CARICOM

Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS)

Baseline Report and Assessment

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On the cover: Wigton Wind Farm, Jamaica, photo by Mark Konold

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Baseline Report and Assessment

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Alexander Ochs, Project Director
Mark Konold, Project Manager
Washington, D.C.
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List of Acronyms

APUA	Antigua Public Utilities Authority
BNEF	Bloomberg New Energy Finance
C-SERMS	Caribbean Sustainable Energy Roadmap and Strategy
C-SERMS I	Phase 1 of the Caribbean Sustainable Energy Roadmap and Strategy
CAFE	Corporate Average Fuel Economy
CARICOM	Caribbean Community
CCCCC	Caribbean Community Climate Change Centre
CCREEE	Caribbean Center for Renewable Energy and Energy Efficiency
CDB	Caribbean Development Bank
CEIS	Caribbean Energy Information System
CIPORE	Caribbean Information Platform on Renewable Energy
CNG	compressed natural gas
CO_2	carbon dioxide
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
EU	European Union
EU ETS	EU Emissions Trading Scheme

FIT	feed-in tariff
FSRU	Floating Storage and Regasification Unit
GDP	gross domestic product
GIZ	German Agency for International Cooperation
GRENLEC	Grenada Electricity Services Limited
GVEP	Global Village Energy Partnership
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
OAS	Organization of American States
OLADE	Latin American Energy Organization
OTEC	ocean thermal energy conversion
PPA	power purchase agreement
PPP	purchasing power parity
PV	photovoltaic
REETA	Renewable Energy and Energy Efficiency Technical Assistance
SE4ALL	United Nations Sustainable Energy for All initiative
SIDS	small-island developing state
SKELEC	St. Kitts Electricity Company Limited
T&TEC	Trinidad and Tobago Electricity Commission
VINLEC	St. Vincent Electricity Services Limited

Executive Summary

The Caribbean region stands at a crossroads, faced with several critical challenges associated with the generation, distribution, and use of energy. Despite the availability of tremendous domestic renewable energy resources, the region remains disproportionately dependent on imported fossil fuels, which exposes it to volatile oil prices, limits economic development, and degrades local natural resources. This ongoing import dependence also 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.

While onerous, these shared challenges are far outweighed by the region's tremendous potential for sustainable energy solutions. By acting on this potential, the Caribbean can assume a leading role in the global effort to combat climate change while promoting sustainable regional economic and societal development. Representing a geographically, culturally, and economically diverse cross-section of the region, the Caribbean Community (CARICOM) provides the ideal platform to construct the legislative and regulatory frameworks necessary to achieve this transition.

CARICOM represents 15 diverse member states: Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago. Although these states vary widely, they face many common energy challenges.

CARICOM's Caribbean Sustainable Energy Roadmap and Strategy

CARICOM has already begun to play a crucial role in the regional transition to sustainable energy. Recognizing the need to develop a coordinated regional approach to expedite uptake of renewable energy and energy efficiency solutions in the Caribbean, CARICOM adopted its regional Energy Policy in 2013 after a decade in development. The policy charts a new climate-compatible development path that harnesses domestic renewable energy resources, minimizes environmental damage, and spurs social opportunity, economic growth, and innovation.

To translate these 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 Baseline Assessment and Report*, the Worldwatch Institute provides an analysis of the region's current energy and energy policy situation, evaluates regional potential for renewable energy and energy efficiency solutions, and recommends regional targets for energy sector transformation in the short, medium, and long terms.

Outline and Contribution of the *C-SERMS Baseline Assessment and Report*

It is remarkable that the suggested regional renewable energy target of 48% of installed power capacity by the year 2027 has already been approved by delegates of the Commission on Trade and Economic Development (COTED) in 2013, based on a draft version of this report. In addition to renewable energy, energy efficiency, and carbon dioxide (CO_2) emission targets, this report suggests individual national targets for all three categories for each member state. If achieved, they would make the regional target a reality.

To achieve the ambitious sustainable energy and climate targets suggested, this report outlines key strategies as well as concrete priority projects, policies, and initiatives to be undertaken in the region. This *Baseline Assessment and Report* hopes to make an important contribution to acceleration of the energy transition in CARICOM countries and to lay out practical next steps that CARICOM can undertake as part of C-SERMS and other ongoing sustainable energy initiatives.

Current Regional Energy Situation

CARICOM member states exhibit heavy, if not exclusive, dependence on fossil fuel imports. In most cases, distillates (diesel) and fuel oil are utilized due to their low capital costs and modularity. Natural gas also is consumed within some CARICOM states, whereas coal and nuclear play only a minimal role in the region's energy balance. Representing potential game changers for the Caribbean energy sector, momentum is growing for deployment of certain renewable energy and energy efficiency technologies. Increased use of distributed solar photovoltaics (PV) in Haiti, for example, is expanding affordable electricity access to remote and underserved areas. Compared to their abundant potential, however, these options remain underutilized.

Although energy demand in the region reflects diverse end-uses, power systems in most CARICOM states share several defining characteristics. Most rely on a single utility that holds monopoly control over transmission and distribution of on-grid electricity. Regional grid interconnection remains largely underexplored due to factors including the challenges associated with isolated grids, insufficient infrastructure, and investment cost. Although energy access for CARICOM citizens is generally high, some states face low quality of service and a few show significant unmet demand. These conditions are often exacerbated by deteriorating infrastructure and high rates of technical and non-technical losses.

Despite the fact that CARICOM accounts for only a very small share of global CO_2 emissions, a forecast of sustained growth in energy demand means that emissions are projected to increase rapidly in the coming decades under business as usual. However, assessment of the region's renewable energy and energy efficiency potentials demonstrates that strong continued economic growth can be de-linked effectively from growth in greenhouse gas emissions.

Renewable Energy and Energy Efficiency Potential

Every CARICOM member state exhibits significant and largely unexploited potential for developing renewable energy resources. If fully developed, these resources could transform many states into net energy exporters. Hydropower comprises the majority of renewable power generation in CARICOM and worldwide. Regionally, the resource is ideal for states with hilly topography and high rainfall rates. In member states with substantial agricultural activity, biomass and municipal solid waste provide a flexible and easily accessible entry point to renewable energy generation.

Solar PV and wind resources are abundant throughout the region but remain extremely underutilized. Most CARICOM member states, in particular those located within the volcanic arch of the Lesser Antilles, possess significant untapped geothermal resources. Other groundbreaking technologies, such as ocean wave and tidal power generation, are broadly appealing in CARICOM because all member states have significant coastline territory.

The Need to Find Synergies Across Renewables and to Integrate Them with Energy Efficiency Efforts

Individually, no renewable energy resource can reliably meet growing demand for energy across all member states by itself (although geothermal can power entire member nations). When developed simultaneously, however, these resources possess significant synergistic potential and can reduce each other's disadvantages.

This is particularly the case when combined with abundant regional potential for energy efficiency. Energy efficiency and energy savings measures can be deployed across many economic sectors and are often both the cheapest and the fastest way to lessen the environmental and economic costs associated with a given energy system. Opportunities for efficiency include smart architecture and construction measures, efficient consumer appliances, electricity grid interconnection, and grid infrastructure improvement. A number of pilot programs are already exploring the impacts of innovative energy efficiency measures in a variety of economic sector applications.

Existing Sustainable Energy Policy Frameworks in CARICOM Member States

Realizing the enormous potential for renewable energy and energy efficiency in CARICOM will require a robust and dynamic enabling framework of regulatory policy and legislation that, so far, remains inadequate. Regional and national governing bodies must be proactive in implementing these frameworks to encourage the investment needed to allow energy efficiency improvements and renewable energy projects to take hold. Although efforts to incentivize renewable energy and energy efficiency in CARICOM have increased in recent years, 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.

In addition to adopting the regional Energy Policy, all 15 CARICOM member states now have national energy strategies in some stage of development or implementation. Many member states have taken

the lead in setting targets, creating responsible agencies, and developing domestic policy mechanisms to support an increase in renewable energy and energy efficiency. At the regional level, policymakers have jointly defined net billing as the appropriate minimum standard for policy support, and important progress has been made toward a favorable regulatory environment for investments in sustainable energy technologies across CARICOM. Despite these important steps, however, sustainable energy development across the region continues to be limited by policy and data gaps, administrative ineffectiveness, and often inefficient and uncoordinated implementation efforts.

Many overarching plans for energy sector reform have set ambitious targets for the use of renewable energy, but they lack concrete mechanisms to achieve their goals. The situation is even worse on the energy efficiency side: less than half of CARICOM member states have included targets for efficiency improvements in their national strategies. These targets should be adopted more broadly, as they often are achieved at lower upfront costs than targets for renewable energy supply. In addition to sustainable energy targets, a number of member states have announced national targets for emissions reductions. These targets are significant because they convert the regional commitment to climate change mitigation into national-level contributions.

Setting CARICOM Targets for Renewable Energy, Energy Efficiency, and Greenhouse Gas Emissions

Regional targets for renewable energy, energy efficiency, and greenhouse gas emissions are important for CARICOM because they can unite individual member states behind a unified vision for sustainability in the Caribbean while ensuring that national action plans are mutually enhancing rather than conflicting. Having already agreed to a framework of regional renewable energy capacity share targets in the short term (20% by 2017), medium term (28% by 2022), and long term (47% by 2027), many individual member states must now strengthen existing national targets to achieve these goals. Ample renewable resource endowments in some member states imply that targets realistically can be set as high as 100% over the next 15 years or even sooner. All member states have sufficient renewable energy potential to commit to a significant share (at the lowest, 29% in Trinidad and Tobago) of renewables generation by 2027.

CARICOM member states also must take advantage of opportunities for energy efficiency improvements at all stages of the energy sector, including generation, transformation, distribution, and final energy consumption. This process should begin at the regional level to provide the necessary guidance for appropriate target setting at the national level. For CARICOM, energy intensity will prove a more productive metric through which to measure efficiency than energy use alone, as it better correlates the goals of reduced energy use with encouraging economic growth. Based on observed global uptake of energy efficiency measures, C-SERMS recommends a 33% reduction in energy intensity—to be applied evenly across all member states—as both an ambitious and attainable target. Resulting 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 lowering production costs.

Regional targets for greenhouse gas emissions reductions form the third pillar of the regional vision put forward by CARICOM. Although the aggregate emissions of its member states are negligible in comparison to global figures, an ambitious emissions reduction target will be critical in signaling to the

international climate mitigation community, in particular financing and technical support bodies, that CARICOM is committed to promoting sustainability through energy sector transformation. Reflecting the projected sustained growth in demand for energy in the region, regional and national emissions reduction efforts should be measured relative to a business-as-usual model, and must be monitored continually to ensure that member states are on track to meet their long-term targets.

Corresponding to recommended individual member state targets for renewable energy generation and the region-wide energy intensity reduction standard, C-SERMS provides tailored CO_2 emissions reduction targets for each member state to achieve by 2027. Combined, these targets lay the foundations for profound regional action on climate change in the short term (18% reduction by 2017), medium term (32% reduction by 2022), and long term (46% reduction by 2027).

Sustainable Energy for CARICOM: A Strategy to Achieve Regional Targets

Achieving the ambitious regional and national targets for renewable energy generation, energy efficiency, and CO_2 emissions reductions will require coordinated efforts on both the regional and national levels. Nationally implemented policy mechanisms and reforms must be compatible with regional targets, and CARICOM must contribute actively to the support and coordination of these national efforts—ensuring that the progress of individual member states is guided, reported, monitored, and verified.

Outlining concrete work programs will be vital in advancing national energy sector reform efforts tailored to the particular characteristics of CARICOM countries. This report suggests detailed and thematically driven work programs outlining priority initiatives, policies, projects, and activities (PIPPAs). Although starting to implement the PIPPAs promptly is vital, many will require sustained effort and monitoring in the long and medium terms. The report therefore provides implementation time frames for each activity. It also distinguishes which of the PIPPAs are to be undertaken at the regional level, the national level, or both.

Although successfully completing individual PIPPAs will have significant positive impact on the region and/or implementing member state, they should not be siloed or treated as unrelated efforts. When simultaneously advanced, PIPPAs have significant synergistic potential. Ultimately, only the completion of the full slate of activities outlined in the PIPPAs will allow CARICOM to meet and likely exceed its regional sustainable energy goals, including the energy efficiency, renewable energy, and climate goals proposed in this report. Further design and implementation of the PIPPAs should be orchestrated by CARICOM to ensure that no member state feels left alone on this challenging path.

Exploiting opportunities and addressing challenges in sectors such as transportation, regional energy trade, and the water-energy-food nexus also will be critical to realizing the ambitious targets for sustainability laid out by CARICOM and its member states. To advance these objectives while avoiding replication of effort among the extensive community of Caribbean-based sustainability initiatives, the CARICOM Energy Unit must increase its presence as a central platform for collaboration, information sharing, and resource coordination.

Through regional collaboration, CARICOM's 15 member states now have a tremendous opportunity to maximize their individual resources and to spearhead sustainable energy development region-

wide 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. Full transformation of the CARICOM energy sector will be a long-term process requiring extensive commitment and dedicated collaboration among all member states as well as 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 instead will 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.

1 The Caribbean at an Energy Crossroads

Confronted by acute challenges associated with energy consumption and generation, the Caribbean region stands at a crossroads. Heavy dependence on imported fossil fuels exposes many Caribbean countries to volatile oil prices, produces high electricity tariffs, limits economic development and social opportunity, and negatively affects human health and the environment. It also fails to establish a precedent for global action to mitigate the long-term consequences of climate change, which pose an urgent threat to small-island states and low-lying coastal nations.

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.

1.1 Energy and the Regional Context of CARICOM

Established in 1973 under the Treaty of Chaguaramas, CARICOM is a regional organization representing 15 member states: Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago.

