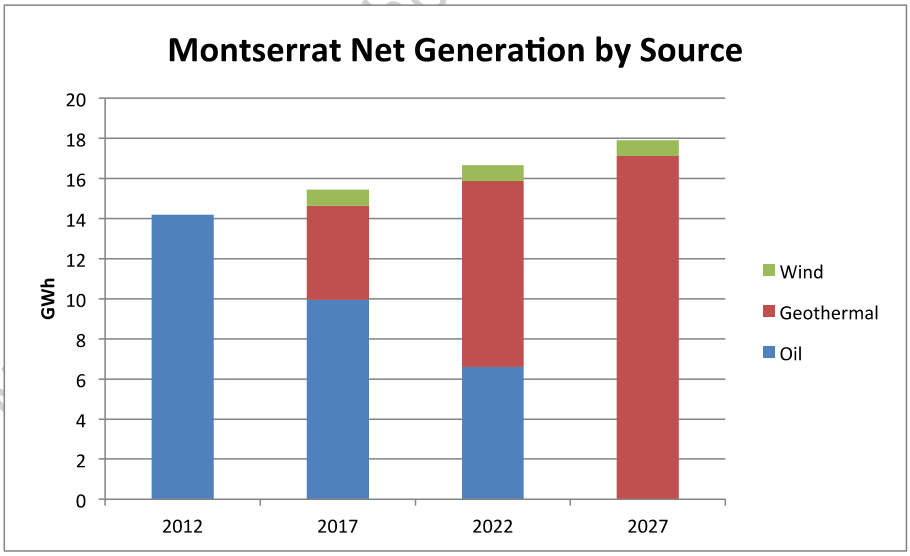


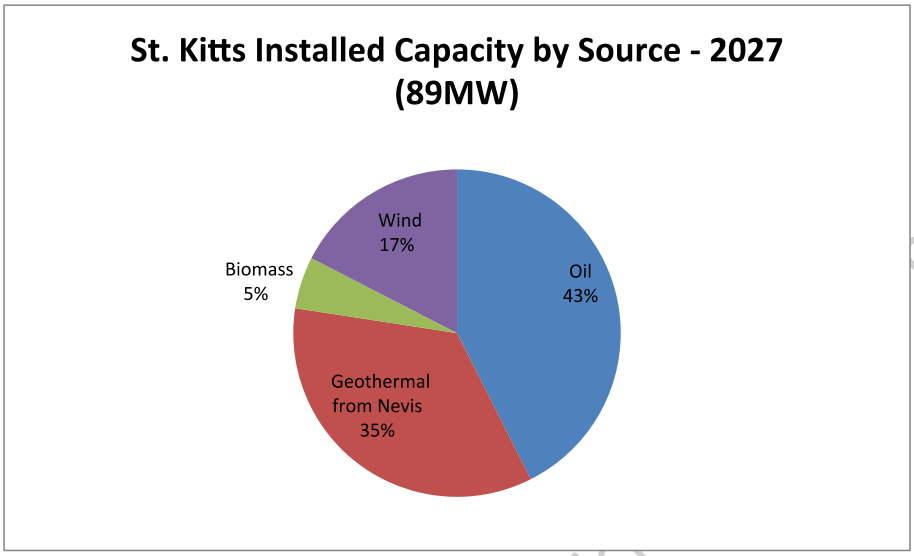


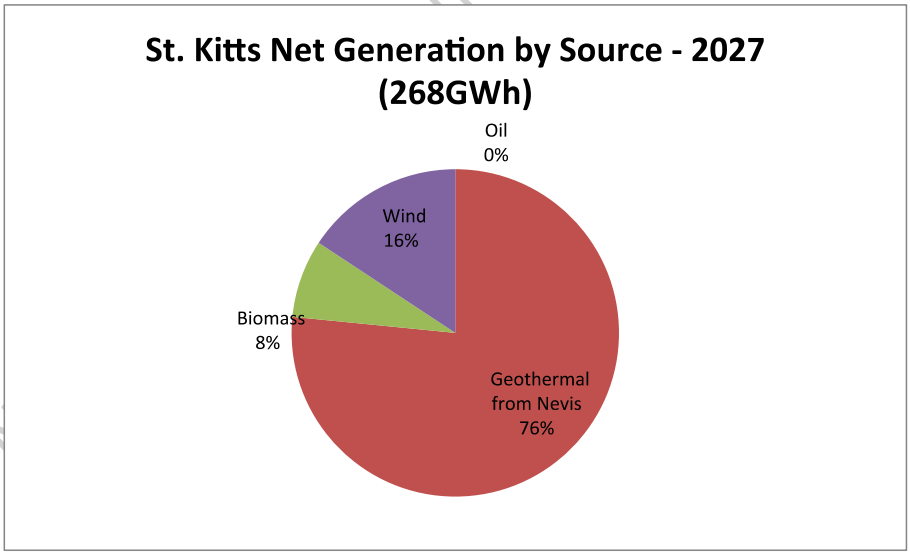


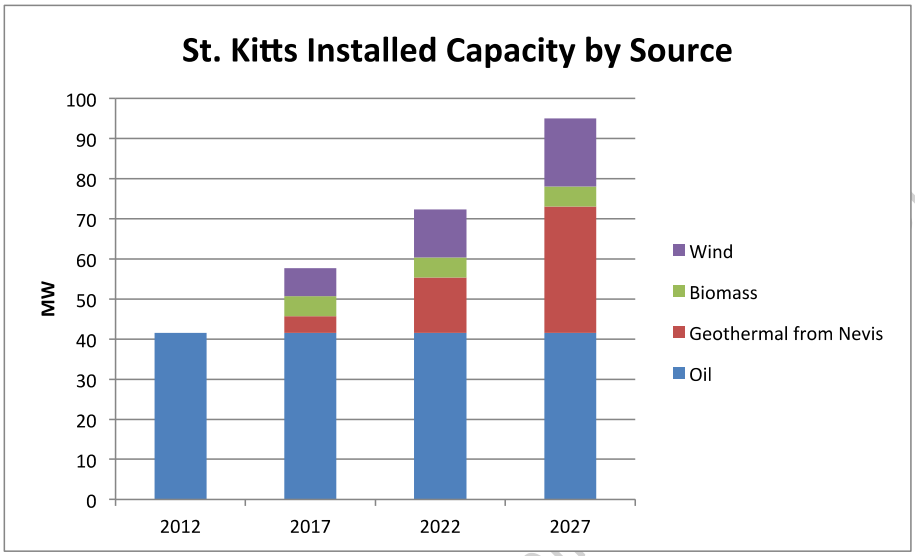


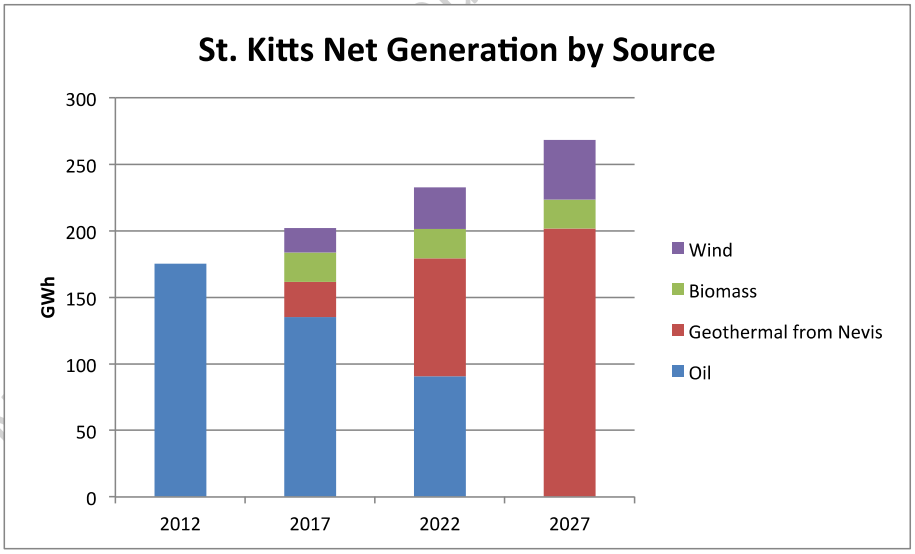


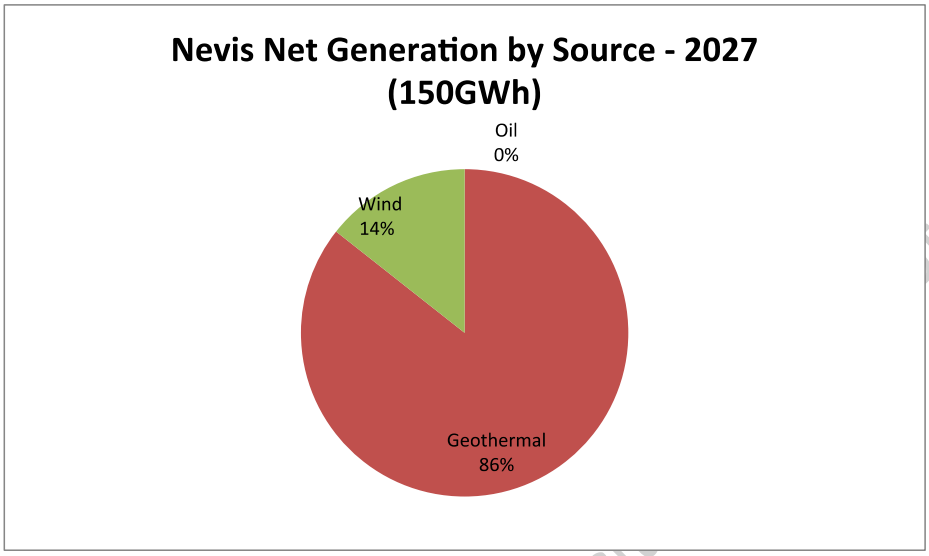


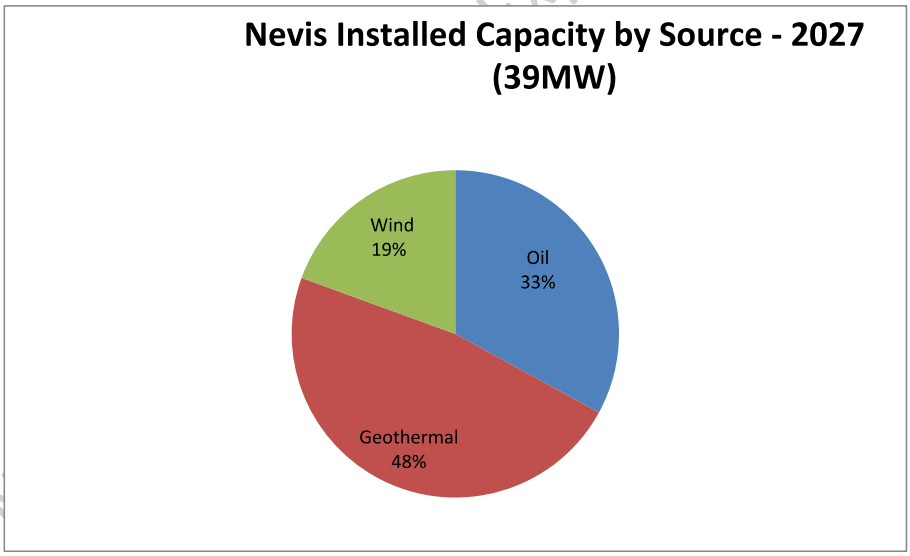