CARICOM member states, representing a total population of just over 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 the tourism and service sectors represent the economic mainstays of many CARICOM member states, other important industries, including agriculture, manufacturing, and mining, flourish across the region. In 2015, the per capita gross domestic product (GDP) (at purchasing power parity, PPP) ranged from USD 1,799 in Haiti to USD 32,654 in Trinidad and Tobago. This wide range in GDP demonstrates

both the region's economic diversity (see Table 1) and the need for a regional energy strategy to consider a wide range of development capacities and priorities.[1]

Table 1. Selected Indicators of CARICOM Member States

Country	Population (2014)	Total Land Area	Urban Population Share (2014)	GDP (2015)	GDP Per Capita (2015)	Major Industries
		square kilometers	percent	billion USD, PPP	USD, PPP	
Antigua and Barbuda	91,295	443	24	2.1	22,966	Tourism, construction, light manufacturing
The Bahamas	321,834	13,380	83	9.3	25,577	Tourism, banking, cement, oil transshipment
Barbados	289,680	430	32	4.6	16,425	Tourism, sugar, light manufacturing, component assembly
Belize	340,844	22,966	44	3.0	8,321	Tourism, oil, food processing, garments, construction
Dominica	73,449	751	69	0.8	11,154	Agriculture, tourism, financial and other services, water bottling, soaps, essential oils
Grenada	110,152	344	36	1.3	12,231	Food and beverages, textiles, light assembly, tourism
Guyana	735,554	214,969	29	5.8	7,200	Bauxite, sugar, rice milling, timber, textiles, gold mining
Haiti	9,996,731	27,750	57	19.1	1,799	Textiles, sugar refining, flour milling, cement
Jamaica	2,930,050	10,991	55	24.7	8,784	Tourism, bauxite/alumina, rum, chemicals, agricultural processing
Montserrat	5,215	102	9	0.04	8,500	Tourism, rum, textiles, electronic appliances
Saint Lucia	163,362	616	18	2.0	11,832	Tourism, clothing, assembly of electronic components, beverages
St. Kitts and Nevis	51,538	261	32	1.3	21,585	Tourism, cotton, salt, copra, clothing
St. Vincent and the Grenadines	102,918	389	50	1.2	11,088	Tourism, food processing, cement, furniture, clothing
Suriname	573,311	163,820	60	9.5	17,062	Bauxite and gold mining, alumina production, oil, lumber, food processing
Trinidad and Tobago	1,223,916	5,128	9	44.3	32,654	Petroleum and petroleum products, LNG, methanol, ammonia, urea, steel products, beverages, food processing, cement

Source: See Endnote 1 for this section.

Despite this diversity, CARICOM member states face many shared energy challenges. (See Figure 1.) Most CARICOM members rely almost exclusively on fossil fuels for both transportation and electricity generation. Because most member states have few to no 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 them to devote a large portion of their annual GDP to energy imports. This impedes broader economic and social development by depleting and damaging natural resources, diverting to foreign energy 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 economic development and foreign investment well beyond the energy sector.[2]

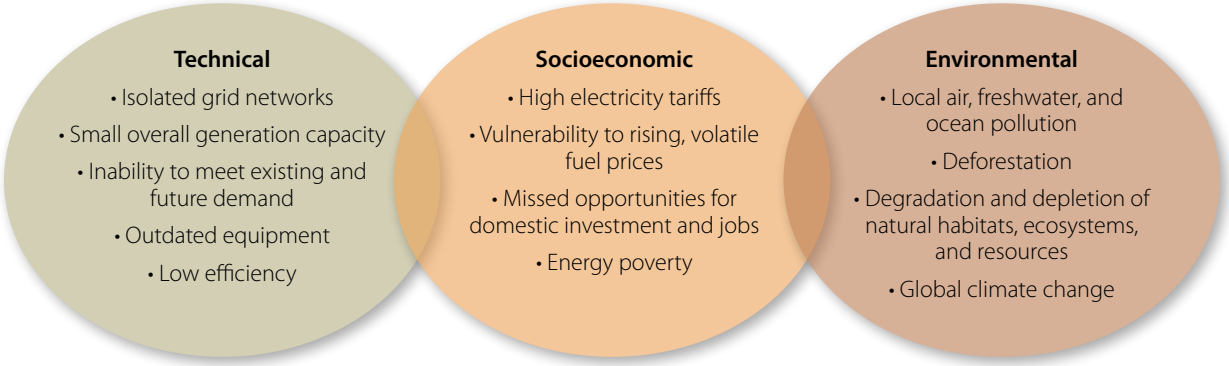

FIGURE 1. Major Energy Challenges in the CARICOM Region

The characteristics of most electric power systems throughout the region—isolated, outdated grids, small overall generation capacity, and 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, these systems rely mainly on expensive imported fuels such as heavy fuel oil (HFO) and diesel, further exacerbating the cost issues facing CARICOM member states. Low efficiency across the region in the transportation, manufacturing, food processing, residential, and commercial sectors, as well as in the electricity sector itself, further aggravates energy system costs. All member states share a particular vulnerability to the environmental and socioeconomic impacts of climate change, caused largely by the burning of fossil fuels. These impacts include 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. Proven grid technologies exist that can be used to renovate outdated infrastructure, and tested economic models and effective policies are available to make the necessary investments happen. Caribbean countries, 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 that is financially, economically, and socially sustainable.

Small-island states such as those in CARICOM can serve as ideal showcases for low-emissions 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 the development of indigenous and renewable energy resources.

Recognizing the need to forge 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.[3]

Just over a decade later, promoting a shift to sustainable energy through increased use of renewable energy sources and improvements in energy efficiency became a central focus of the CARICOM Energy Policy. This Energy Policy, approved in 2013, looks to maximize the positive economic, social, and environmental benefits that have come from developing sustainable energy solutions around the world. The renewables sector has become a powerful economic force, with investments of USD 270 billion in 2014 alone.[4] Increased investment and technology deployment have contributed to a robust industry network that supports more than 7.5 million jobs worldwide, three times as many as in 2008.[5]

An energy system that is built on the efficient use of domestic renewable energy sources can provide extensive benefits to society, including greater energy affordability, expanded energy access, reduced negative health impacts of fossil fuel use, and greatly minimized resource depletion and environmental degradation. These benefits should not be underestimated: in the United States alone, reliance on fossil fuels results in an estimated USD 120 billion annually in "hidden costs" related to pollution control and health care.[6]

1.2.1 Benefits of a Regional Approach to Energy Development in CARICOM

The recent passage of the CARICOM Energy Policy demonstrates the region's understanding that a cohesive and coordinated regional approach will make it easier to tackle the many challenges of a fundamental energy transition and help to achieve sustainable energy goals more efficiently and cost-effectively. Although individual CARICOM member states can contribute greatly to advancing the production, import, deployment, 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 can create economies of scale and allow

energy to be produced where it is cheapest, and then traded, resulting in cost-effective sustainable energy supply options to the benefit of all participating states.

In the Caribbean region, where many countries are too small to independently develop renewable energy projects on a scale large enough to attract investments from volume-oriented international financial markets, a regional approach can aggregate projects and reduce transaction costs, thereby increasing the attractiveness of investments and creating new financing opportunities. Over time, and if designed properly, a regional approach also can contribute to the development of regional supply chains, knowledge sharing, and capacity building, leading to broader economic and social benefits, including accelerated job creation.

Given these advantages, regional cooperation on sustainable energy development is advancing in many parts of the world. The European Union (EU) is just 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 and North Africa (MENA) region, and the Union for the Mediterranean all represent regional inter-governmental efforts to cooperate on sustainable energy development.

Regional coordination comes with a 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 regional program. Member states must agree on how to share burdens fairly and equitably in a practicable way. 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 effective 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 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 The Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS)

Supporting and complementing 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 Organization of American States' (OAS) Global Sustainable Energy Islands Initiative—have been established to address sustainable development challenges in the region. They have resulted in many important studies and projects, as well as in 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 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 members agreed in 2009 to develop and implement a regional Sustainable Energy Roadmap focused on improving energy efficiency and increasing the use of renewable energy. Phase 1 of the Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS I) has been tasked with serving 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, energy efficiency, and modern grid technologies in the region.

C-SERMS I is also tasked with recommending preliminary sustainable energy targets for the region based on an initial assessment of renewable resource potential, 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. In particular, targets provide investors with the signals of long-term stability that they need in order to commit the financing required for project implementation.

On a global scale, national targets for both energy efficiency improvements as well as renewable energy capacity and shares are being adopted at an increasing rate. The number of countries promoting renewable energy and policy support tripled from 45 in 2004 to 137 in 2014, more than half of which were developing countries.[8] Similarly, regional organizations have begun suggesting targets for cooperation among their member states. Intergovernmental organizations such as the EU and ECOWAS have taken the lead in pioneering this regional approach. (See Section 5.1.) Efforts within CARICOM to replicate this approach led to the creation in February 2015 of the Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE). CCREEE focuses on technical implementation and execution of CARICOM's regional renewable energy and energy efficiency programs, projects, and activities, fostering information sharing and regional cooperation.[9]

CARICOM's determination to set regional targets represents a significant milestone for the organization and for the region as a whole, placing it within a select group of leading organizations that are setting the groundwork for comprehensive regional energy planning. The targets for renewable energy, energy efficiency, and greenhouse gas emissions that are suggested in this report have been defined with input from CARICOM and all member states. Supported by targeted technical, financial, and policy measures, as well as sufficient institutional capacity, they are intended to serve as an important strategic planning mechanism to achieve overarching regional sustainability and development goals. Ultimately, they can 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

This report and the overall C-SERMS initiative build on existing regional efforts by examining previous analyses and available data. Working with the CARICOM Secretariat and its member states, the goal has been to advance a new vision for the region's future energy landscape. The study explores and defines

short-term (2017), medium-term (2022), and long-term (2027) targets for renewable energy penetration, energy efficiency improvements, and reductions in carbon dioxide (CO_2) emissions. (See Figure 2.)

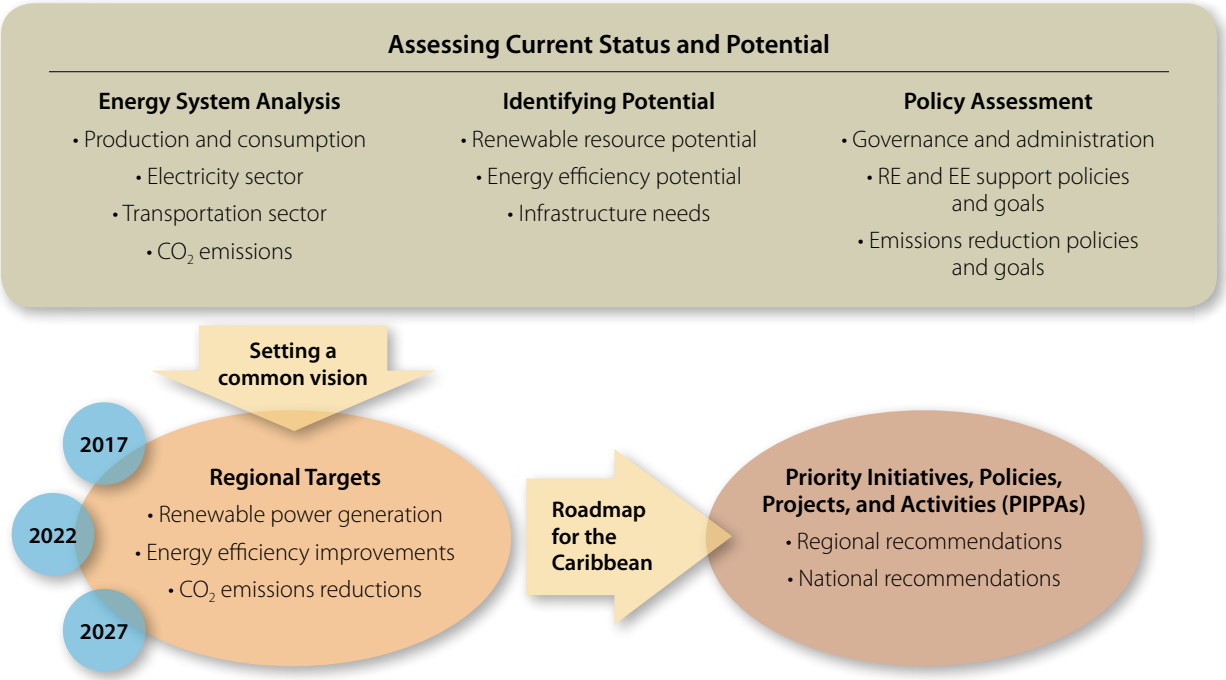

FIGURE 2. **C-SERMS Phase I Methodology**

An early draft of this analysis 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. It provided an initial overview of the energy situation in CARICOM member states. Two years on, this final *Baseline Report and Assessment* builds on feedback on the earlier draft as well as on regional and international best practices to present a strategic overview of how CARICOM can continue to advance the C-SERMS initiative and its objectives. The report has been updated to reflect current data and progress made as CARICOM continues to pursue a coordinated regional strategy of sustainable energy development.

This study first surveys key aspects of the region's current energy situation, including overall energy inputs and outputs (Section 2.1), electricity (Section 2.2), transportation (Section 2.3), and CO_2 emissions (Section 2.4). It also identifies significant data gaps within each of these categories. The report subsequently details the region's potential and current initiatives for both renewable energy (Sections 3.1 and 3.2) and energy efficiency (Sections 3.3 and 3.4) and reviews the socioeconomic impacts of renewables to better inform policymakers of their true value, particularly in the long term. The report also identifies key challenges and opportunities associated with integrating renewable energy technologies into existing power grids (Section 3.5) and interconnecting regional grid systems (Section 3.6).

The report then identifies CARICOM's existing regulatory policy environment (Section 4.1), along with concrete existing policies for renewable energy and energy efficiency (Section 4.2), as a baseline for

a comprehensive set of regional renewable energy, energy efficiency, and emissions reduction targets (Section 5). Finally, the report concludes with recommendations for a series of national and regional-level priority projects, policies, and initiatives that should be undertaken by CARICOM and its member states to achieve these goals (Section 6 and Annex B), along with projections of CARICOM member state energy capacity and sectoral emissions forecasts for different energy generation scenarios (Annex A).

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

CARICOM member states exhibit heavy—and in many cases nearly exclusive—reliance on fossil fuels to fulfill their energy needs. In most cases, they rely on sources such as distillates (diesel) and fuel oil because of the low capital costs and ease of modularity associated with using these fuels.[1]

Although some member states continue to investigate coal as a potential baseload fuel source, it plays a minimal role in the region's overall energy balance.[2] In 2013, CARICOM projected that the share of nuclear power used in the region might rise to 8% by 2035.[3] However, nuclear power capacity has not yet been developed by any CARICOM member. 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 from natural gas and remains CARICOM's primary producer and sole exporter of that resource.[4] Haiti obtains approximately 20% of its primary energy from traditional biomass, particularly charcoal.[5] In addition to being an emissions-intensive energy source, widespread charcoal use contributes to Haiti's serious deforestation, increasing the country's vulnerability to severe weather events and limiting opportunities for agricultural development.