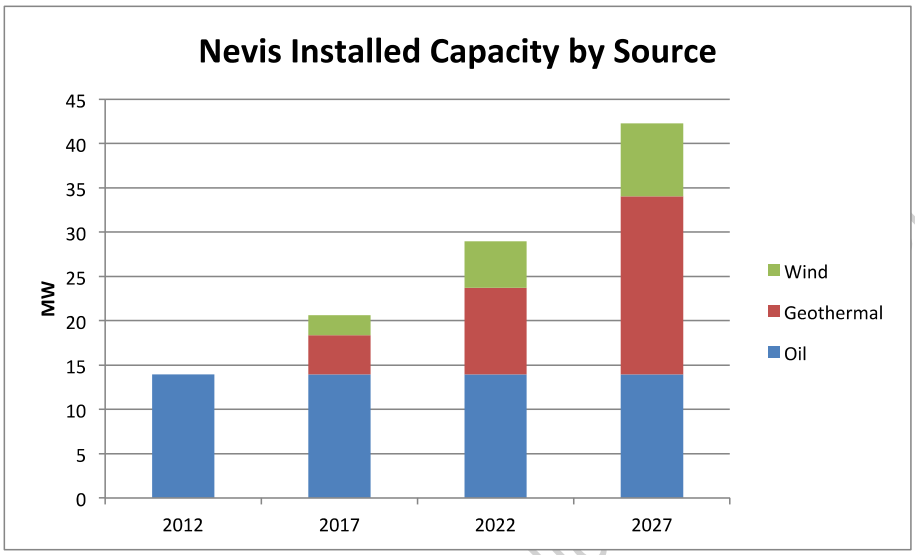


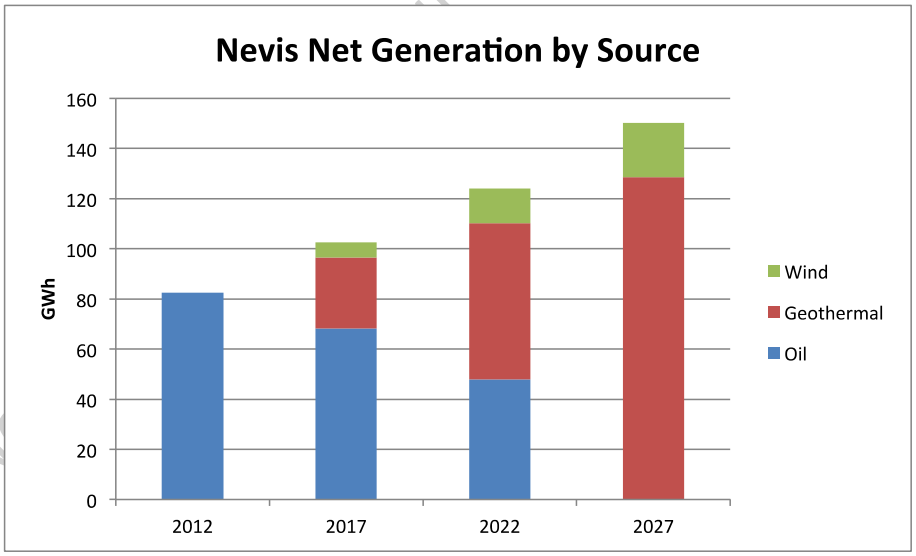


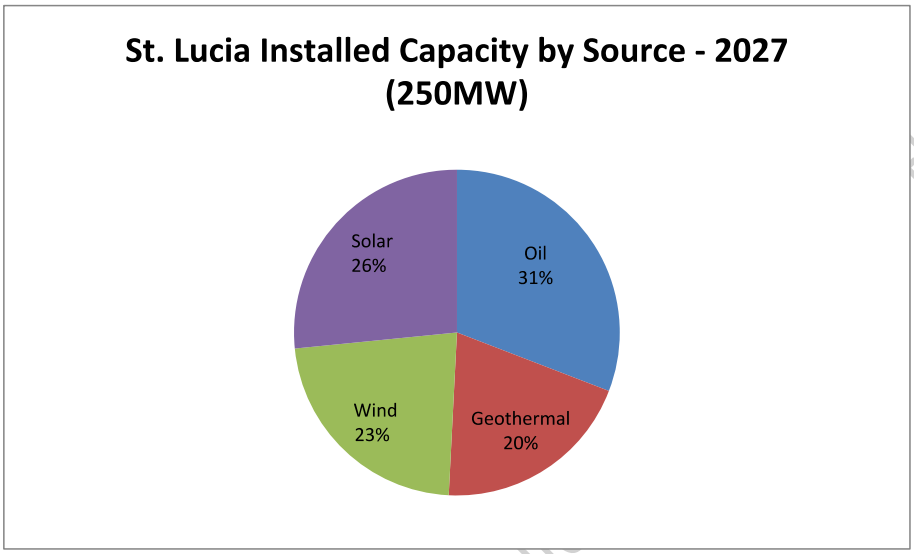


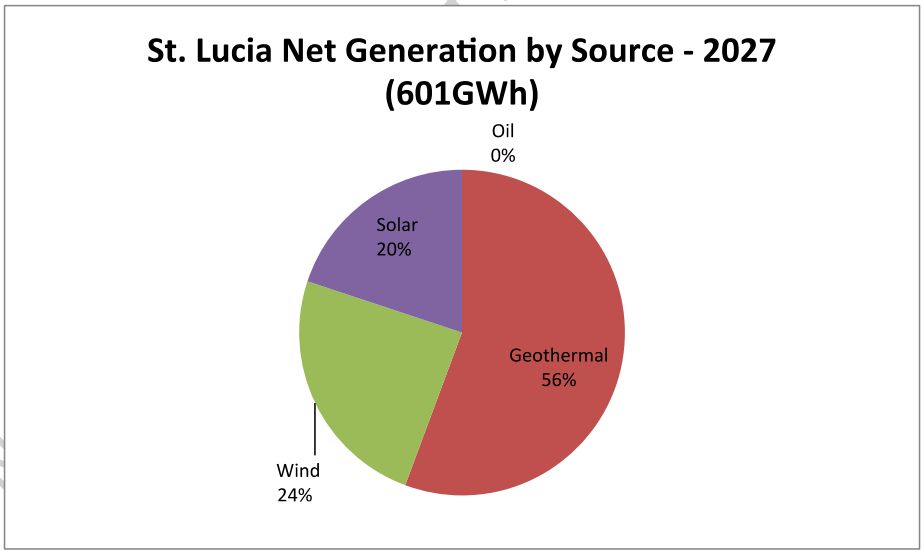


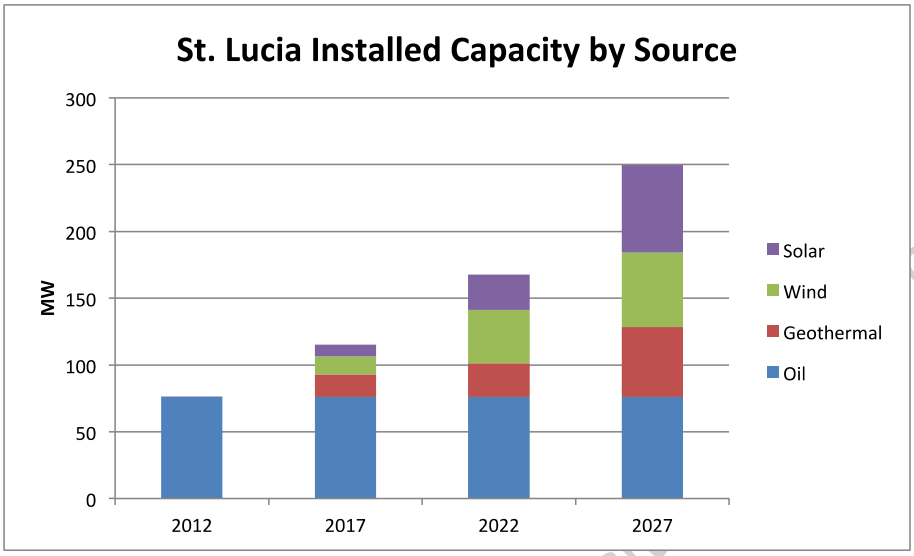


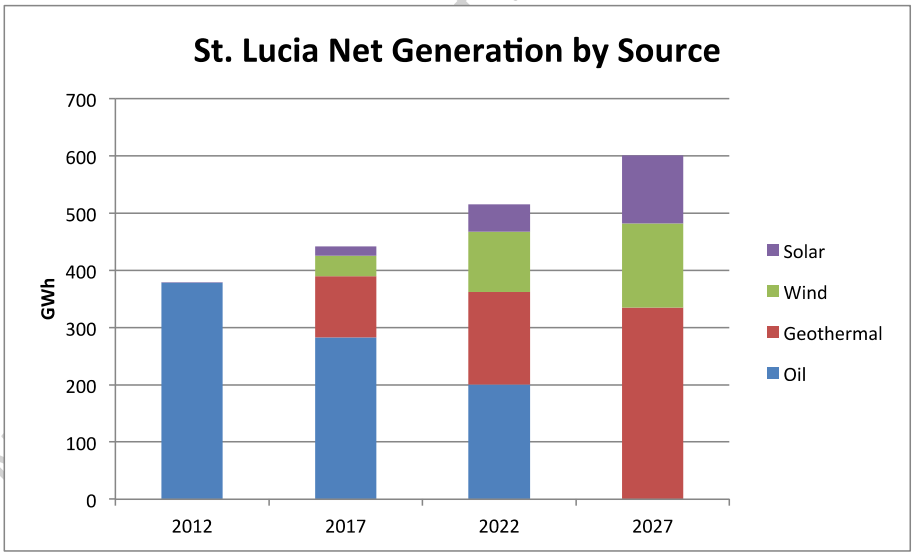


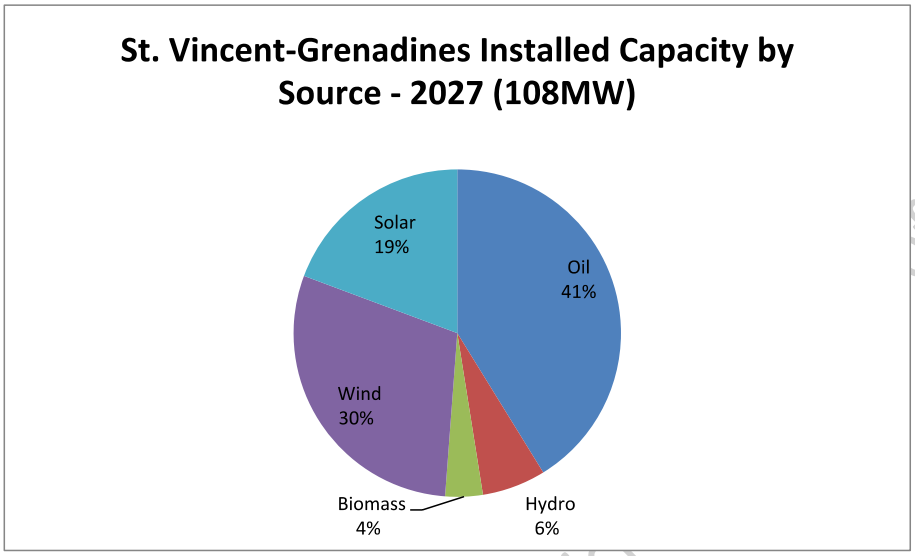


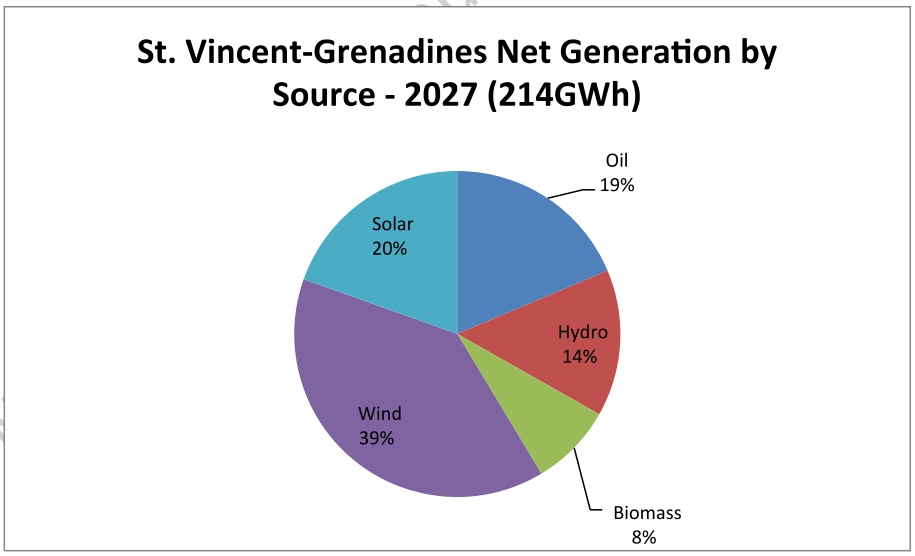


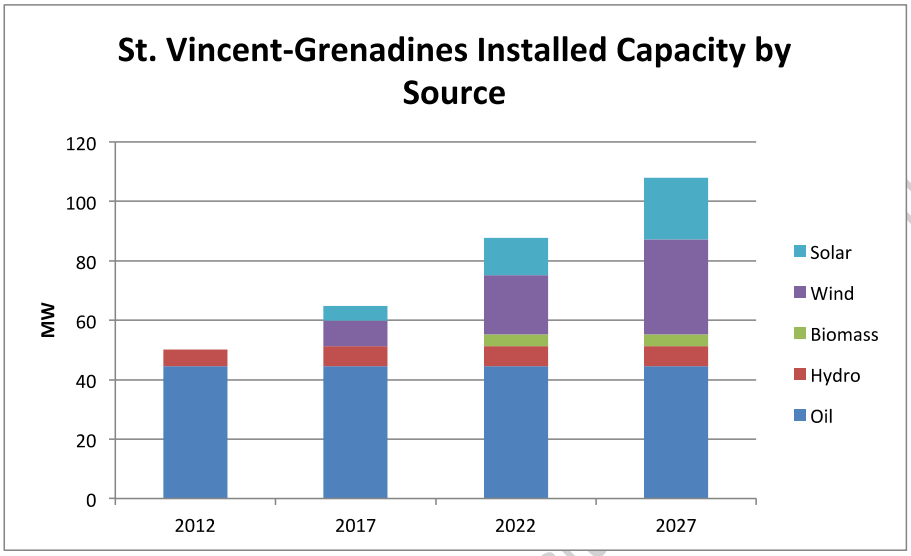


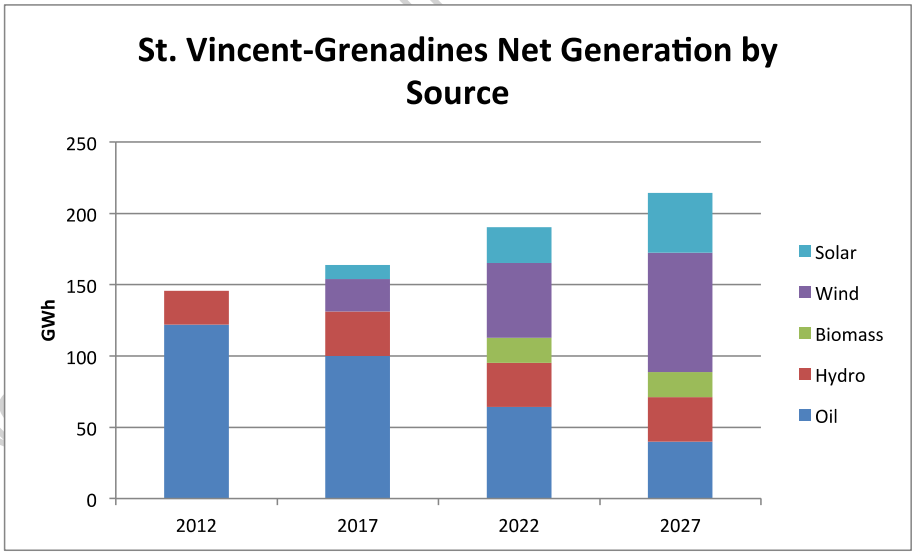


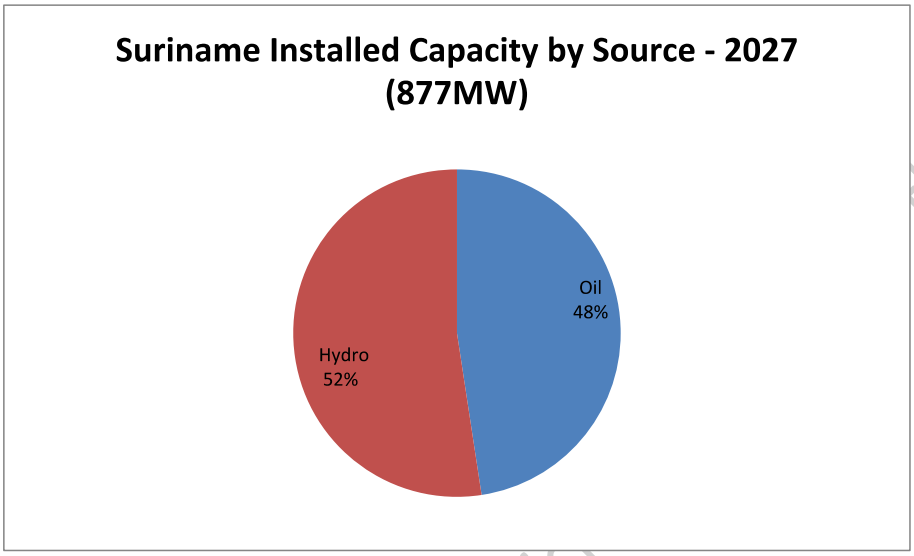


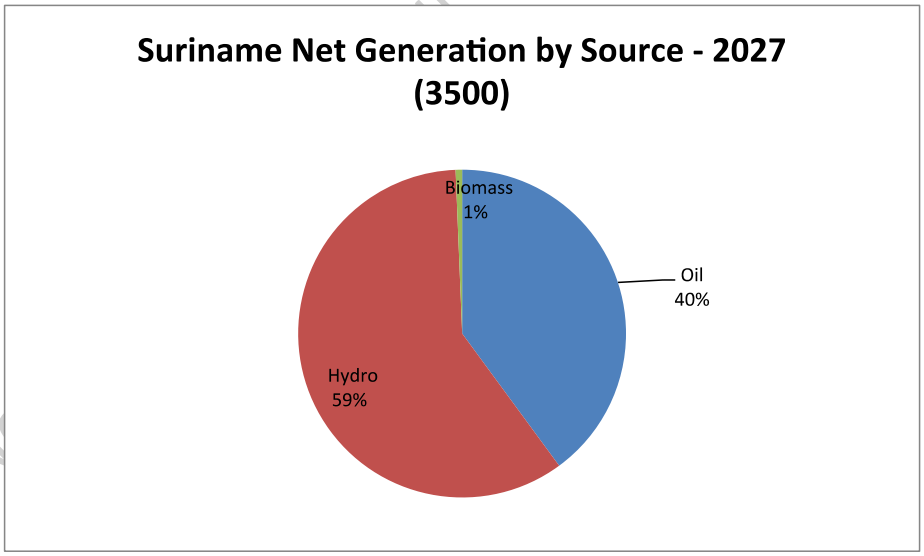


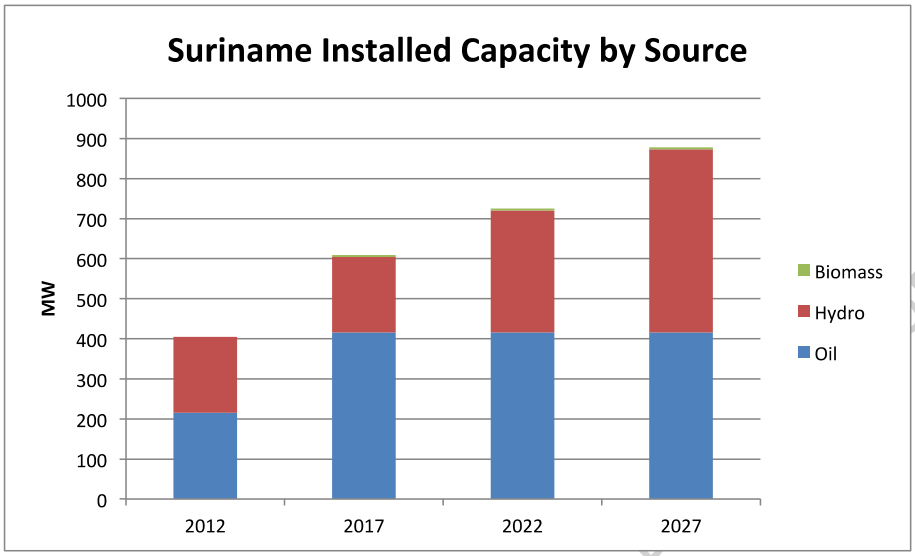


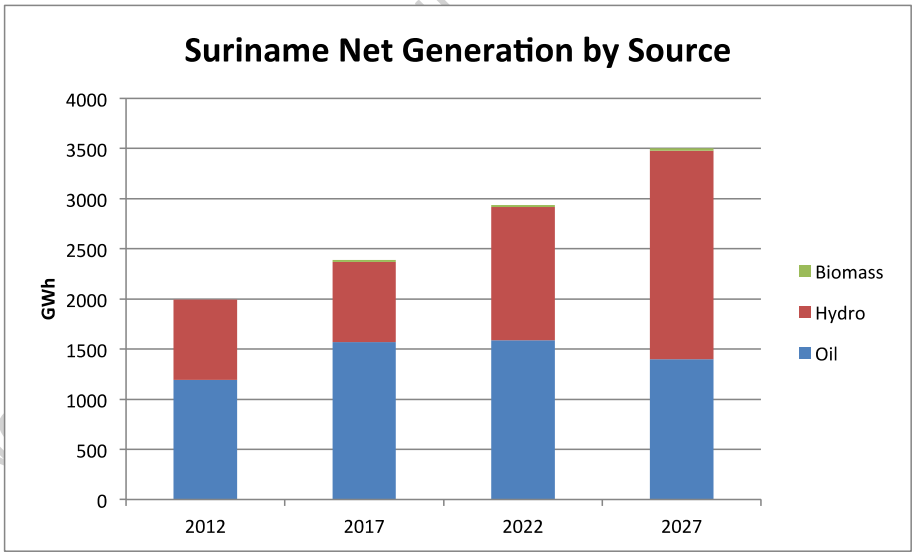


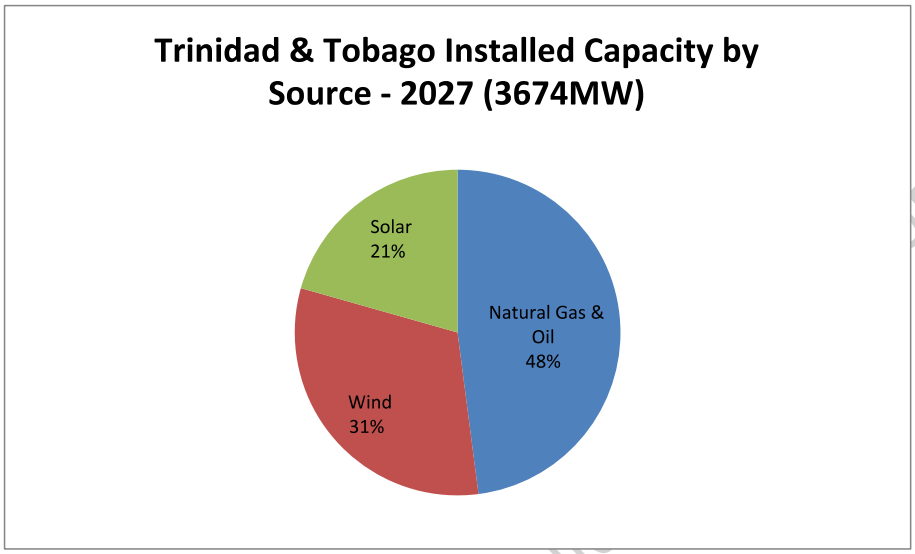