Although the use of renewable energy in the CARICOM region is comparatively minor, hydropower produces a significant share of electricity in Belize, Haiti, and Suriname. Belize also relies extensively on modern biomass, and Jamaica leads CARICOM member states in developed wind power. Other countries, such as Barbados, Guyana, St. Kitts and Nevis, and St. Vincent and the Grenadines, 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 installed nationwide.[6] And Montserrat, which has enormous geothermal energy potential, has set ambitious targets to source 100% of its electricity supply from geothermal by 2020 and has secured USD 6.5 million in funding from the U.K. Department for International Development for exploratory drilling.[7] 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 Section 3.

2.1.2 Energy Production and Consumption

In the majority of CARICOM member states, energy consumption continues to outweigh primary energy production.[8] (See Figure 3.) As a result, 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, although recent exploration by ExxonMobil of regional offshore assets may soon add Guyana to this list.[9] Even in these countries, however, production often is insufficient to meet domestic demand, and only Suriname and Trinidad and Tobago are net producers by volume.[10] Due to the high overall volume of oil produced and consumed in Trinidad and Tobago, the country remains a regional outlier.

Energy production is the cornerstone of Trinidad and Tobago's economy, accounting for some 45% of nominal GDP and 58% of government revenue in 2010. As a result, the country produces energy at levels far above those seen in other CARICOM states, accounting for roughly 97% of regional primary energy

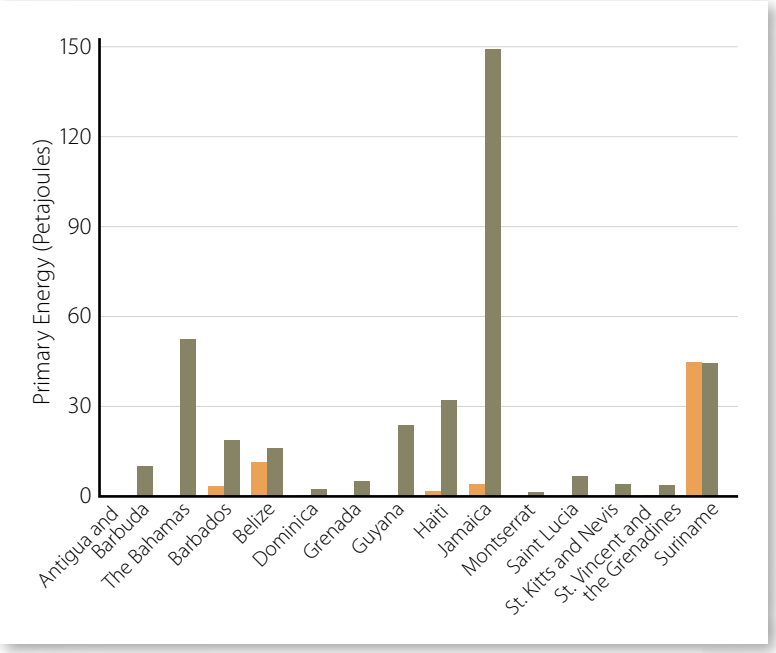

FIGURE 3.

Primary Energy Production and Consumption in CARICOM Member States, 2012

Note: Figure excludes Trinidad and Tobago.
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production in 2012.[11] It also consumes much more than the other member states, accounting for 75% of all primary energy consumed within the region that year.[12] (See Figure 4.)

Although most member states depend 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.[13] (See Figure 5.)

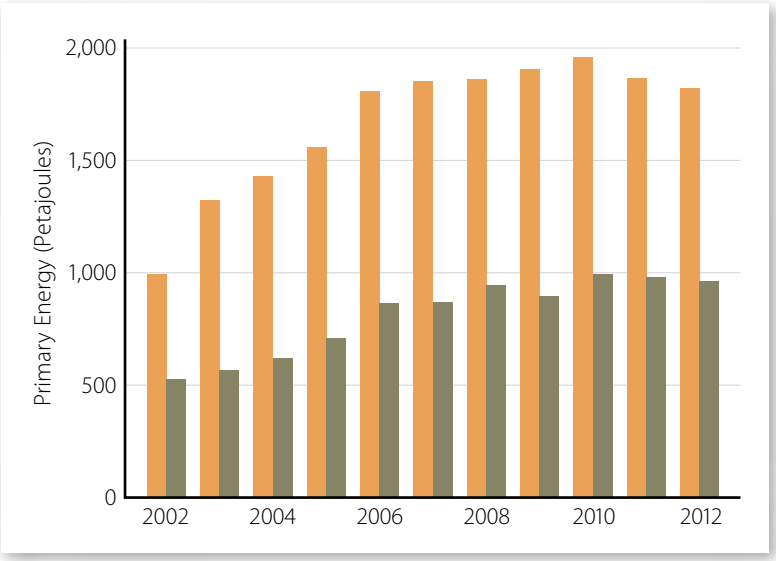

FIGURE 4.

Primary Energy Production and Consumption in Trinidad and Tobago, 2002–12

Source: EIA
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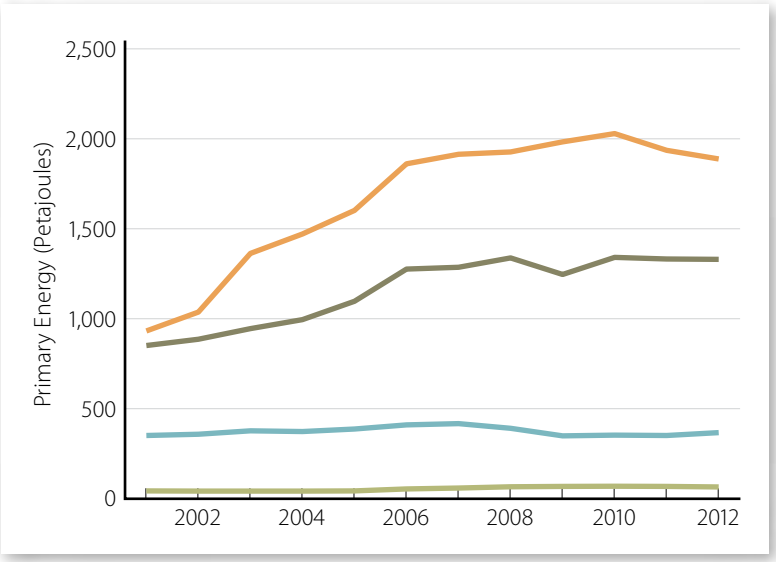

FIGURE 5.

Primary Energy Production and Consumption in the CARICOM Region, 2001–12

Source: EIA
© Worldwatch Institute

2.1.3 Petroleum Imports and Exports

Imports

Most CARICOM member states depend heavily on imported fossil fuels. For several members, particularly the larger energy consumers, the global economic recession triggered a general downward trend in petroleum imports, including through the Petrocaribe agreement, during the years leading up to 2011.[14] (See Figure 6 and Sidebar 1.) Only a few countries (Jamaica, Suriname and Trinidad and Tobago) have the

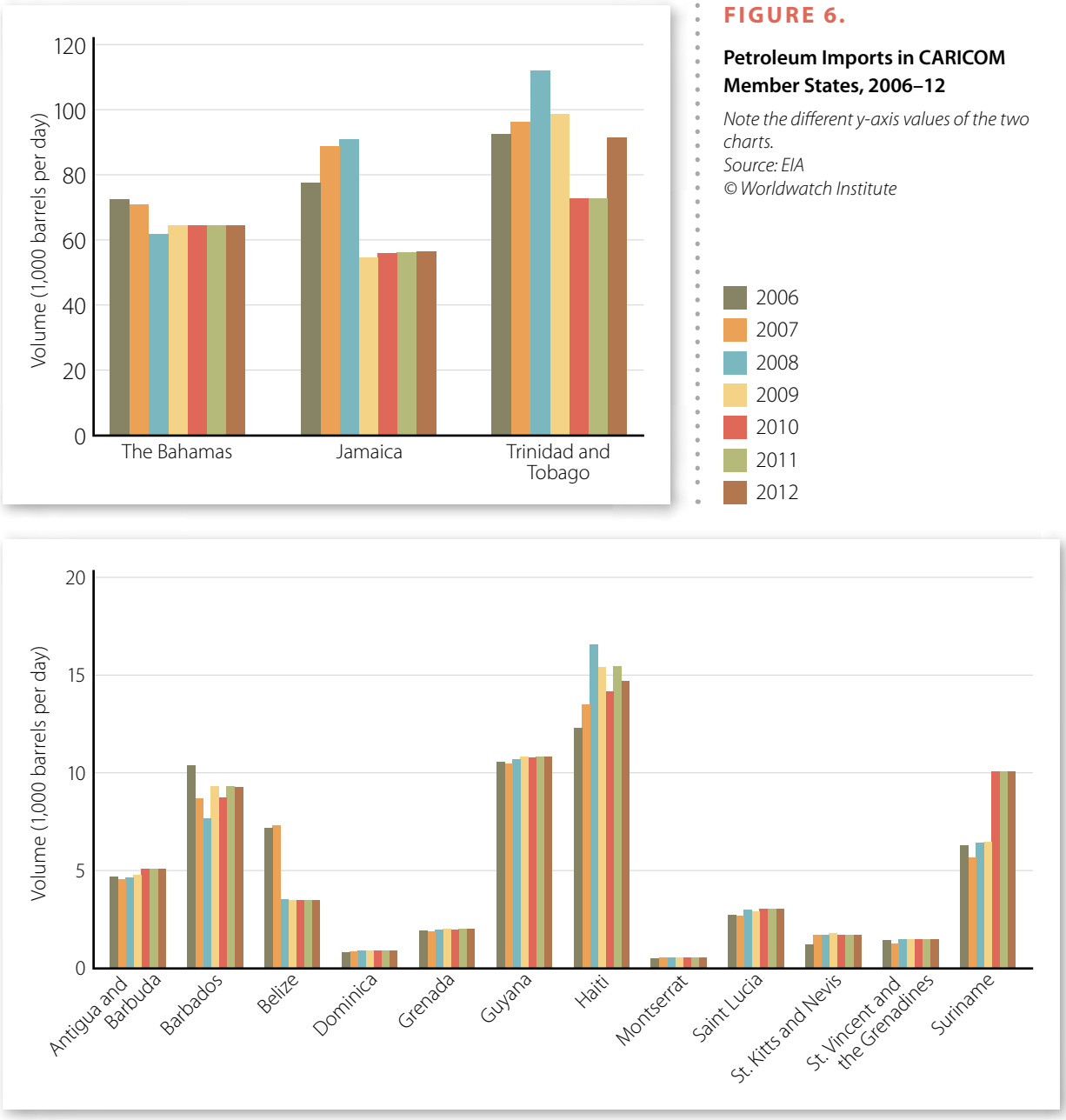

FIGURE 6.

Petroleum Imports in CARICOM Member States, 2006–12

Note the different y-axis values of the two charts.
Source: EIA
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Sidebar 1. The Impact of Petrocaribe on the CARICOM Region

Since its inception in 2005, the Petrocaribe S.A. agreement has been an important factor in energy policy throughout the CARICOM region. Twelve 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.

Although 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 arguably has had mixed impacts on energy security, reducing intra-regional trade while leaving many countries highly dependent on oil imports from a single country and vulnerable to terms that can change on fairly short notice. The pact also has contributed to the high debt-to-GDP ratios of many Caribbean nations. Moreover, the agreement 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	Share Financed Through Loans	Interest Rate	Financing Period*
USD/barrel	percent	percent	years
>15	5	2	5
>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

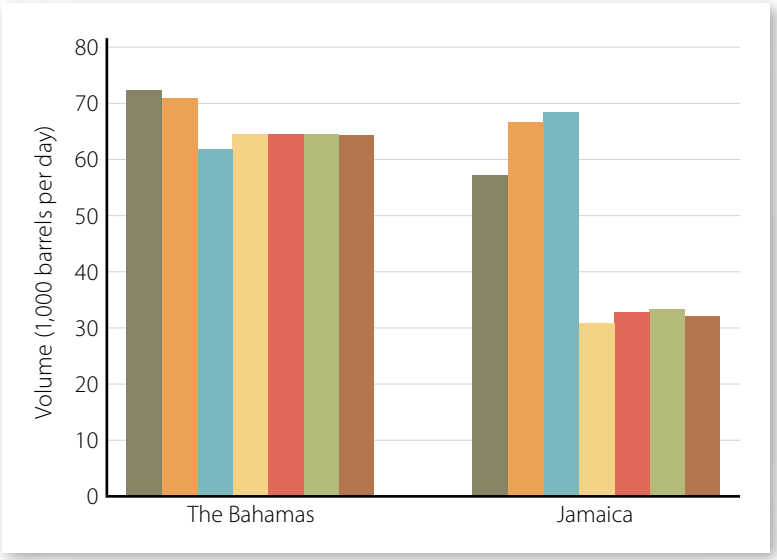
** An additional two-year grace period is included on top of the given financing period for total repayment periods of 17 and 25 years.*

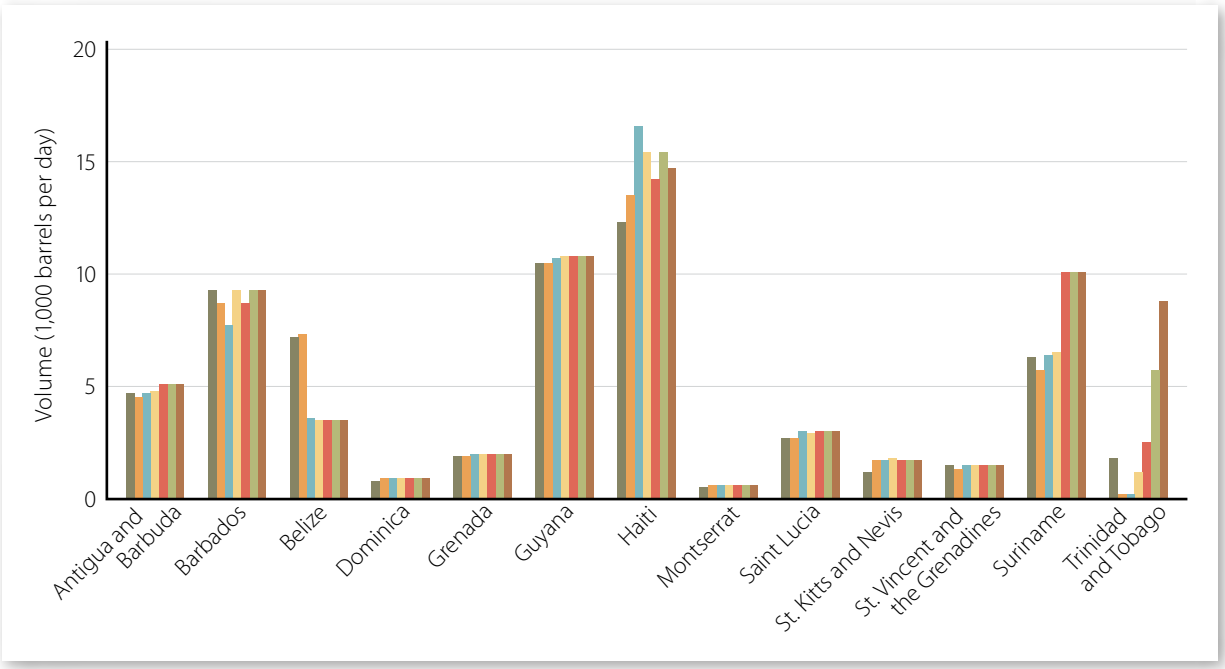
The combination of changing domestic economic conditions in Venezuela, reductions in oil production, and the death of President Hugo Chavez has made the future of Petrocaribe unclear. The agreement costs Venezuela an estimated USD 5 billion in forfeited revenue annually. With the country's production 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.