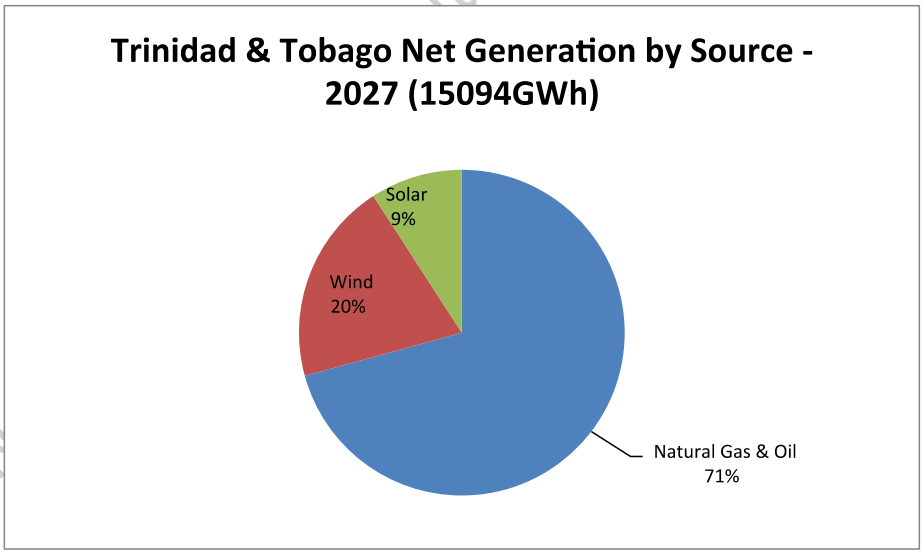


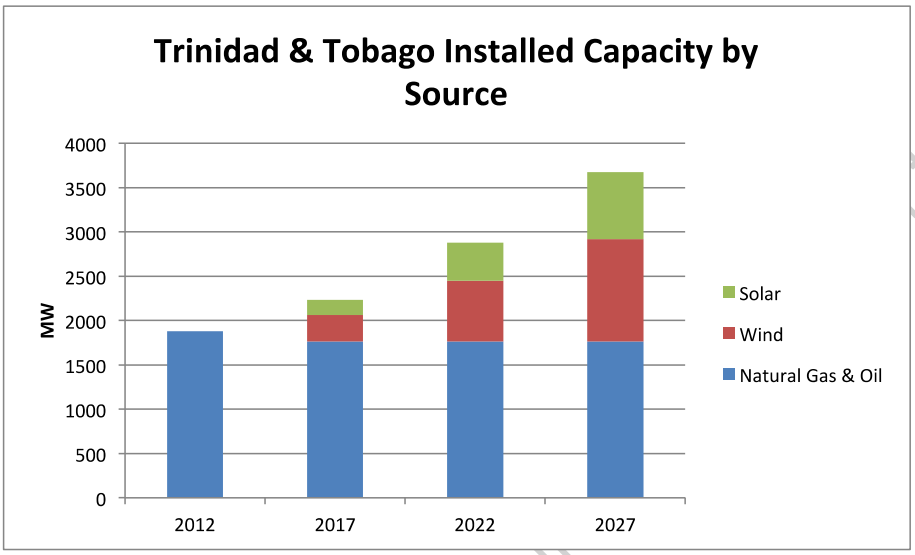


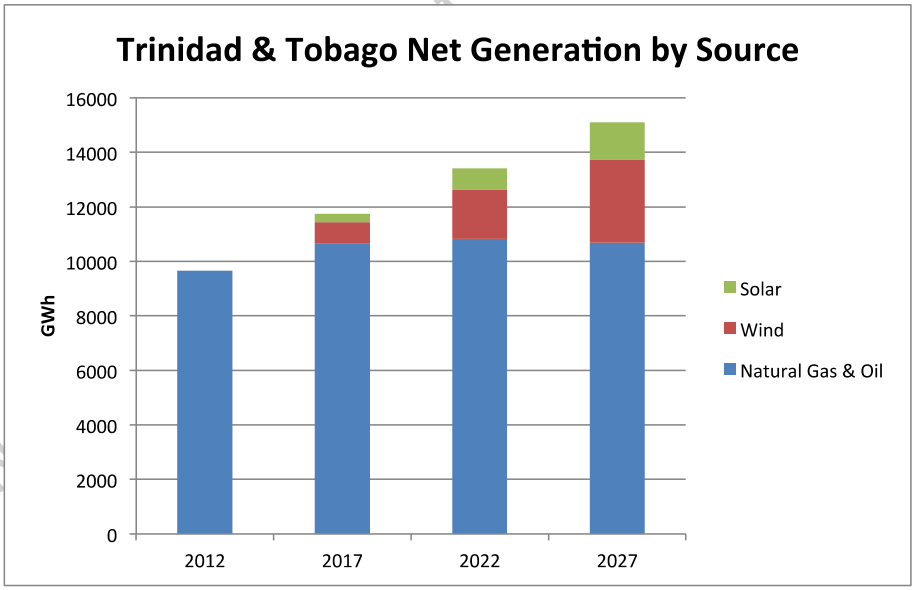


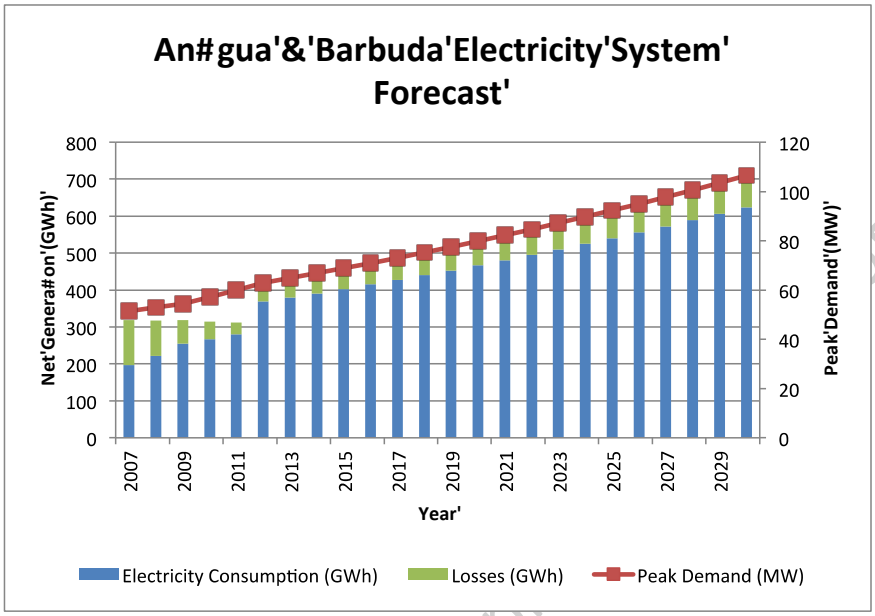


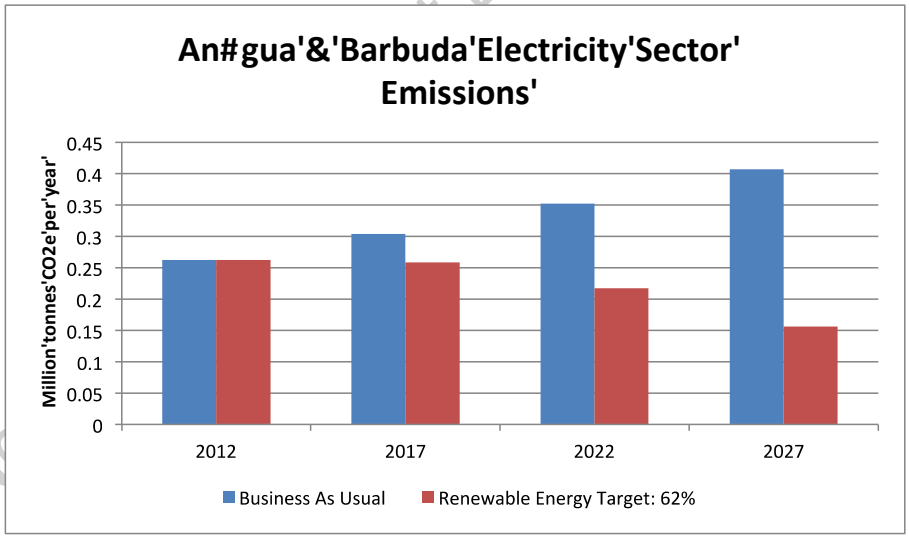


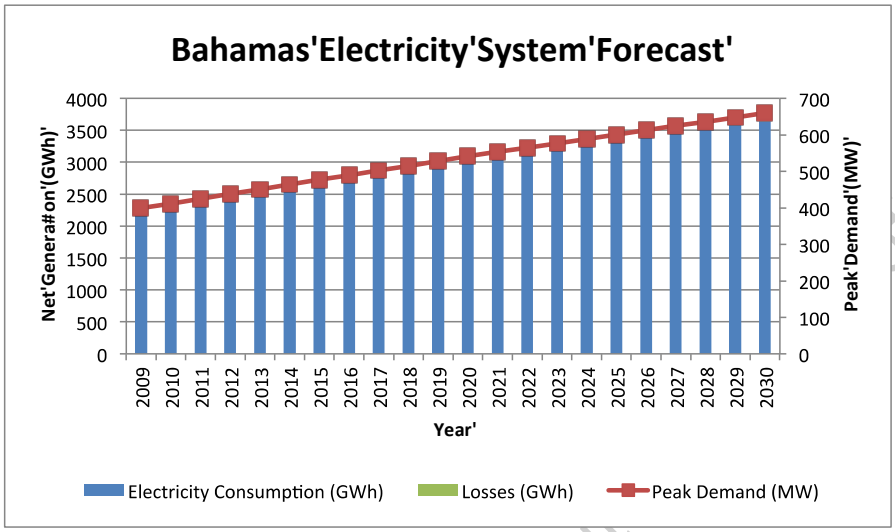


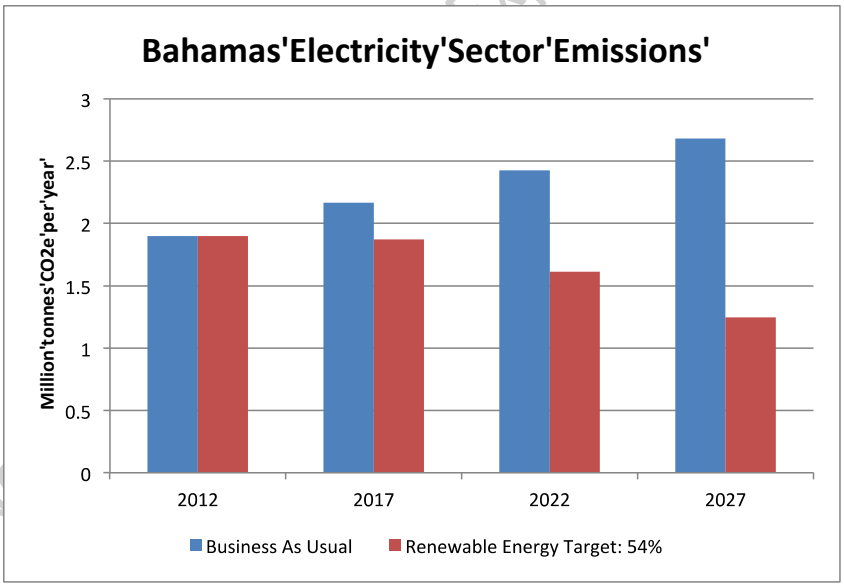


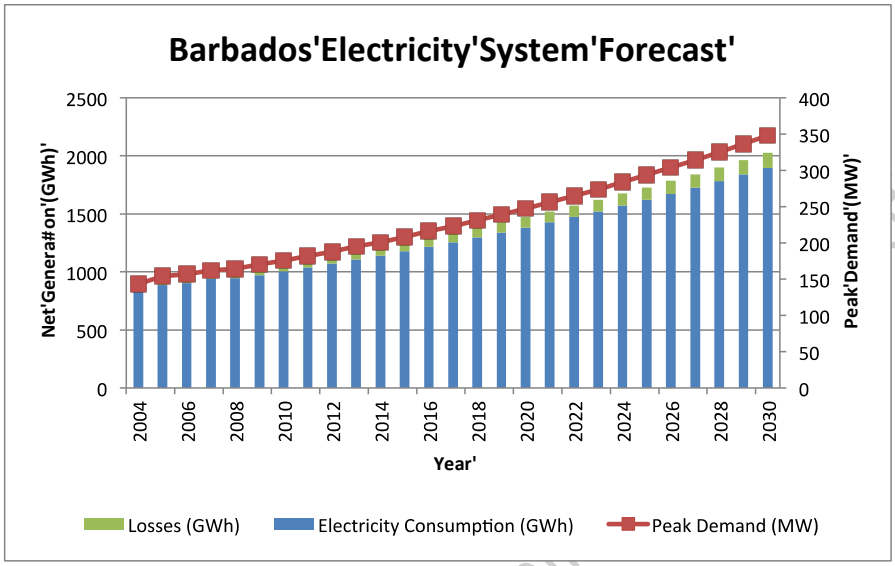


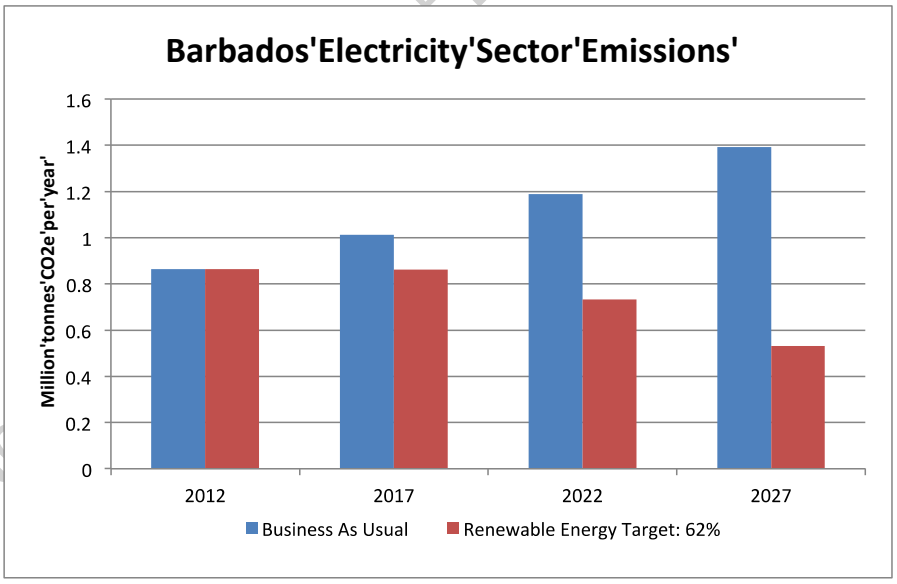


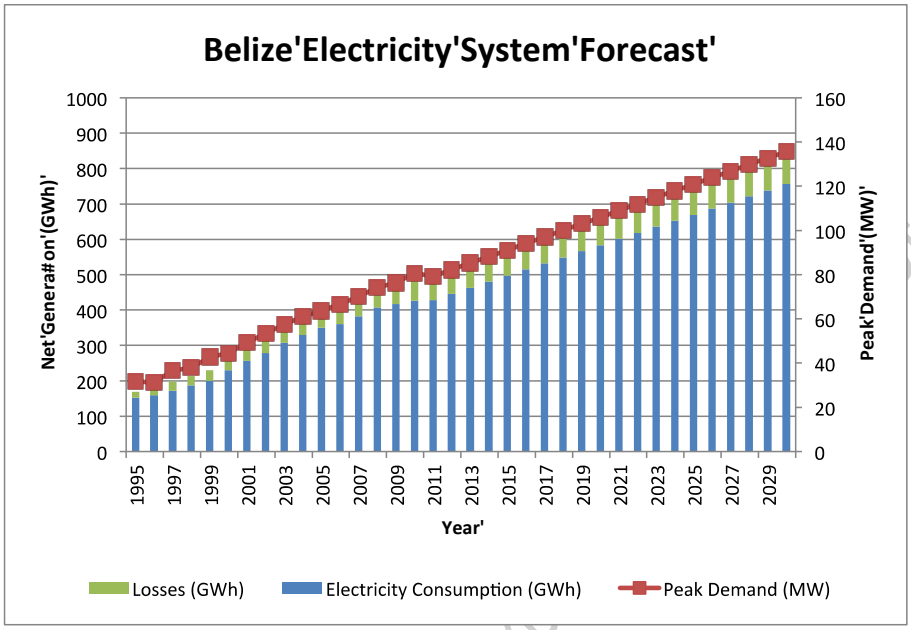


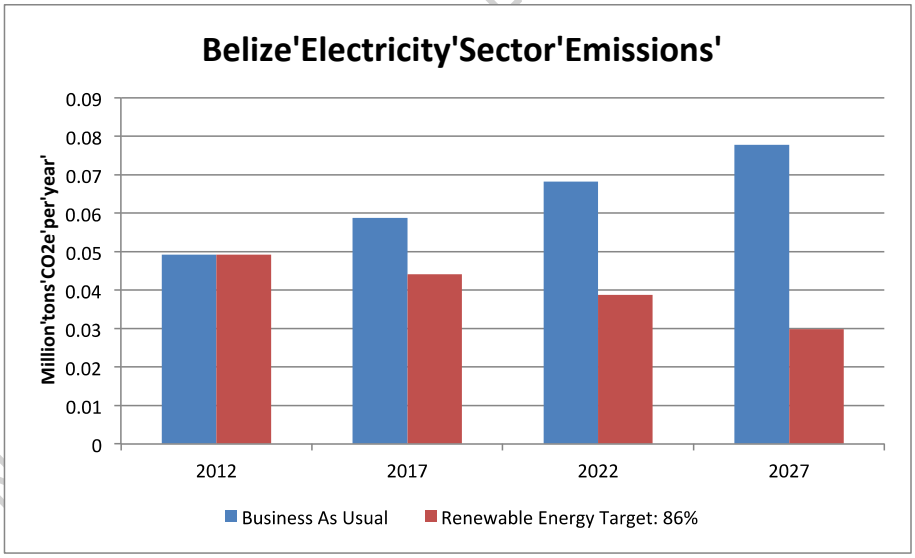


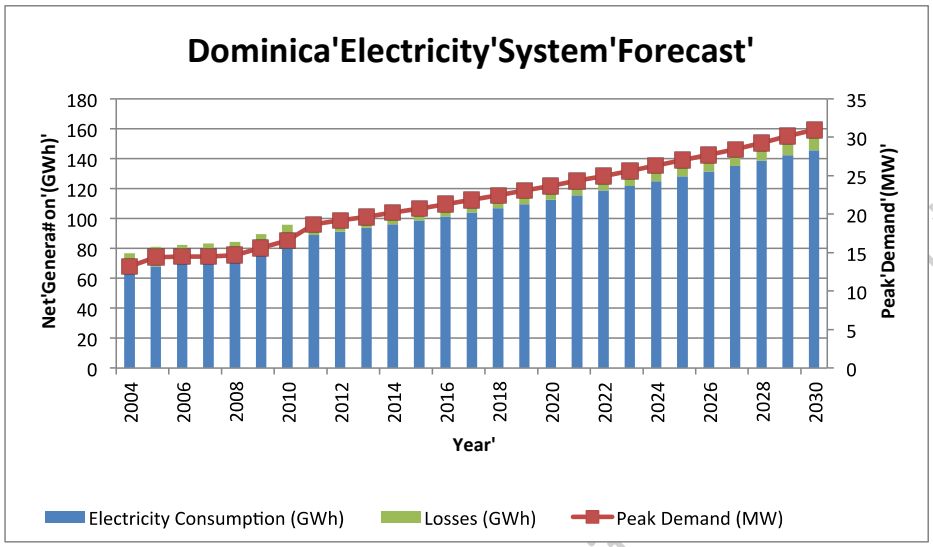


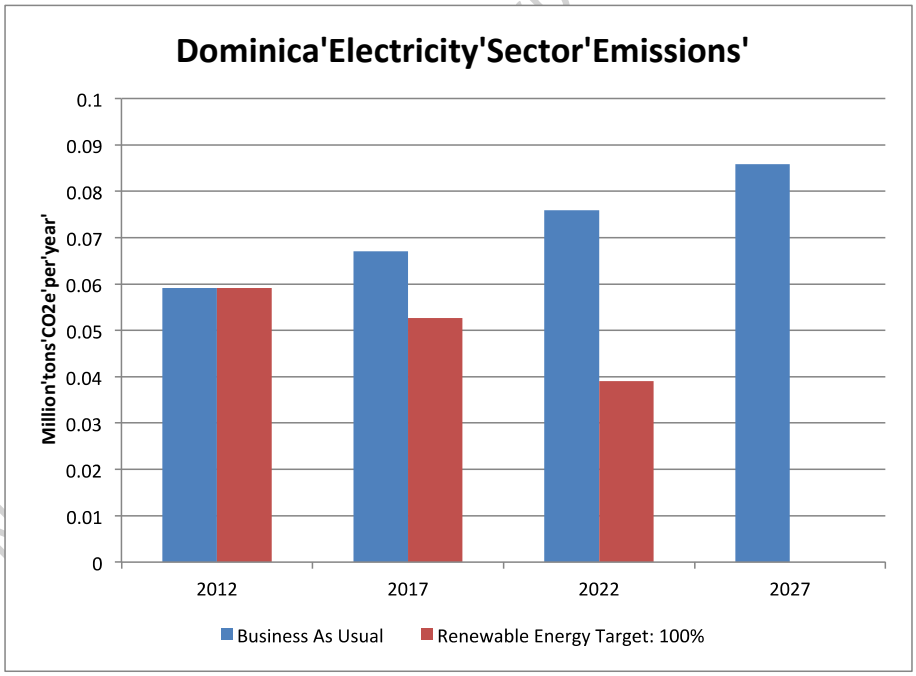


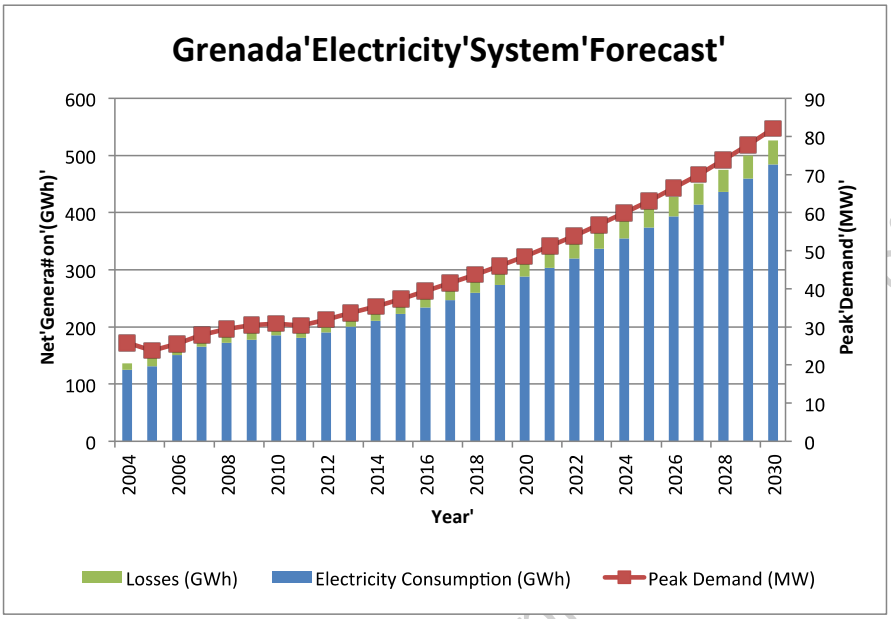


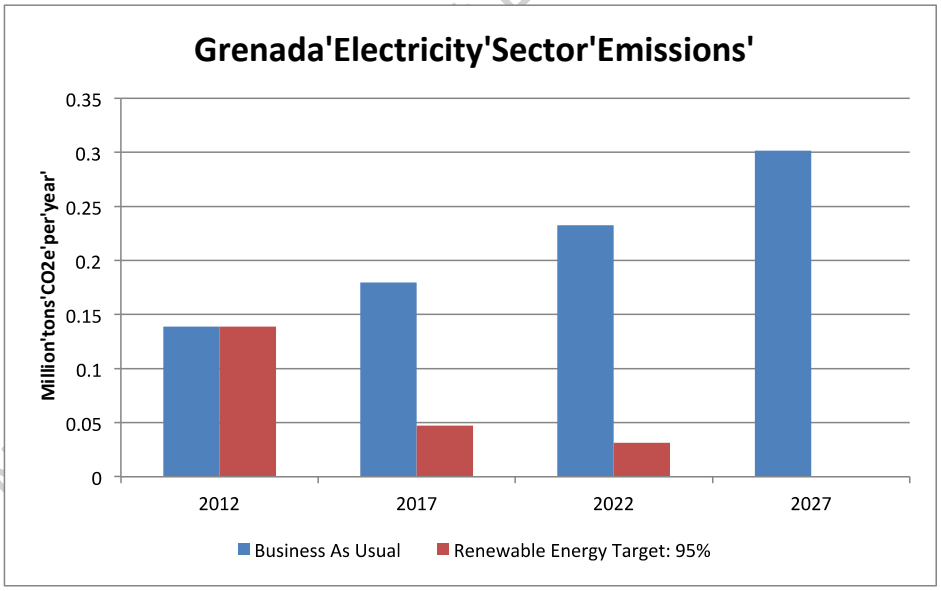