Source: See Endnote 14 for this section.

refining capacity to process crude oil, with Trinidad and Tobago importing and processing significantly more than either of the other two.[15]

All CARICOM member states import refined petroleum products, mainly residual and distillate fuel oils, reflecting the region's widespread use of diesel generators.[16] (See Figures 7 and 8.) The relatively





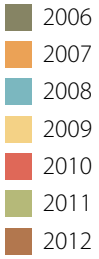


FIGURE 7.

Refined Petroleum Imports in CARICOM Member States, 2006–12

Note the different y-axis values of the two charts.
Source: EIA

significant amounts of imported motor gasoline reflect the importance of the transportation sector, discussed further in Section 2.3.

Exports

Seven countries have exported either crude or refined petroleum since 2000: Antigua and Barbuda, The Bahamas, Barbados, Belize, Jamaica, Suriname, and Trinidad and Tobago, which exports far more than the others.[17] (See Figure 9.) Belize and Jamaica last exported in 2000 and 2008, respectively, indicating regional

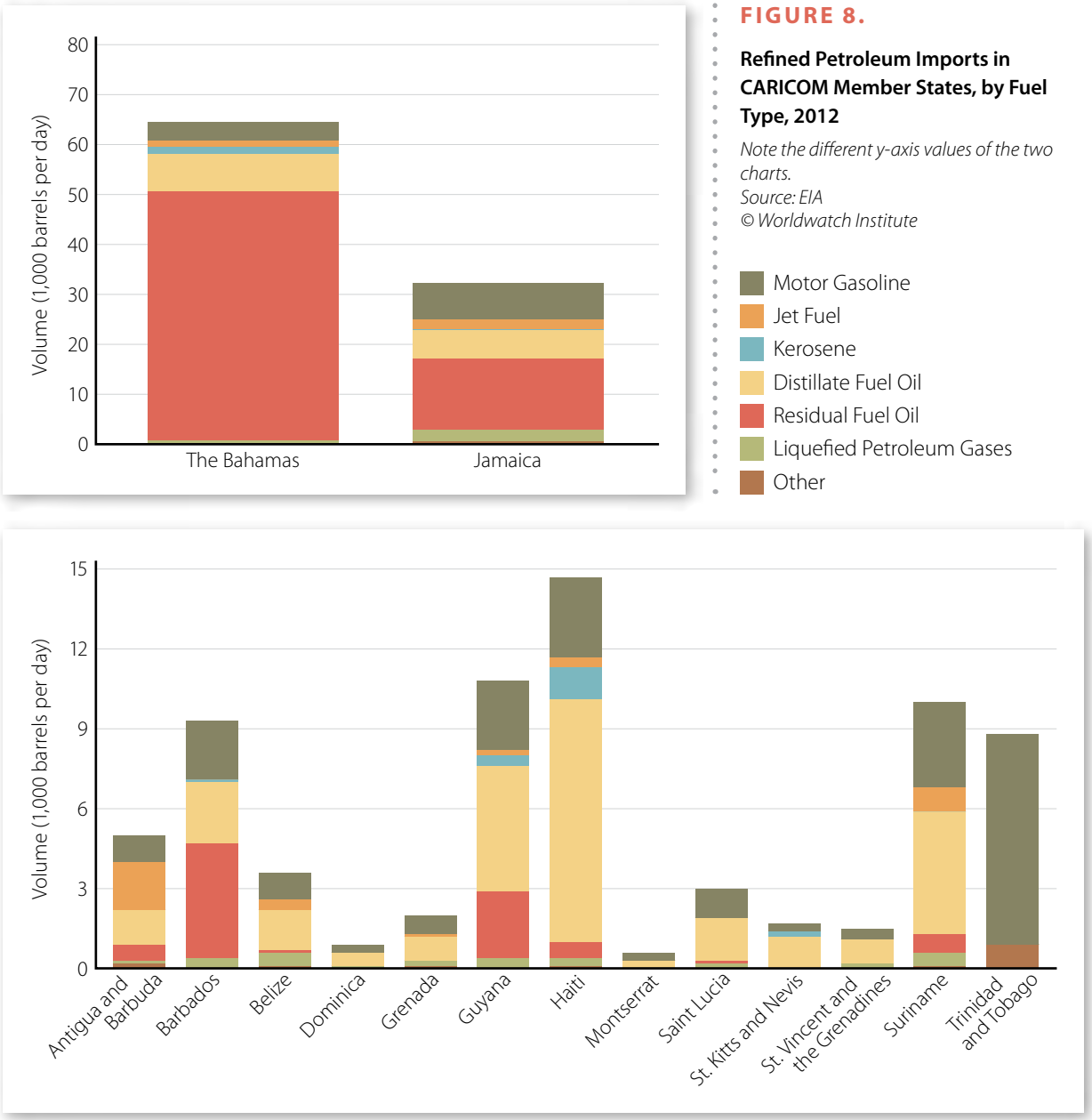


FIGURE 8.

Refined Petroleum Imports in CARICOM Member States, by Fuel Type, 2012

Note the different y-axis values of the two charts.
Source: EIA

shifts in the import/export balance. Of the seven countries, four (Barbados, Belize, Suriname, and Trinidad and Tobago) were exporters of crude oil, with Barbados exporting crude to Trinidad and Tobago for refining. As of 2013, the majority of refined petroleum exports were residual fuel oils.[18] (See Figures 10 and 11.)

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

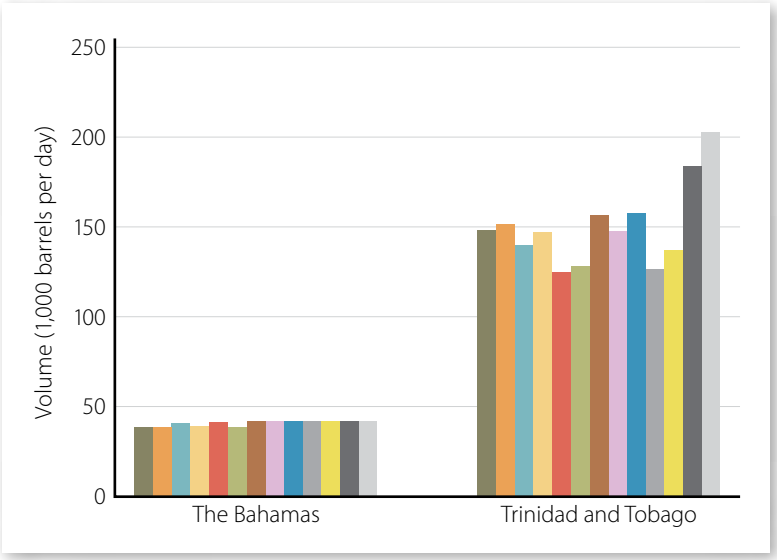
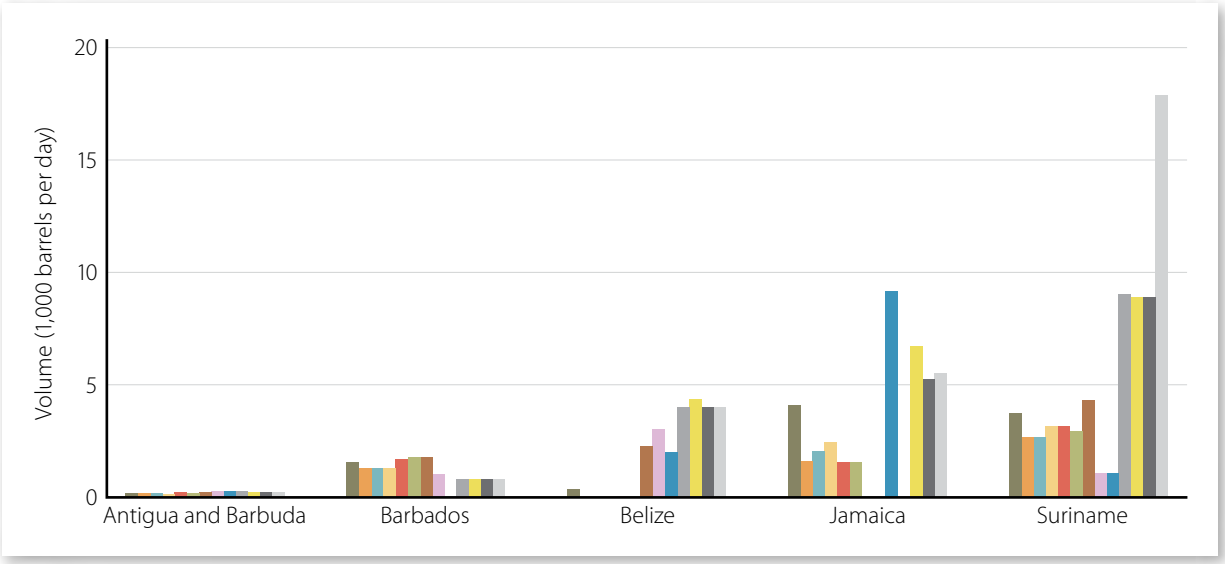


FIGURE 9.

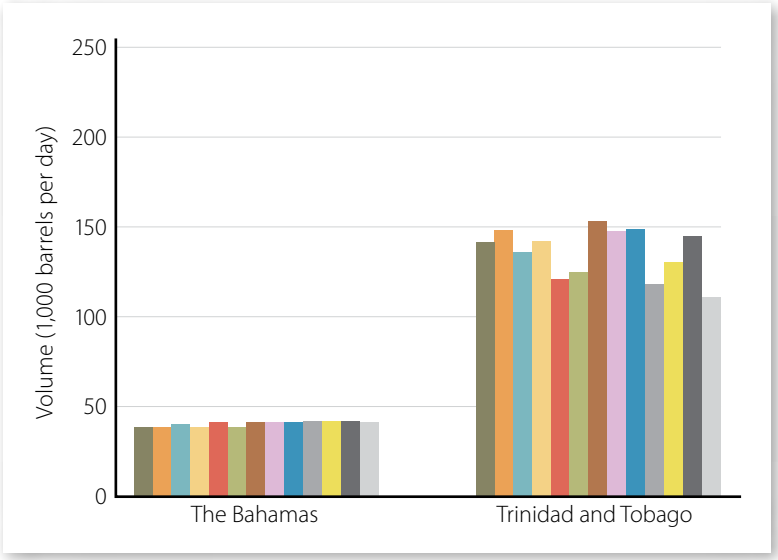
Petroleum Exports in CARICOM Member States, 2000–12

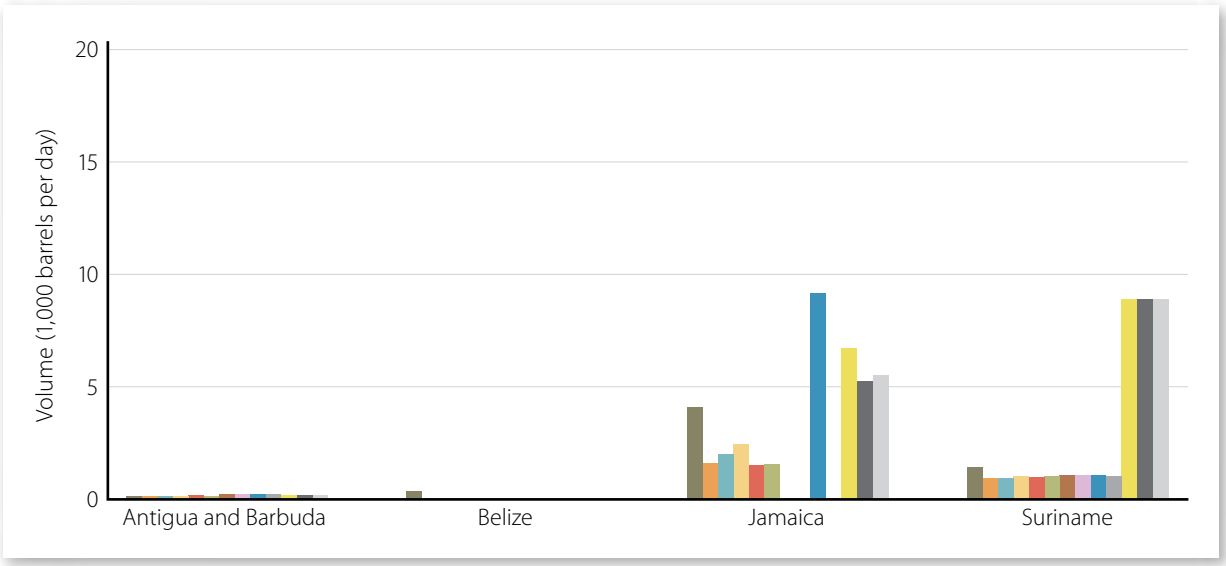
Note the different y-axis values of the two charts.
Source: EIA © Worldwatch Institute



the early 1990s, and by 2011, the country's natural gas output was approximately eight times higher than that of oil.[19] This domestically produced gas is used for a variety of purposes, including liquefied natural gas (LNG) production (56.5%), petrochemical manufacturing (28.6%), and electricity generation (8.0%).[20] (See Figure 12.) In 2014, Trinidad and Tobago was the world's sixth largest LNG exporter, representing just over 6% of the global export market.[21] This LNG is exported outside CARICOM, however, since member states currently do not have the capacity to import and utilize it.