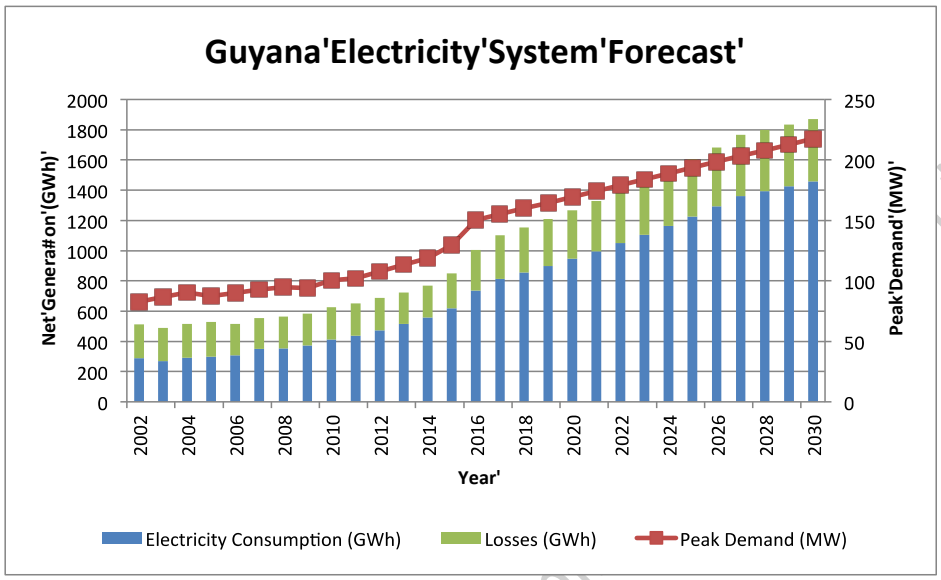


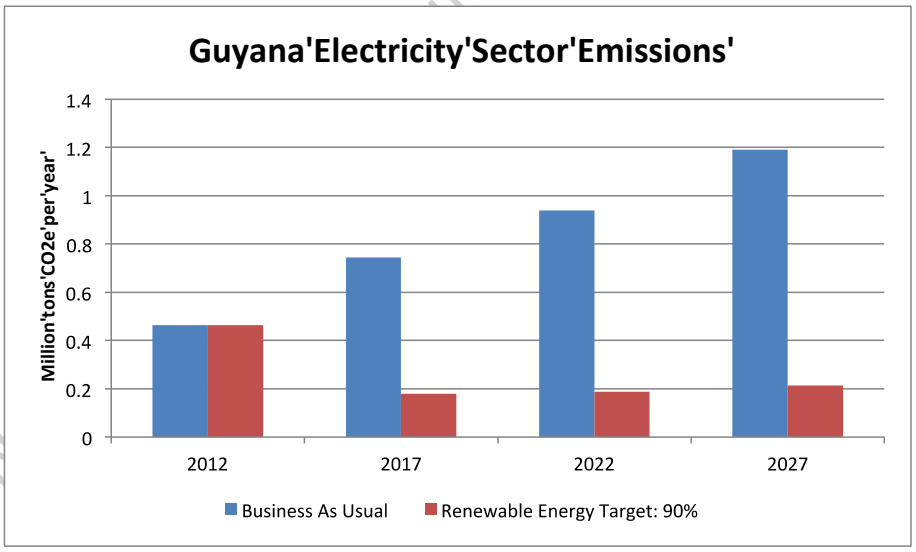


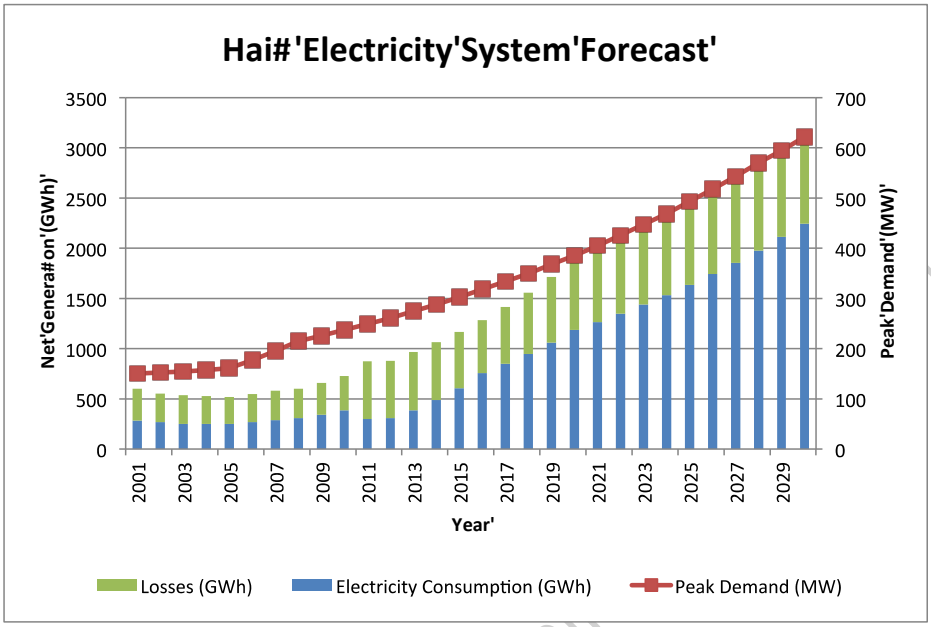


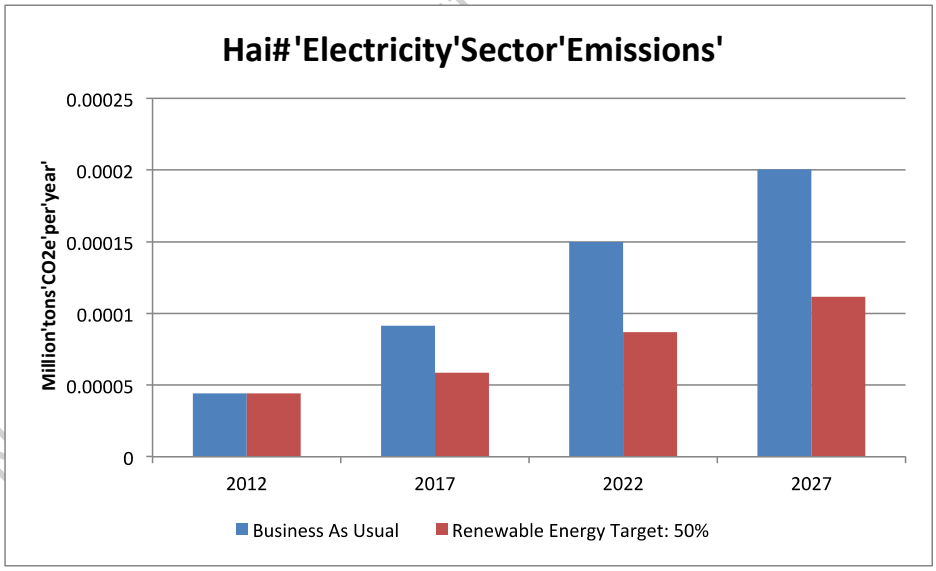


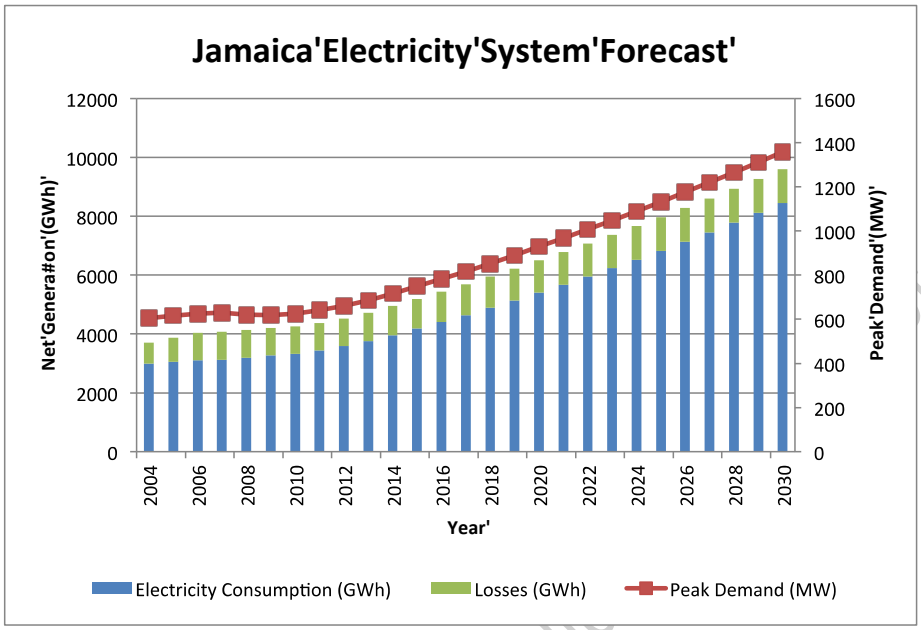


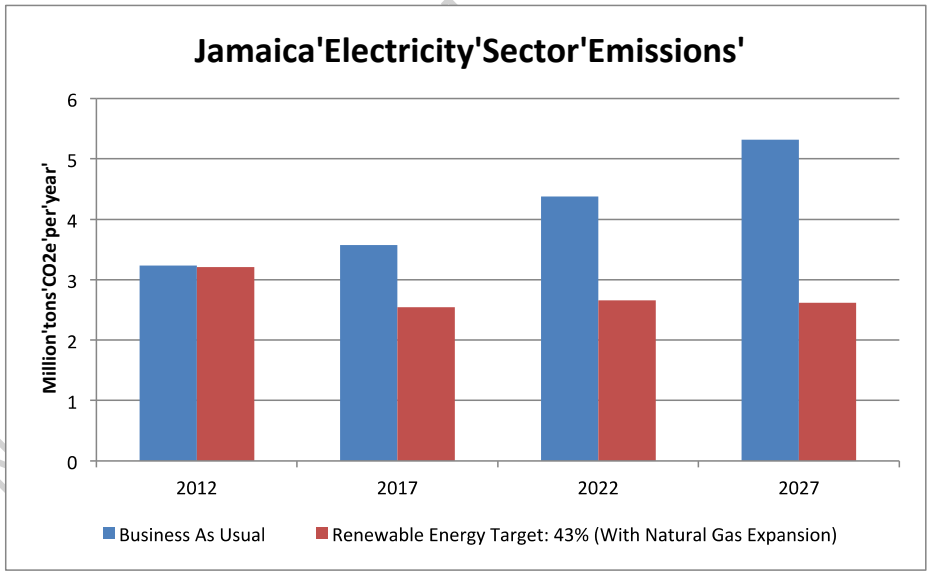


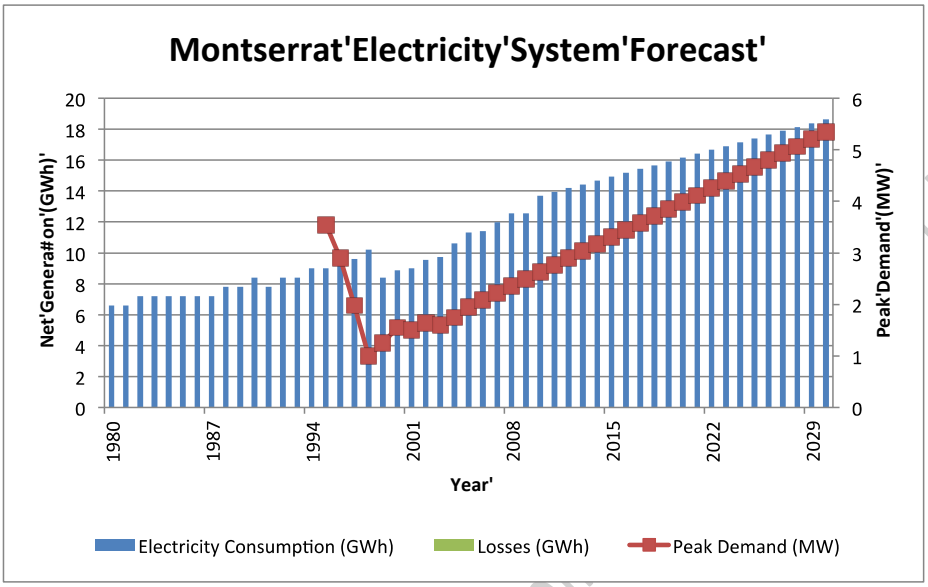


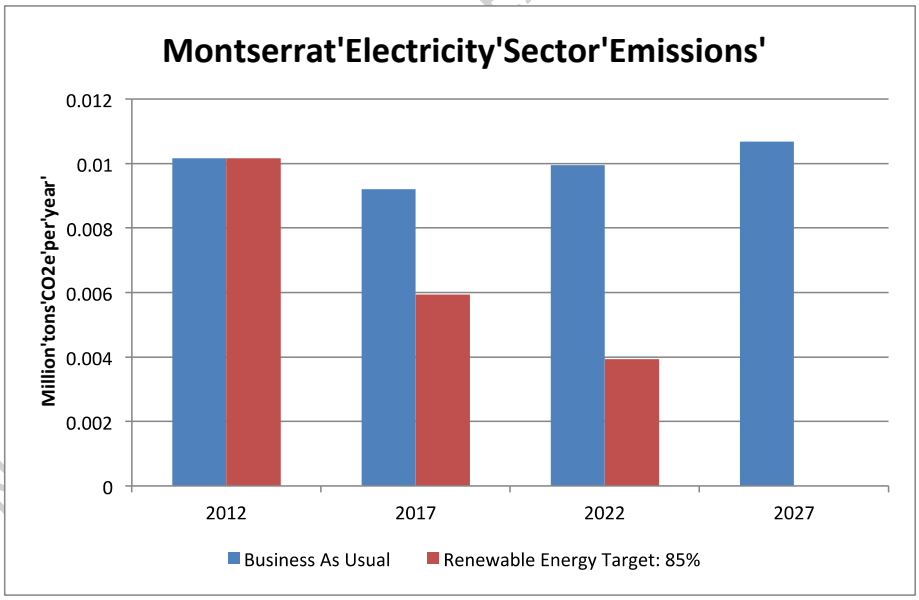


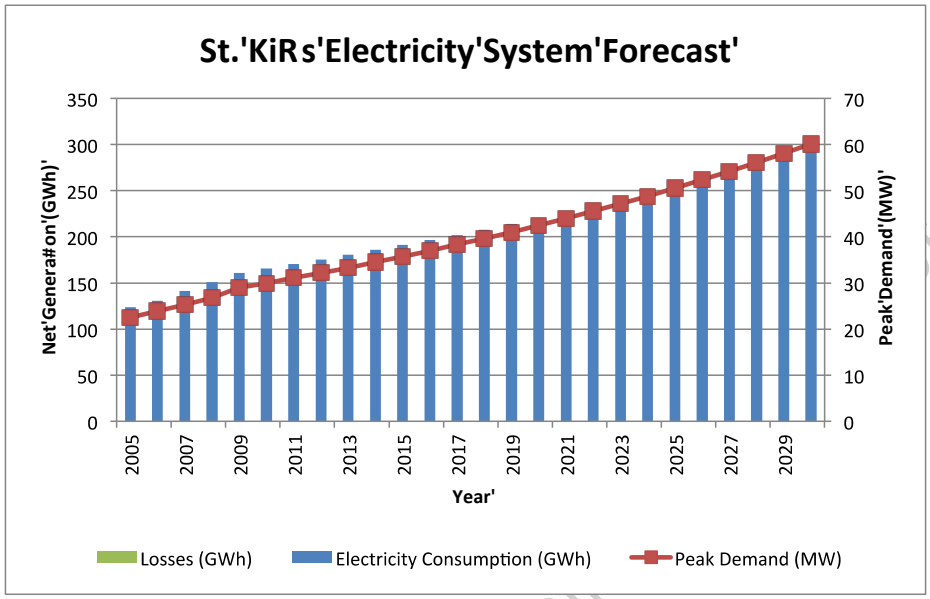


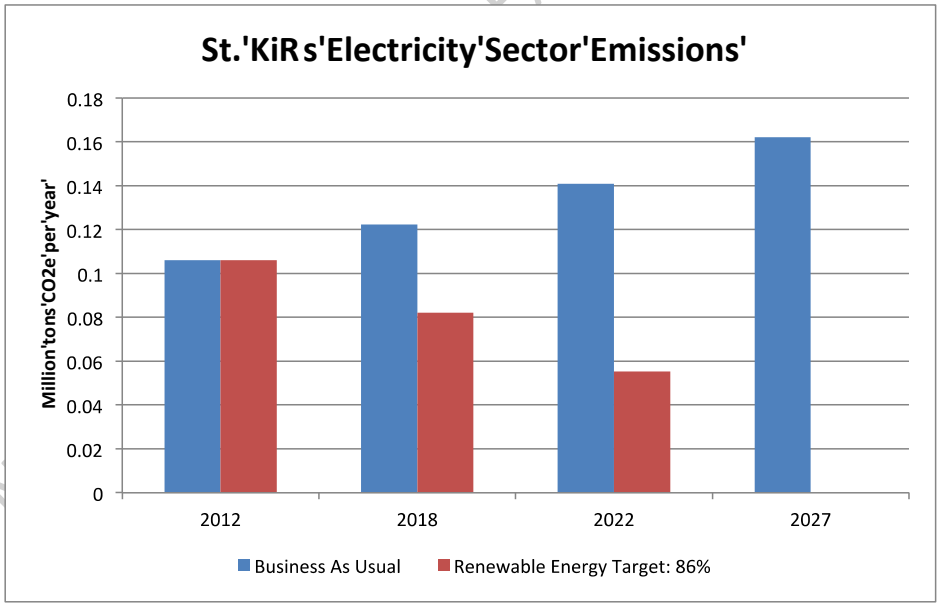


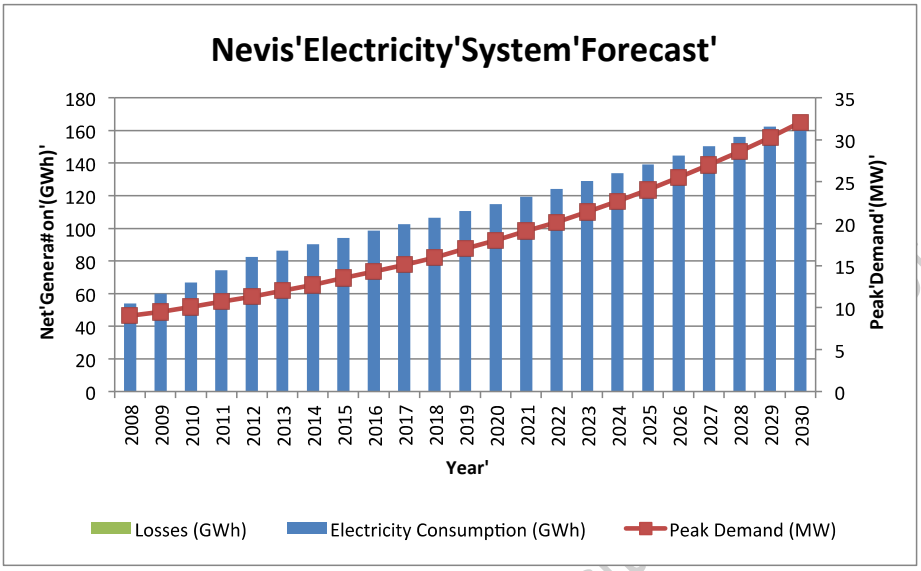


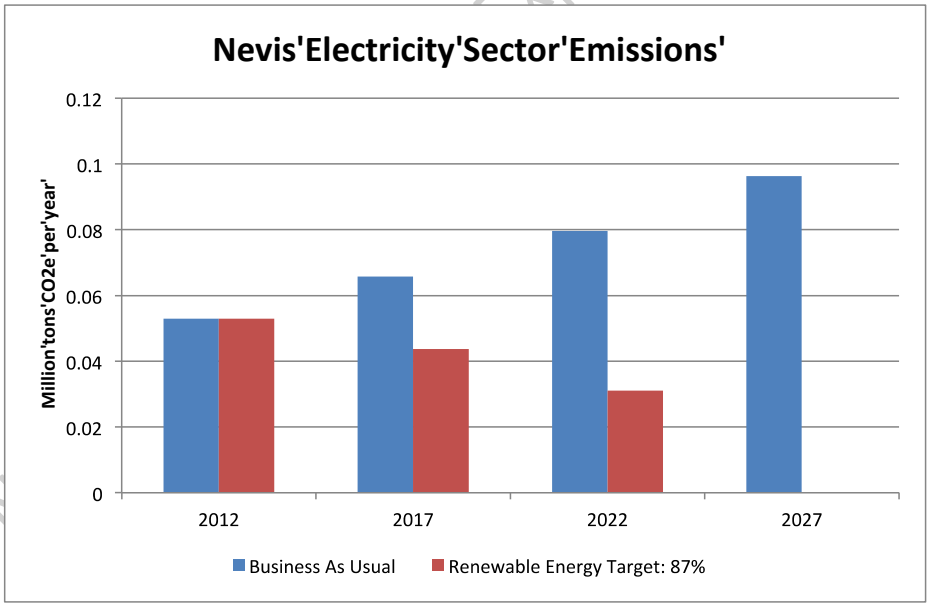


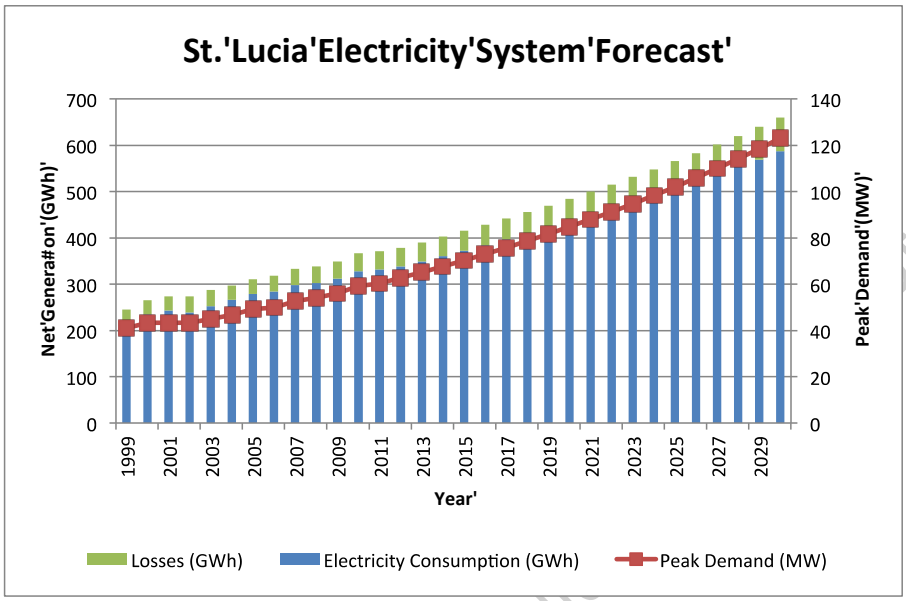


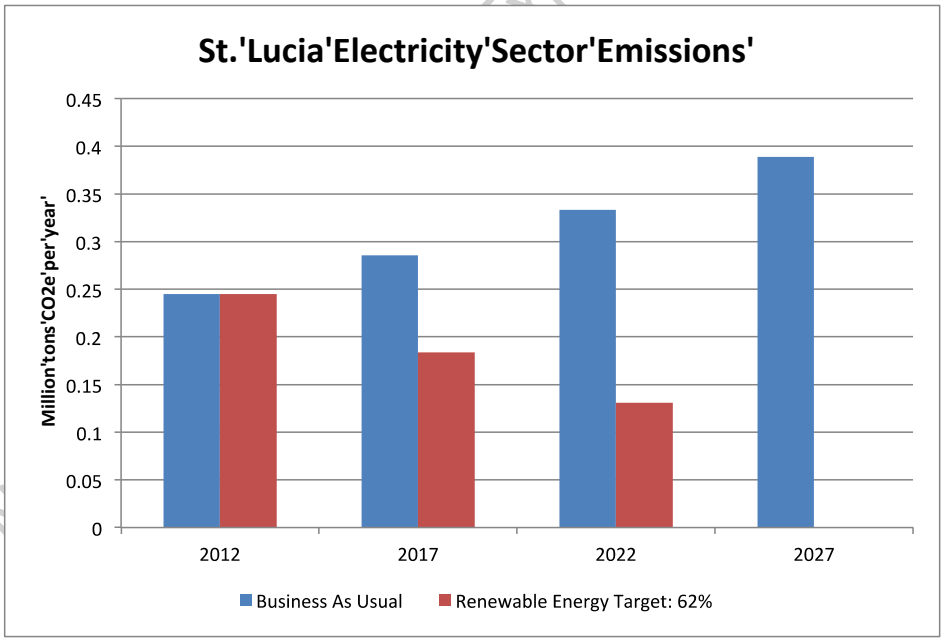