In the Caribbean region as a whole, only the Dominican Republic and Puerto Rico, both of which are observer states in CARICOM, had operational LNG regasification terminals as of year-end 2014. Meanwhile, Jamaica has sought to diversify its energy supply mixture by considering a Floating Storage and Regasification Unit (FSRU). A government assessment projects demand of 2.5 million tons of LNG





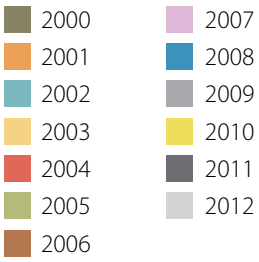


FIGURE 10.

Refined Petroleum Exports in CARICOM Member States, 2000–12

Note the different y-axis values of the two charts.
Source: EIA © Worldwatch Institute

annually by 2025 if the FRSU is implemented.[22] These efforts have, thus far, been stymied by disagreement between the Jamaican government and two utility providers, Jamaico and JPS, over per-unit volume costs for LNG import.[23]

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 elsewhere, including Argentina, South Korea, and Spain. The United States had been a large importer of natural gas from Trinidad and Tobago, but hydraulic fracturing ("fracking") has led to a decline in U.S. LNG imports. Nevertheless, some CARICOM member states continue to consider the option of LNG, particularly in light of advances in infrastructure technology.

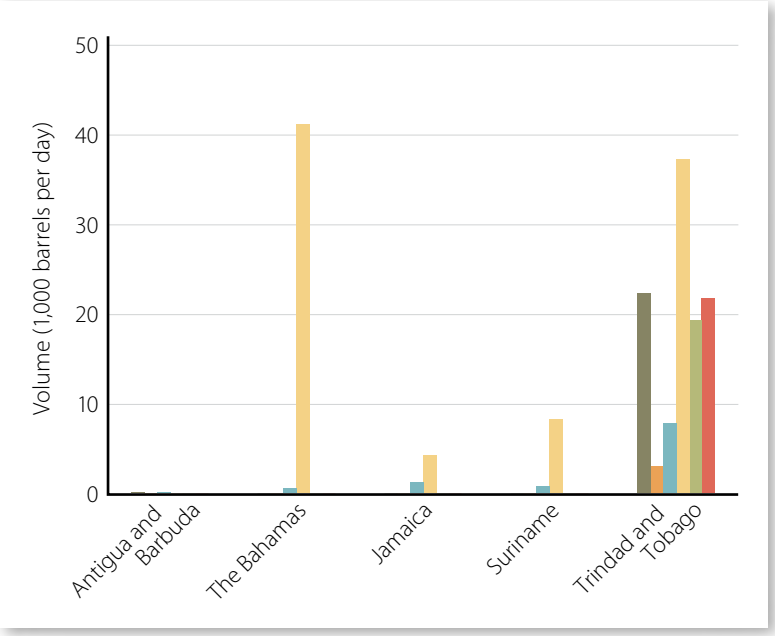


FIGURE 11.

Refined Petroleum Exports in CARICOM Member States, by Fuel Type, 2012

Source: EIA
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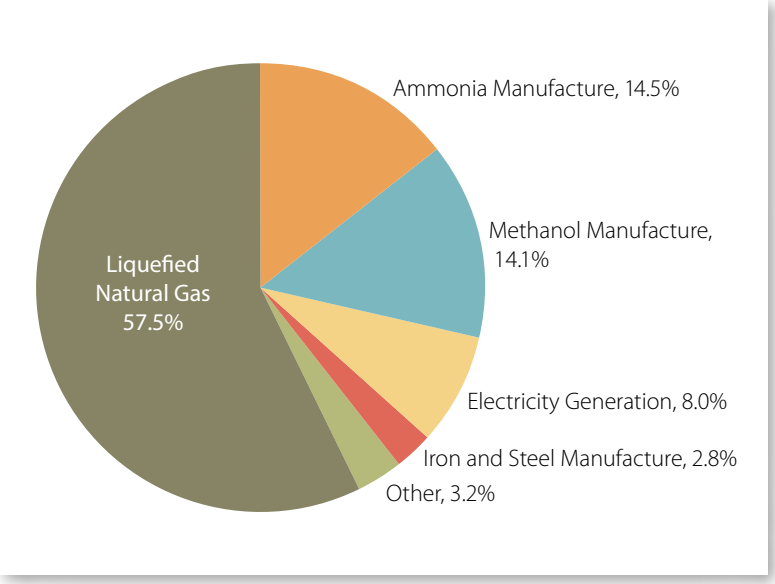


FIGURE 12.

Natural Gas Use in Trinidad and Tobago, by Sector, 2014

Outside of Trinidad and Tobago, Barbados has developed an extensive domestic natural gas network connecting 16,575 residential and 640 commercial customers.[24] Jamaica is close to finalizing plans for a long-awaited overhaul of its generation system using natural gas.[25] Currently, Jamaica utilizes compressed natural gas (CNG) because this allows for modest volumes of gas to be delivered over relatively short distances, foregoing the need for regasification.[26]

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 available data.[27] (See Figure 13.) Transportation accounts for a large share of total consumption in all states for which data are available, indicating the critical role that this sector must play in any effective regional energy strategy. Transportation's share of energy consumption is especially high in Barbados (48%), Belize (45%), and Grenada (33%). (See Section 2.3 for more on transportation.)

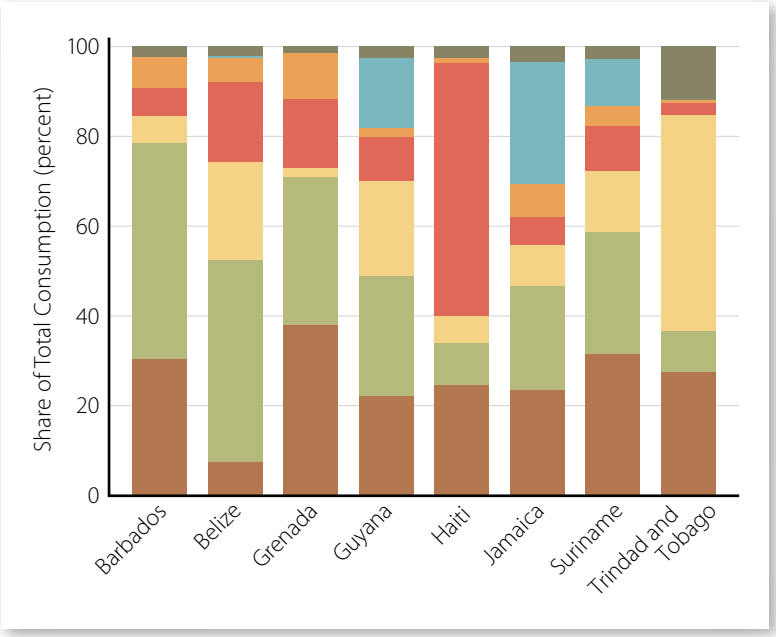


FIGURE 13.

Total Primary Energy Consumption in Selected CARICOM Member States, by Sector, 2014

Note: Remaining CARICOM member states are not included due to lack of available data.
Source: OLADE

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 economies. Thus, C-SERMS, while emphasizing the need to reduce emissions, also must consider the economic importance of energy-intensive industries for member states and for the region as a whole. In Suriname, for example, the bauxite/alumina industry is a mainstay of the economy, accounting for 15% of GDP and 70% of export earnings in 2008.[28] Promoting renewable power in such industries is not without challenges because existing production capacities and storage systems must be scaled up greatly to meet industrial demand for energy.

More climate-compatible industry alternatives do exist, however. The potential for ecotourism in Suriname is significant, with nearly 12% of the country's land area already incorporated in national parks.[29] Achieving regional targets for renewable energy, energy efficiency, and emissions reductions will require thorough and innovative analysis of ways in which major energy-intensive industries can be integrated into a sustainable energy transition, likely through a combination of energy efficiency improvements, co-generation opportunities, and the development of climate-compatible industry alternatives.

The tourism sector has enormous economic importance throughout CARICOM. It also accounts for 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% of the island's total generation capacity, highlighting the crucial role that the sector must play in a regional energy strategy.[30] Many resorts and tourism operators in the region already are engaged in efforts to boost energy efficiency and reduce environmental impacts. (See Section 3.4.)

2.1.6 Ongoing Developments and Potential Game Changers

Over the coming years, several key energy developments have the potential to dramatically change the Caribbean energy sector. These include:

***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, hydropower, solar, and wind is growing in the region, offering new opportunities for power generation, heating, cooling, and transportation. Energy efficiency is being taken more seriously across the region than ever. Many goals have been set, and policies and concrete projects are in the phases of either design or implementation. Existing projects and potentials are discussed later in this report.

***Geothermal energy development*:** Although geothermal energy has been slow to develop in CARICOM, it offers tremendous opportunities for those member states with high resource potentials, and even for the region as a whole if it can benefit from opportunities for interconnection and trade. Investment risks, long lead-times, and economies of scale have hampered geothermal exploration in the Caribbean in the past, but several new initiatives indicate that some CARICOM members are close to overcoming these challenges. Geothermal plants are undergoing preliminary construction in St. Kitts and Nevis and in St. Vincent and the Grenadines. Exploratory drilling has taken place in Dominica and Montserrat. Meanwhile, Grenada and Saint Lucia are conducting on-site resource assessments and exploring the possibility of commercial-scale extraction. These developments are discussed in Section 3.

***Increased use of distributed renewable energy 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 access in remote and underserviced areas in a more cost-effective manner.

***Use of nascent renewable energy technologies*:** In light of the Caribbean's unique geographical characteristics, nascent renewable energy solutions are being explored as well. 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 the top world sites, 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 deployed widely.

***Offshore oil production*:** Despite the heightened focus on using renewable energy technologies in recent years, regional interest in offshore oil exploration has grown as well, triggered by hopes of diversifying

economies and easing demand for imported oil. In addition to Trinidad and Tobago, which already has many offshore oil facilities, several other CARICOM members are exploring the option. The Bahamas is drilling near Cuba's offshore territory, and development will depend on the results of the exploration process and a voter referendum. Barbados, Jamaica, and Suriname also are engaged in exploratory drilling. In Guyana, ExxonMobil has discovered substantial offshore oil reservoirs from exploratory drilling and is assessing the commercial viability of extraction.[31] A similar offshore drilling program in Belize remains under moratorium by the country's Supreme Court.[32] If offshore oil drilling gains significant ground in the Caribbean, it will have large ramifications for the region's future energy development.

***Regional electricity connection*:** The potential for regional electricity interconnection has been discussed widely and stands to change the region's energy sector dramatically by providing increased opportunities for trade, more cost-effective supply options, and increased impetus for developing renewable resources such as geothermal and large-scale wind. Best practices for promoting these regional networks given CARICOM's unique geographical, cultural, and economic characteristics are discussed in Section 6.

2.2 Electricity Sector

2.2.1 Overview

The power systems in most CARICOM states share several defining characteristics. The vast majority of member states rely on a single utility that has 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 or rely on agreement with vertically integrated utilities. 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 for those who pay, 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.[33]

2.2.2 Electricity Access

Most CARICOM members have relatively high rates of electricity access.[34] (See Figure 14.) Seven states have universal or near-universal access, and ten have access rates of 90% or higher. Significant exceptions to this pattern include Belize, Guyana, Haiti, and Suriname, which face enormous challenges related to rural electrification and/or energy poverty.

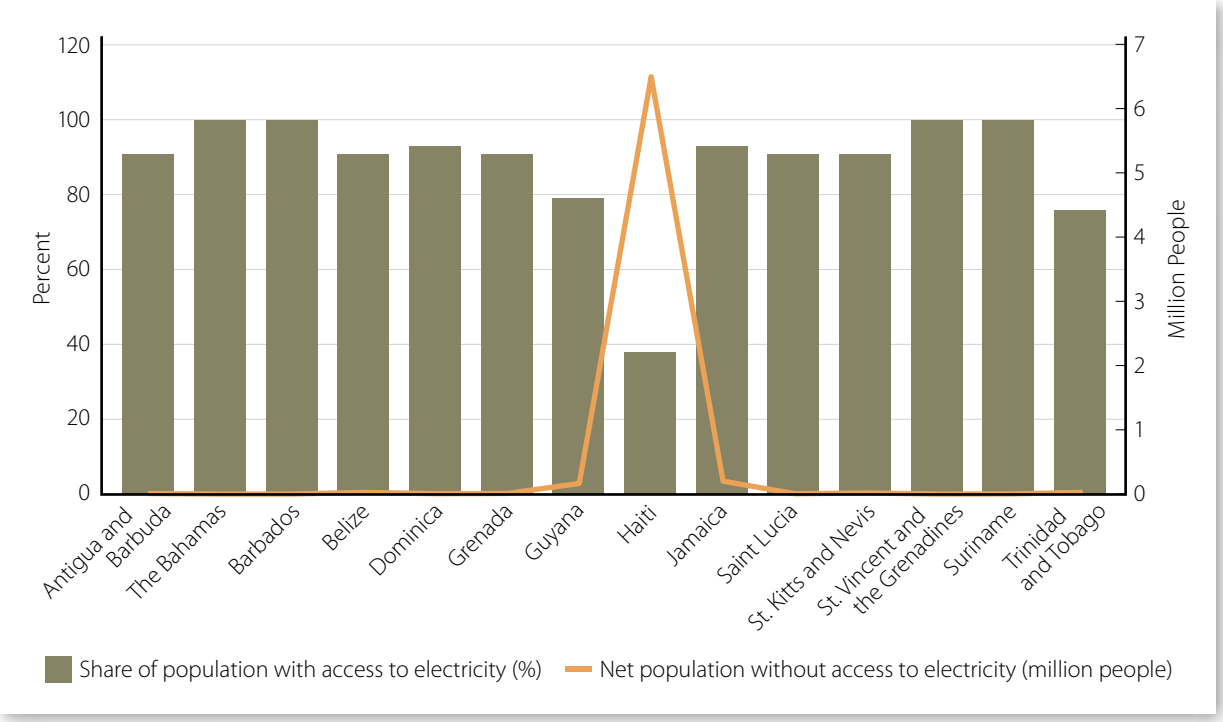


FIGURE 14. Electricity Access in CARICOM Member States, 2015

Source: IRENA, World Bank

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.[35] This poses 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 on several smaller isolated power systems serving the rest of the country.[36] The Hinterlands region of Guyana is similarly disconnected from the national grid.