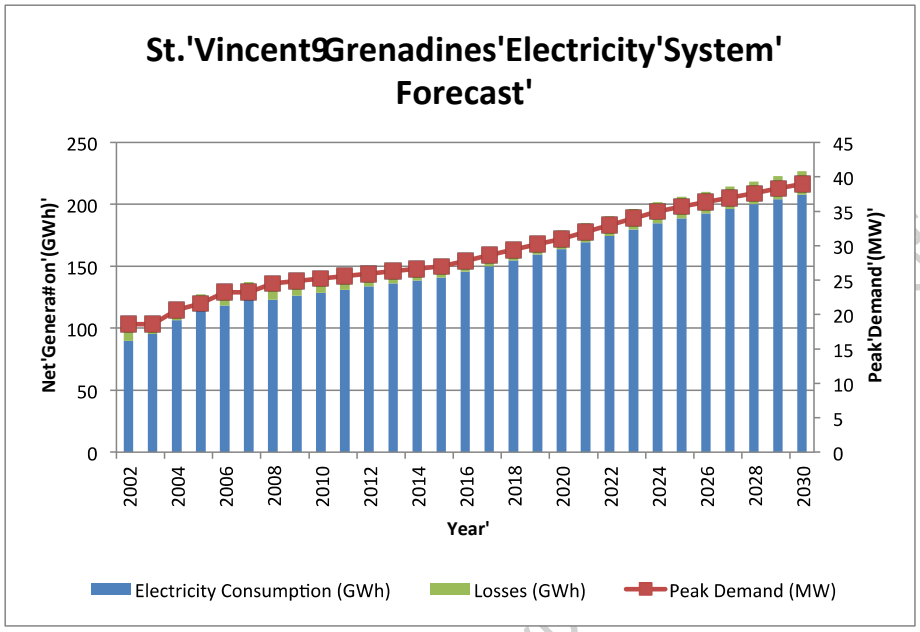


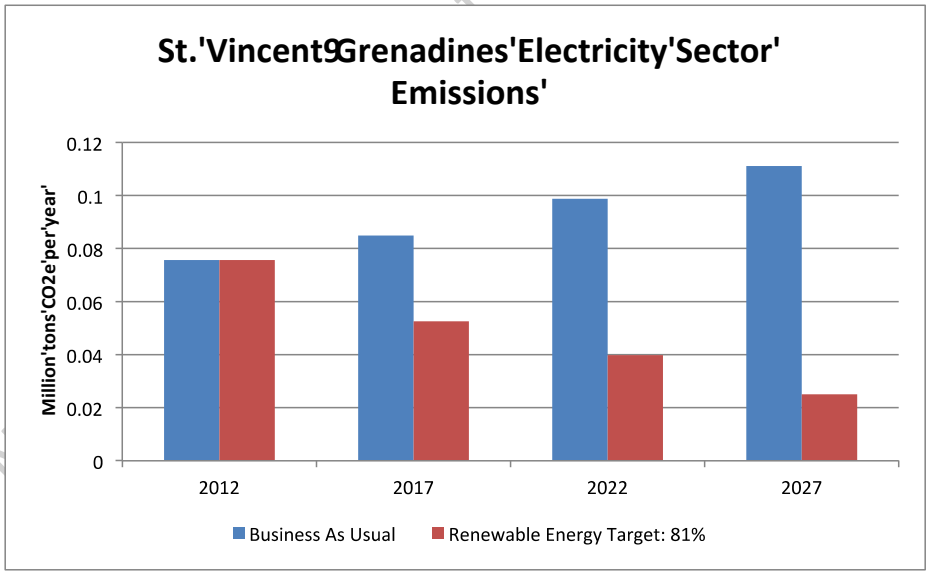


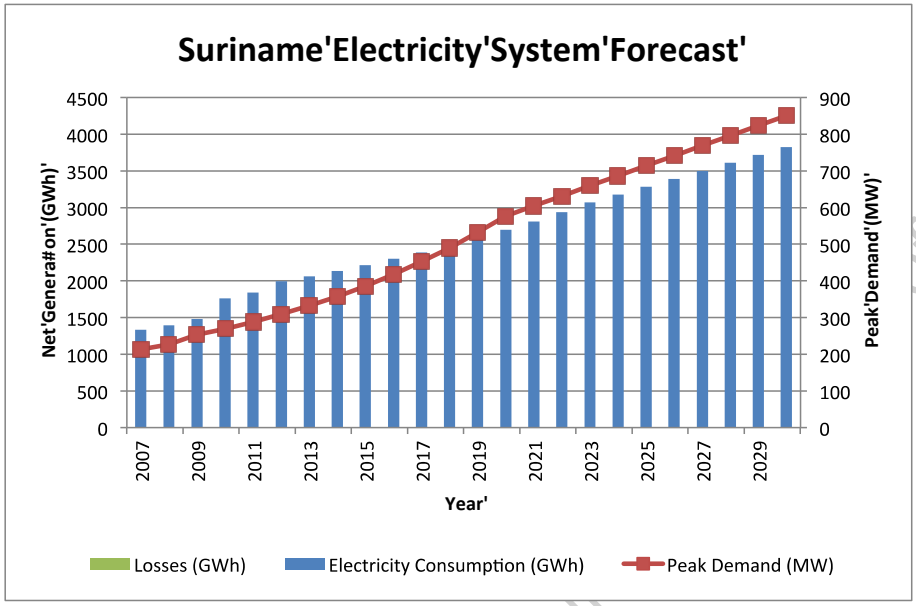


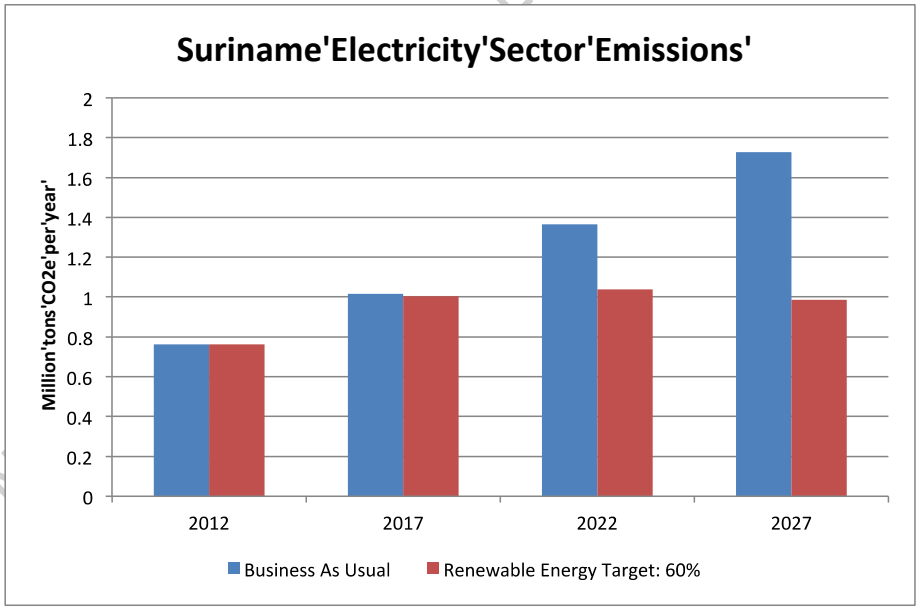


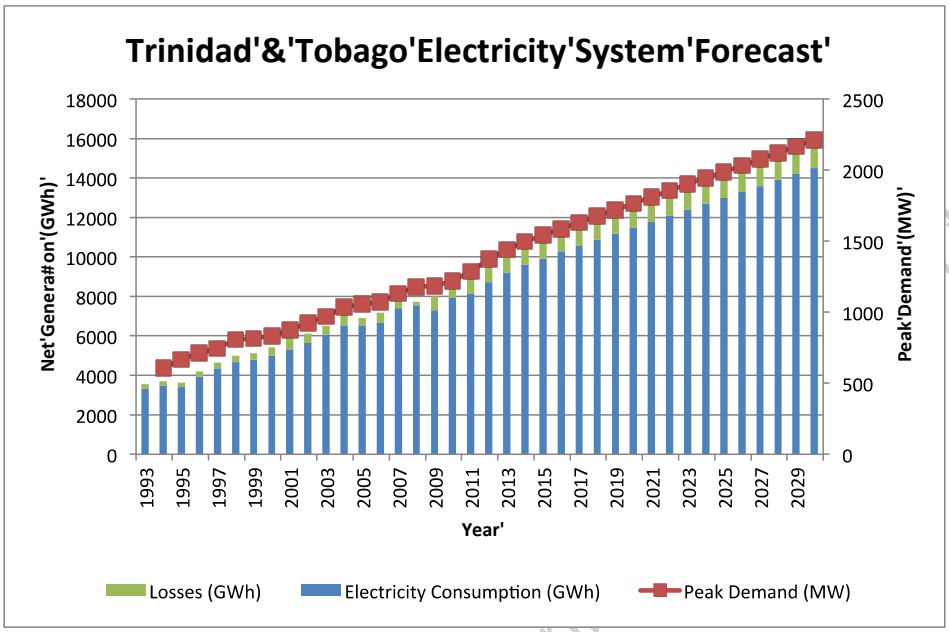


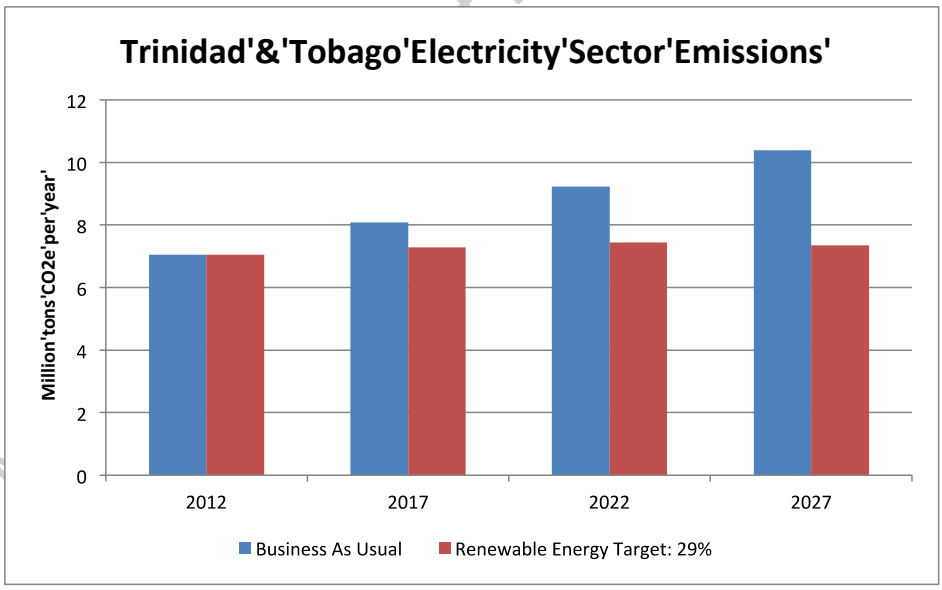












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