The governments of Guyana and Suriname have taken measures to address electrification in remote areas. In Suriname, the government has provided daily allowances of diesel fuel to isolated communities.[37] 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 and often unreliable, prompting growing interest in distributed renewable power as a potential solution. According to a 2013 report from the Inter-American Development Bank (IDB), the average cost of Suriname's Rural Electrification Program is approximately 65–100 U.S. cents per kilowatt-hour (kWh), compared to the average national price of 7 U.S. 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."[38]

A renewable approach to extending electricity services to rural areas has proven effective in Guyana, where the country's 2010 Hinterlands Solar PV Program has installed PV systems for some 15,000 households, creating a total of 2 MW of capacity.[39] The use of such small-scale renewable systems could

provide electricity services to similar communities in other member states, including Belize, Haiti, and Suriname, at a much lower cost. In addition to solar PV, small hydropower and wind as well as biomass systems have proven effective. Guyana already plans to use such systems in targeted rural areas as part of the overall Unserved Areas Electrification Programme.[40]

Energy Poverty in Haiti

Haiti faces the most dramatic energy access issues in the CARICOM region. Only 12.5% of the population has official access to the grid. An additional 12.5% is connected illegally, bringing the total electrification rate to only 25%. Although the majority of CARICOM member states have high electrification rates, the comparatively large size of Haiti's population means that only some 59% of CARICOM's total population has access.[41] (See Figure 15.)

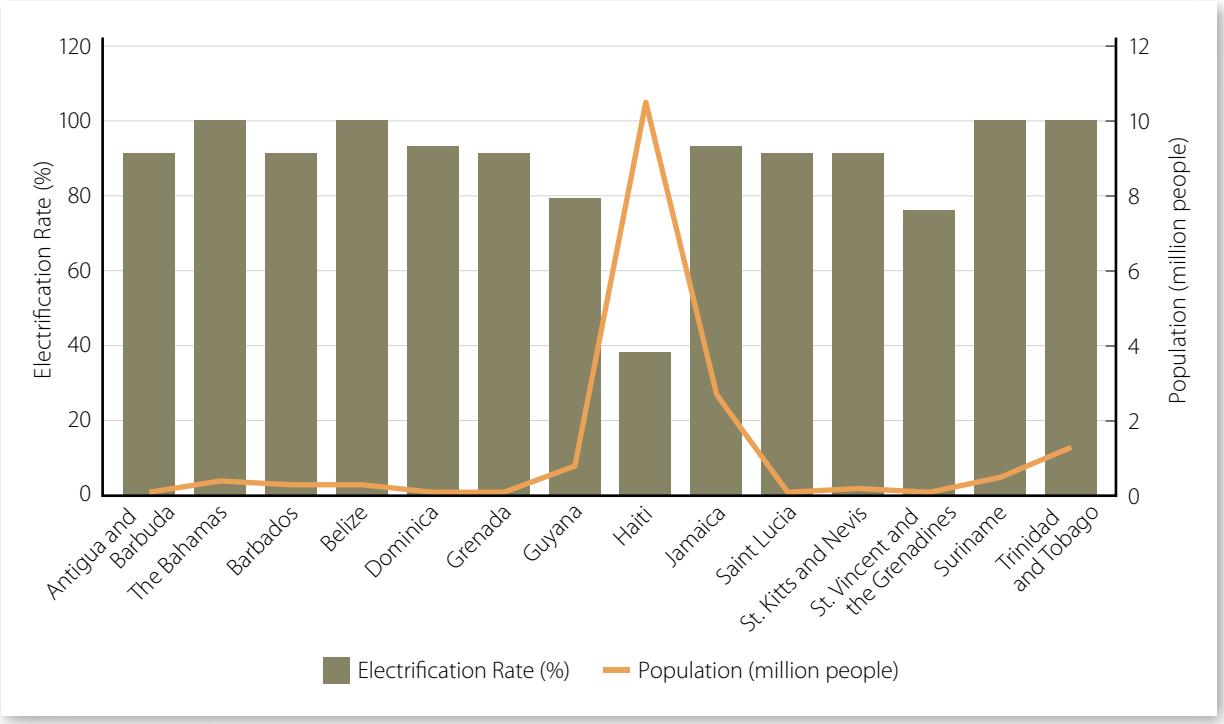


FIGURE 15. Population Size versus Electrification Rate in CARICOM Member States, 2012

Source: World Bank

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.[42] As of 2014, approximately 75% of the country's total installed capacity was located in the greater Port-au-Prince area, even though only about a quarter of the population lives there.[43] Electrification rates in most other areas average about 5%.[44]

As a consequence, Haiti's power sector priorities differ greatly from those of other CARICOM states. Installed capacity in the country must be increased dramatically and rapidly simply to meet existing

demand. Because the Haitian utility, Electricité d'Haiti (EDH), has limited financial and human capacity to expand electricity services and already struggles to provide reliable electricity to the urban population of Port-au-Prince, it is unlikely that it will attempt to extend grid services beyond the capital area in the near future.[45] This makes distributed and renewable energy sources, provided by IPPs, 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, Martelly 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 the use of solar energy.[46] At the same time, several small companies and nonprofits have begun building mini-grids throughout the country. The nonprofit EarthSpark initiated a mini-grid in the southern town of Les Anglais in late 2012, which now supplies more than 400 customers. The grid uses smart meter technology to enable a business model of pre-paid energy. Although the initial small grid was 100% diesel-powered, the expanded mini-grid is a hybrid solar-diesel system with battery storage. The success and momentum behind such projects highlights the potential for mini-grids and smart meter technology in Haiti.[47]

Self-generation

Given the electrification and reliability issues in Belize, 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, several 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) entirely or partly 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. Recently, however, organizations and private institutions have demonstrated the feasibility and affordability of self-generation via renewables.[48] (See Sidebar 2.)

2.2.3 Status of Generation, Transmission, and Distribution Systems

Installed Capacity

Installed electricity capacities in the CARICOM region vary greatly by member state, from more than 2,000 megawatts (MW) in Trinidad and Tobago to less than 10 MW in Montserrat.[49] (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, and existing grids fail to reach large segments of the population. In the region as a whole, energy systems often are 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.

Although installed capacity throughout CARICOM remains predominantly fossil fuel-based, renewable technologies (both grid-tied and off-grid) are being used in the region.[50] (See Table 4.) A small share of this is distributed and self-generation via solar photovoltaics (PV), biomass, and wind. In Guyana, PV is used for rural electrification. In Haiti, there is momentum behind increased use of PV, biomass, and

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 traditionally has been done through the use of privately owned diesel generators, an inefficient and often expensive source of power that contributes to local air and noise 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 19,045-square-meter, solar-powered facility with more than 300 beds. Now fully operational, HUM provides primary care services to an estimated 185,000 people in Mirebalais and other nearby communities—seeing as many as 700 patients a day, 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 serves 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% 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 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 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.

Source: See Endnote 48 for this section.

waste-to-energy technologies, employed by local entrepreneurs often with the backing and support of non-governmental and international agencies.

In the CARICOM region as a whole, 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 further 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 to date. Geothermal developments could drastically change the CARICOM power mix over the medium to long term, but no installed capacity exists. Overall, the rate of additions in renewable capacity has been relatively slow. However, a variety of

Table 3. Installed Power Capacity and Share of Renewables in CARICOM Member States, as of 2015

Country	Installed Power Capacity	Installed Renewable Power Capacity	Renewable Share of Installed Power Capacity
	MW	MW	percent
Antigua and Barbuda	113.0	0.8	0.7
The Bahamas	536.0	0	0
Barbados	240.0	5.5	2.3
Belize	141.8	82.5	58.2
Dominica	27.7	7.6	28.6
Grenada	48.6	0.7	1.4
Guyana	383.0	55.1	14.4
Haiti	390.0*	62.4	16.0
Jamaica	926.4	72.0	7.8
Montserrat	5.5	0	0
Saint Lucia	88.6	0.2	0.2
St. Kitts and Nevis	56.4	3.2	5.7
St. Vincent and the Grenadines	52.3	6.4	12.2
Suriname	410.0	189.0	46.1
Trinidad and Tobago	2,368.0†	0.01	0.005
CARICOM Total	5,787.3	485.4	7.9

** Only 244 MW of this capacity is currently operational. † Capacity of the generators has been derated from 2,368 MW to 2,117 MW due to the age, manufacturer, and ambient conditions of the machines that are presently available to the grid.*
Note: "0" indicates that there is no installed renewable power capacity at present. 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.
Source: See Endnote 49 for this section.

proposed projects in the pipeline, if completed, would dramatically alter installed renewable capacity figures in the region.

Transmission and Distribution Losses

Although data gaps make it difficult to fully account 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 Haiti and Guyana facing extremely high losses and Barbados experiencing minimal losses in the sector.[51] (See Figure 16.)

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

Table 4. Installed Renewable Electricity Capacity in CARICOM Member States, as of 2015

Country	Hydro	Wind	Solar	Biomass and Waste-to-Energy	Total
			MW		
Antigua and Barbuda	0	0.001	0.8	0	0.8
The Bahamas	0	0	0	0	0
Barbados	0	0.002	5.5	0	5.5
Belize	54.5	0	0.48	27.5	82.5
Dominica	6.6	0.23	0.78	0	7.6
Grenada	0	.08	0.6	0	0.7
Guyana	0	0	1.04	54.0	55.1
Haiti	62.0	0	0.4	0	62.4
Jamaica	29.0	42.0	1	0	72.0
Montserrat	0	0	0	0	0
Saint Lucia	0	0	0.16	0	0.2
St. Kitts and Nevis	0	2.2	1	0	3.2
St. Vincent and the Grenadines	5.6	0	0.8	0	6.4
Suriname	189.0	0	0	0	189.0
Trinidad and Tobago	0	0.002	0.006	0	0.01
CARICOM Total	346.7	47.8	12.4	81.2	485.4

Note: "0" indicates that there is no installed capacity at present. 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. None of the CARICOM countries had geothermal power capacity at the time of publication.
Source: See Endnote 50 for this section.

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.

Electricity Costs

Excepting Suriname and Trinidad and Tobago, Caribbean electricity prices rank among the highest in the world, largely because of high operating costs linked to rising fuel prices, inefficient transmission and distribution 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.[52] Even so, due to the differences in installed capacity, the diversity of generation sources, governmental subsidies, and other factors, electricity tariffs charged to residential consumers range across CARICOM member states from as low as 4 U.S. cents per kWh to 33 U.S. cents per kWh.[53] (See Figure 17.)

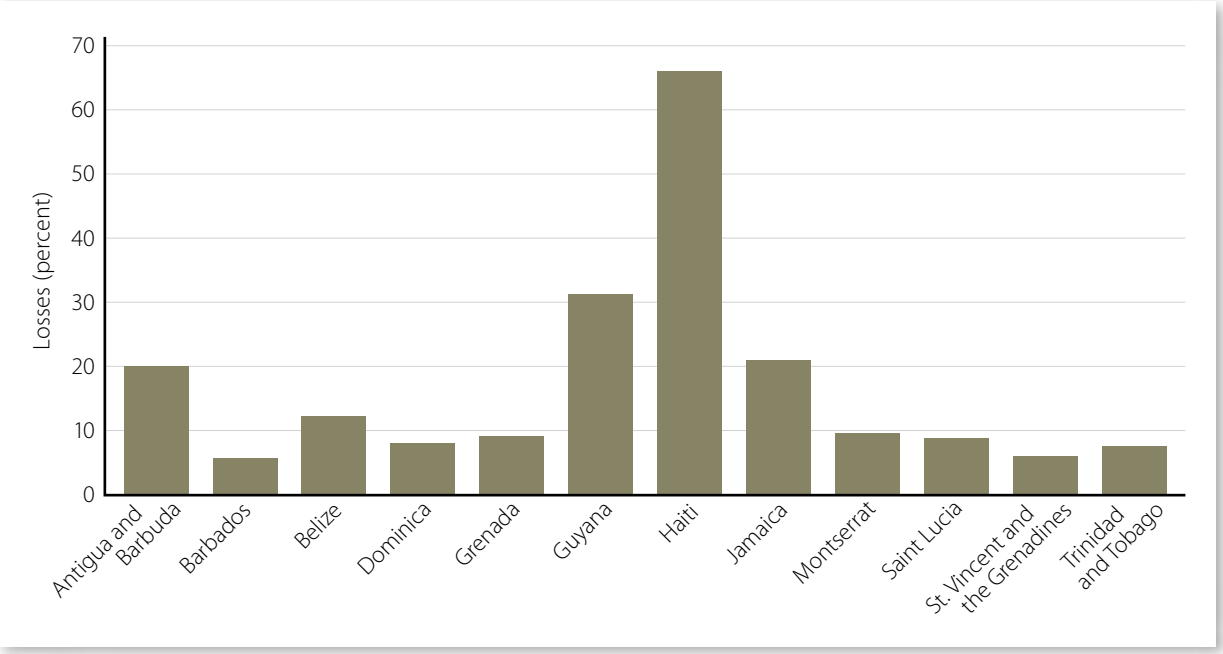


FIGURE 16. Estimated Technical and Non-Technical Electricity Losses in Selected CARICOM Member States, 2012

Note: Data for The Bahamas, St. Kitts and Nevis, and Suriname were not available at the time of publication.
Source: Worldwatch surveys © Worldwatch Institute

2.2.4 Electricity Demand Projections

In 2013, the CARICOM region generated an estimated 18,369 gigawatt-hours (GWh) of electricity and consumed an estimated 20,776 GWh.[54] 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 that are capable of mitigating the challenges posed by certain intermittent renewables when deployed on their own. Many member 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.[55]

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, respectively, by 2027, an increase of 76.8% and 81.9% over 2012.[56] (See Figure 18.) This highlights the need for widespread adoption of energy efficiency and demand management measures to curb growth in the sector.

At the member state level, electricity generation is expected to more than double by 2027 in four countries (Grenada, Guyana, Haiti, and St. Vincent and the Grenadines), while consumption is projected to double in five (these four plus Jamaica), unless ambitious action is geared toward greater energy efficiency. Future growth will continue to show large diversity in the levels of national electricity

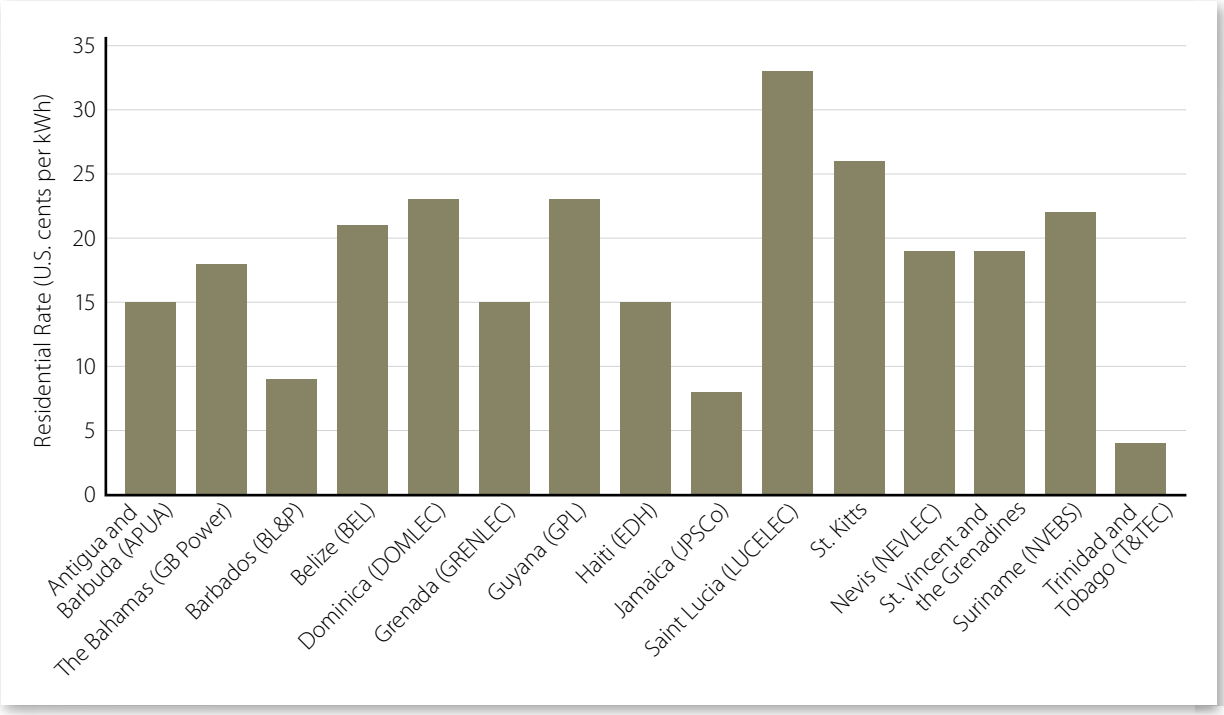


FIGURE 17. Residential Electricity Tariffs of CARILEC Members, 2011/12

Note: Tariffs are for CARILEC members consuming <100 kWh per month.
Source: CARILEC, Worldwatch, GPL © Worldwatch Institute

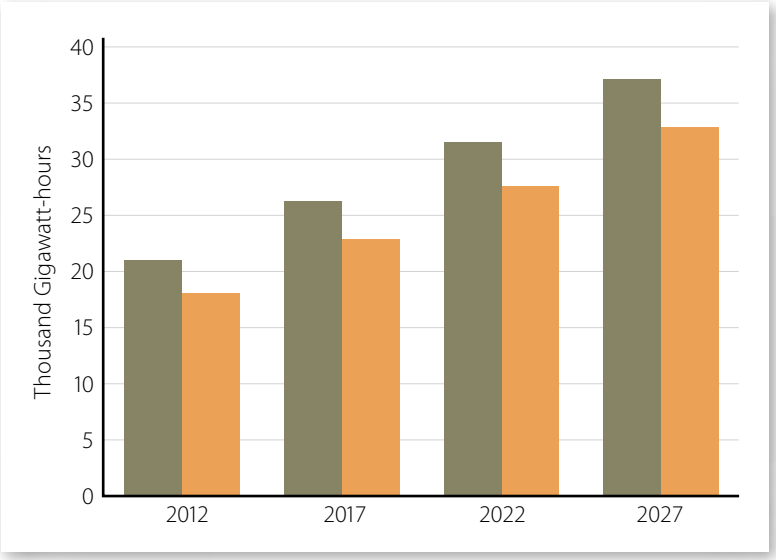
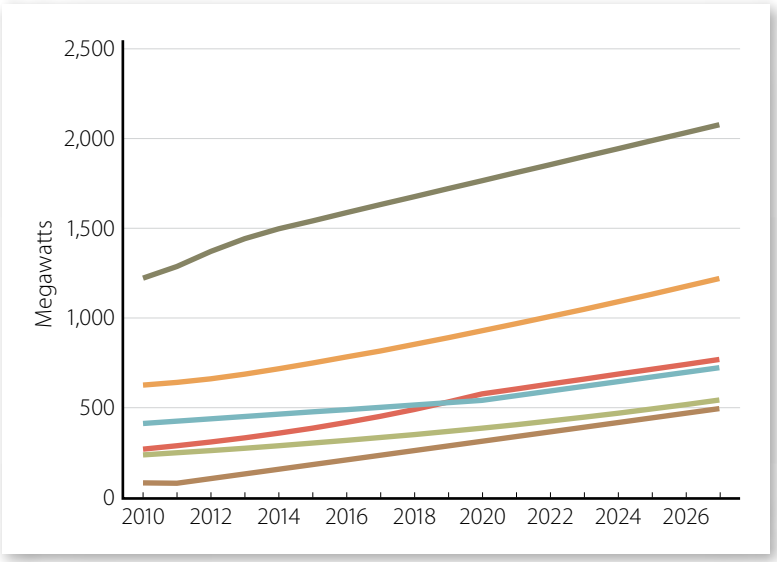


FIGURE 18.

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

Source: Nexant
© Worldwatch Institute

generation and consumption.[57] (See Figure 19.) If no effective mechanisms are implemented to greatly decrease demand, significant expansion of generation capacity in all 15 CARICOM member states will be necessary.[58] (See Figure 20.)



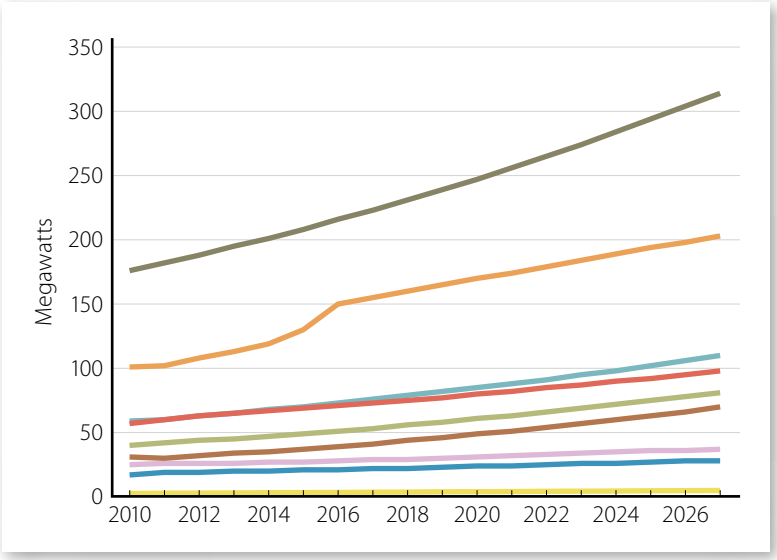


FIGURE 19.

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

Note the different y-axis values of the two charts.

Source: Worldwatch and Nexant

- The Bahamas
- Belize
- Haiti
- Jamaica
- Suriname
- Trinidad and Tobago
- Antigua and Barbuda
- Barbados
- Dominica
- Grenada
- Guyana
- Montserrat
- Saint Lucia
- St. Kitts and Nevis
- St. Vincent and the Grenadines

2.2.5 Data Gaps

Although considerable information is available on the electricity sector in the CARICOM region (unlike for transportation and greenhouse gas emissions), significant data gaps remain. These must be filled in order to move this priority sector forward on the pathway envisioned by CARICOM. The most pressing information gaps include:

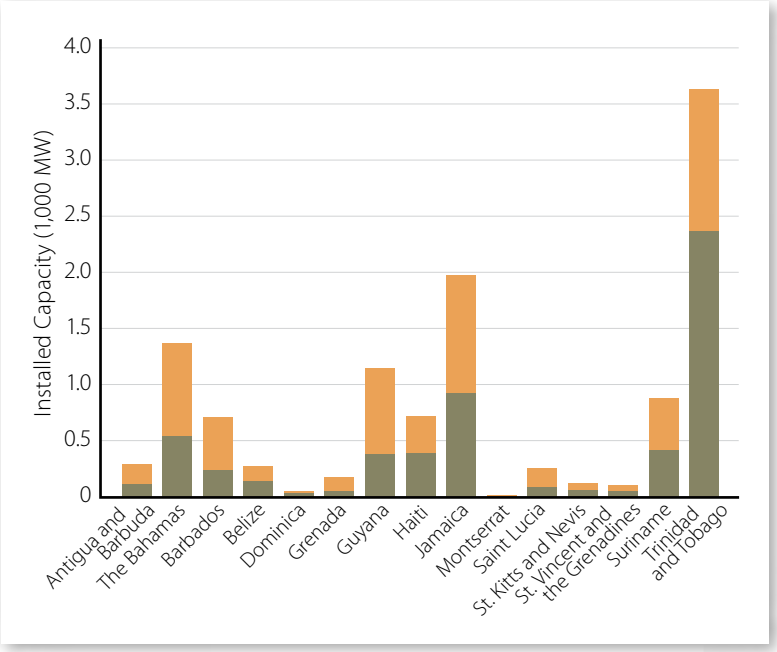


FIGURE 20.

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

© Worldwatch Institute

***Detailed analysis of electricity end-users*:** A thorough analysis of electricity end-users will be critical to make the most efficient use of power generation in the region. These data are not calculated, or not reported, in most CARICOM countries, making fully integrated planning of energy supply and consumption impossible. A more detailed assessment would allow for the design and implementation of energy efficiency measures targeting priority sectors in order to greatly reduce overall electricity consumption. Having a better understanding of consumer behavior will play a role in developing and targeting educational programs designed to reduce electricity consumption.

***Assessment of grid functionality and storage potential*:** Updated grid and storage capacity will be increasingly necessary as utilities look to incorporate greater levels of renewable generation into their systems. These updates often are far less attractive to investors than investments in new generation capacity, but they play an equally central 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 transmission and distribution networks are developed in concurrence with the deployment of new power generation.

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

***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 that 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 three largest energy end-use sectors.[59] The 2013 *International Energy Outlook* projects energy consumption in the transportation sector worldwide to grow from 108.1 quintillion joules in 2014 to 127.4 quintillion joules by 2027.[60] Although energy use for transportation within the CARICOM region varies widely by member state, in most cases its share of total consumption greatly exceeds the global average.[61] (See Figure 21.) In Grenada, transportation accounted for more than 50% of total end-use energy consumption in 2014, illustrating the sector's overwhelming importance and affirming that any effective regional approach to energy reform will need to address transportation.[62] Within CARICOM, transportation—despite its importance—nevertheless represents the energy sector for which the least information is available.

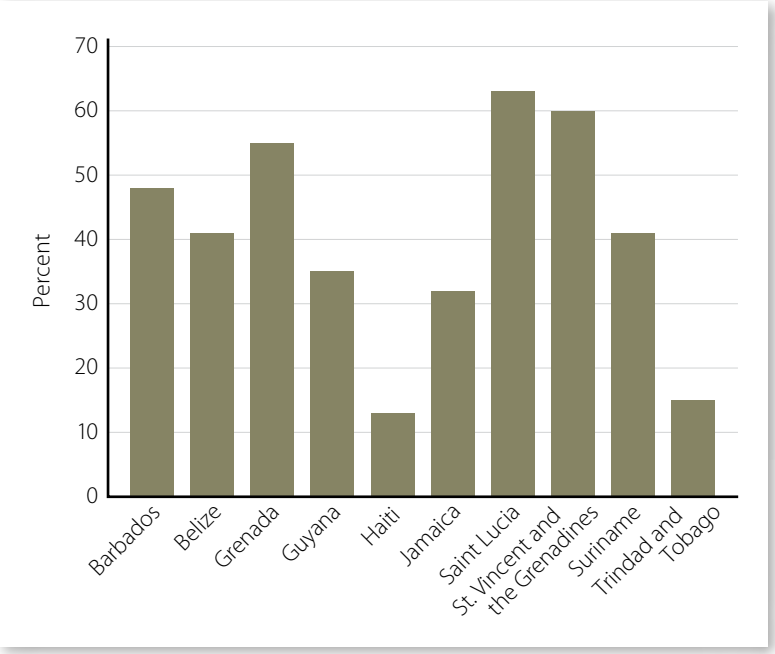


FIGURE 21.

Transportation's Share of Total End-Use Energy Consumption in Selected CARICOM Member States, 2014

Note: Remaining CARICOM member states are not included due to lack of available data.
Source: OLADE
© Worldwatch Institute

Transportation's impacts in the Caribbean are sometimes overlooked because of the sector's complexity and because of the general lack of available data on its status. In addition to substantial fuel requirements and significant greenhouse gas emissions, the sector—if not well designed and regulated—can have negative effects on local pollution, noise, congestion, health, and safety.[63] 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.[64]

Although additional data are needed to fully understand and address these challenges within CARICOM, regional and international best practices can provide guidance for improving the efficiency of transportation and mitigating the sector's heavy reliance on imported fuels through reforms in the road, aviation, and maritime sub-sectors. Progress is needed in changing both the technologies and the practices used.

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.) In the near term, however, the most economical option for reducing fossil fuel use in transportation is improving vehicle fuel economy.[65] (See Table 5.)

Table 5. Potential Average Fuel Economy for New Vehicles, 2005–30

	2005	2010	2020	2030	Reduction by 2030
	Liters of gasoline equivalent per 100 km				percent
Passenger light-duty vehicles	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 65 for this section.

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 cars, trucks, and motorcycles. In the United States, the Corporate Average Fuel Economy (CAFE) Standard requires that domestic auto producers achieve an average fuel economy of 54.5 miles per gallon (4.3 liters of gasoline equivalent per 100 km) 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 USD 1.7 trillion in fuel costs.[66] Although this kind of production-based standard would not be applicable 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% and 73%, respectively, could greatly benefit the CARICOM region.[67] Electric vehicles are significantly more energy efficient than their internal combustion engine counterparts, converting approximately 60% of grid power to energy at the wheels. By contrast, traditional gasoline-powered vehicles make use of only some 20% or less of the energy in gasoline for power at the wheels.[68] 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.[69] Electric vehicles may also be able to serve as energy storage and to 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 would require a more detailed analysis to determine how vehicle charging needs align with country-specific electricity load profiles.

Although their limited range remains a major criticism of electric vehicles, 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.[70] Although the average costs of electric vehicles remain high, they have been dropping steadily and rapidly, and the vehicles have become more reliable as a result of technological advancements. A transition to electric vehicles would require extensive investments in charging infrastructure, but the many associated benefits could more than outweigh the initial costs. Mechanisms such as subsidies or rebates would need to be designed to ensure that, given the comparative expense of these vehicles, mandates or incentives do not marginalize lower-income citizens.

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 CARICOM member states with significant agricultural sectors, such as Jamaica and the mainland countries of Belize, Guyana, and Suriname, domestic production and use of biofuels could be a useful substitute for fossil fuels. Given the significant land-use requirements, biofuel production generally is not seen as an appropriate solution in smaller island states; however, the development of a regional market for liquid fuels based on production in more advantageous environments within CARICOM could benefit the region. Moreover, due to potential negative environmental impacts and the risk of a food-versus-fuel conflict, the use of biofuels in transportation has not been without criticism worldwide, including in the United States and the EU. This means that 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% shift from cars to public transportation, decreasing air pollution and easing traffic congestion.[71]

2.3.2 Best Practices in 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, these two sub-sectors account for some 4.2% of global emissions, a share that is growing rapidly.[72]

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. Adopted as part of the 2008 Emissions Trading System (EU ETS), EU legislation on aviation is at the vanguard of this effort by commodifying greenhouse gas emissions to induce innovation for efficiency.[73] 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 annually—approximately 35% of total airport emissions—at the Zurich Airport in Switzerland.[74]

Simply updating air traffic control systems can reduce the carbon footprint of commercial travel by 12%. 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 Philippine Airlines, which in 2012 purchased a fleet of new airplanes that are 15–20% more fuel efficient than their predecessors.

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 for 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 government in collaboration with the World Shipping Council.[75] These efforts also include financing for pilot projects, assessing the feasibility of incorporating renewables into regional transit initiatives, such as solar-charged ferry transit projects in Saint Lucia funded by the German Agency for International Cooperation (GIZ) and the Global Village Energy Partnership (GVEP).[76]

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 of 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 USD 25 per ton of CO_2 emissions could raise aviation fuel prices by an estimated 8% while only marginally negatively affecting consumer demand by 2–4%.[77]

Measures like this can prove invaluable in reducing aviation sector emissions while limiting negative economic impacts on consumer demand to a manageable level. Globally, there seems to be increasing support for including aviation emissions in emissions trading schemes, spearheaded by the EU ETS. Implementation of any wide-ranging mandates to curb the environmental impacts of either aviation or

maritime shipping likely will require large-scale international commitments that are beyond the scope of CARICOM alone. At this point, concrete projects to reduce emissions, possibly supported by international financing, are an important and more feasible step forward.

2.3.3 Data Gaps

Although it is possible to make general observations about CARICOM's transportation sector, many critical information gaps must be filled before fully integrated planning can occur, whether at the national or regional level. 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]."[78] Detailed information about vehicle and fuel use in the transport sector often is disorganized or is not collected at all, 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. The most pressing information gaps include:

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

***Updated sector plans and strategies*:** In addition to transportation sector data that are unavailable, important information regarding upcoming plans or national strategies for reform is missing. Available information is often outdated, 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% in 2012), preliminary analysis of energy-related emissions indicates significant opportunities for improvement.[79] Of the CARICOM member states, Trinidad and Tobago has by far the highest overall CO_2 emissions from energy consumption, and its emissions have increased greatly over the past decade, in marked contrast to the other 14 member states.[80] (See Figure 22.) This reflects not only the significance and size of the country's fossil fuel sector, but also recent rapid economic growth. The emissions of CARICOM's second highest emitter, Jamaica, declined in recent years, largely reflecting the partial shutdown of the country's mining sector in response to high electricity prices as well as the effects of the global recession.

Emissions per capita are low in most Caribbean nations compared to global figures. However, surprising regional diversity exists. Due to heavy industrialization in the country, Trinidad and Tobago has not only the highest per capita emissions within CARICOM, but also the second highest per capita levels globally, after only Qatar.[81] Similarly high levels in Montserrat reflect the country's complete dependence on temporary, inefficient diesel generators. All other CARICOM member states, however, fall well below the OECD average emissions per capita.[82] (See Figure 23.)

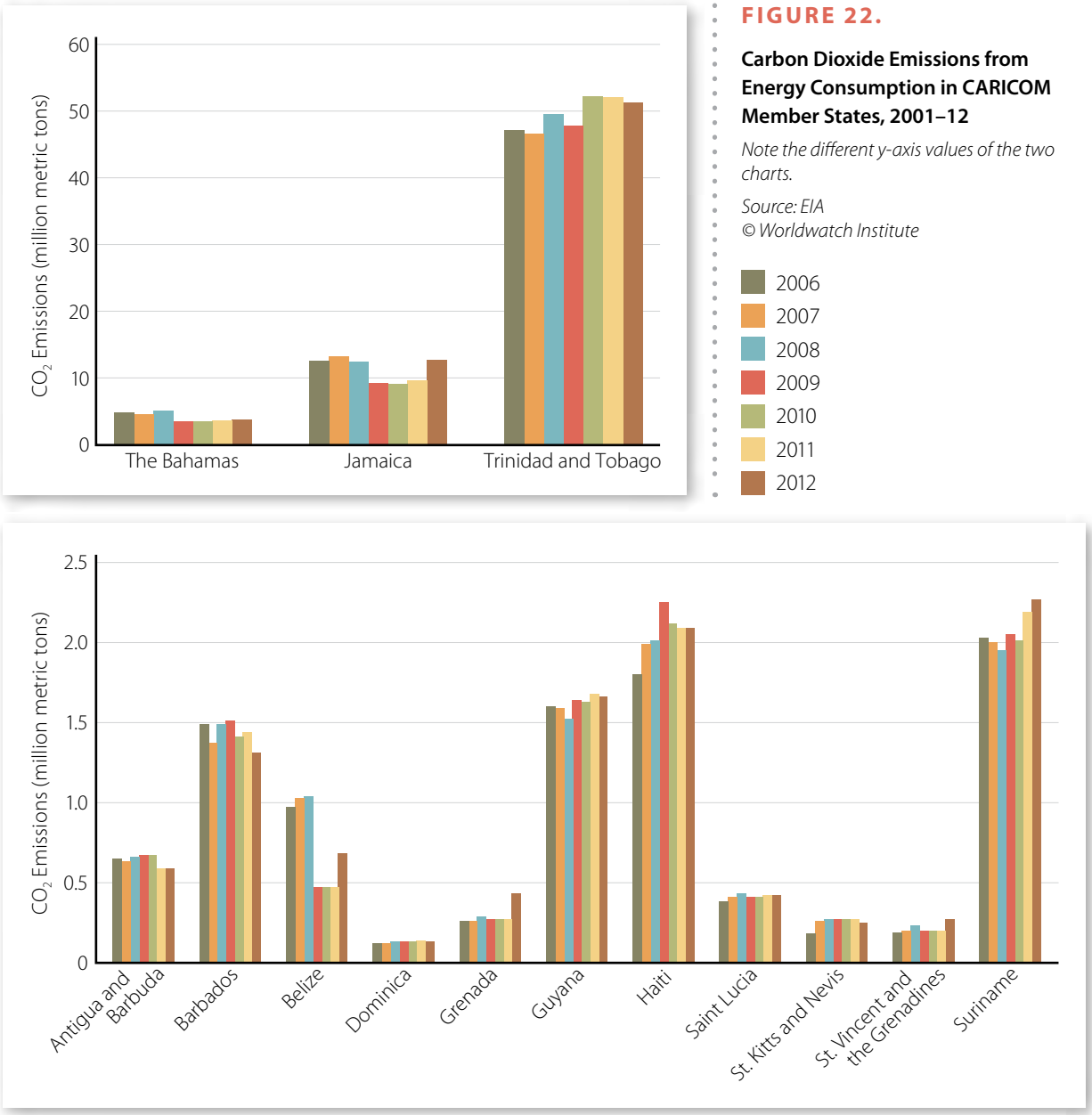


FIGURE 22.

Carbon Dioxide Emissions from Energy Consumption in CARICOM Member States, 2001–12

Note the different y-axis values of the two charts.

Source: EIA
© Worldwatch Institute

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% of all CO_2 emissions and for half of all human-caused greenhouse gas emissions.[83] In a business-as-usual scenario based on the CARICOM region's existing generation mix, Worldwatch projects that power sector CO_2 emissions within member states will increase sharply between 2012 and 2027, reflecting capacity additions and increased generation.[84] (See Figure 24.)

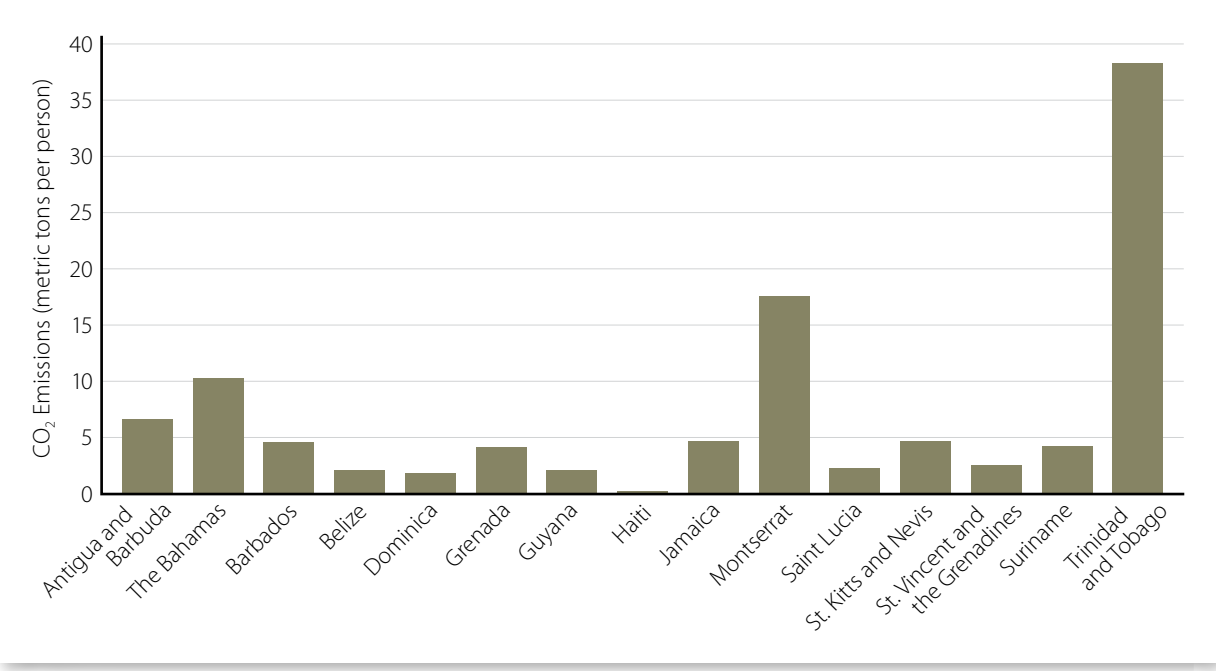


FIGURE 23. **Population Size versus Electrification Rate in CARICOM Member States, 2012**

Source: EIA, World Bank © Worldwatch Institute

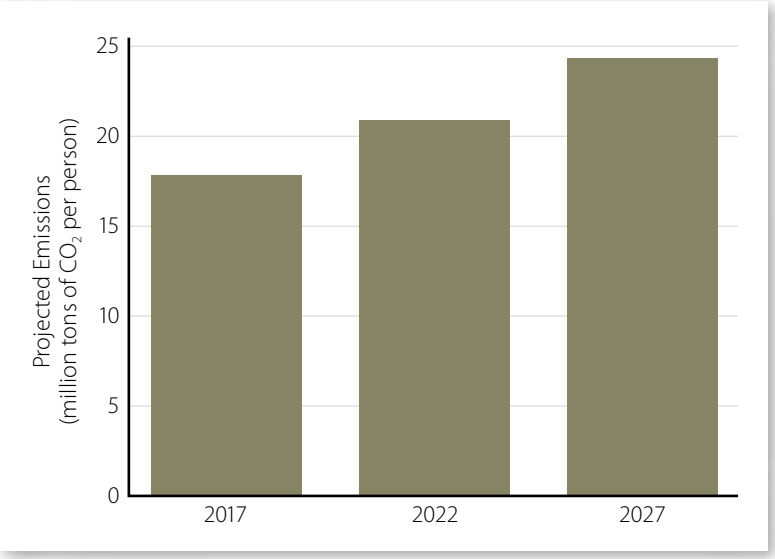


FIGURE 24.

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

Source: Worldwatch
© Worldwatch Institute

2.4.3 Data Gaps

Significant data gaps remain regarding CARICOM greenhouse gas emissions. These include:

***Updated emissions accounting*:** Detailed emissions accounting is a necessary first step in any strategy to reduce emissions throughout CARICOM. Although member states are required to report emissions as signatories of the United Nations Framework Convention on Climate Change (UNFCCC) process, many of these official communications miss data points and/or are outdated. As policies and mechanisms are enacted and implemented to reduce emissions across the region, a detailed monitoring and evaluation system would allow for existing policies to be evaluated and, if necessary, to be adjusted or supplemented by new ones based on observed data and aiming at maximizing their effectiveness.

***Updated sector plans and strategies*:** Information regarding existing emissions reductions strategies and commitments, either linked to UNFCCC communications or independent, is often missing and/or outdated.

***Sectoral emissions data*:** The limited data currently available generally are 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 Potential

Based on existing assessments, every CARICOM member state exhibits significant potential for developing renewable energy resources, including biomass, geothermal, hydropower, solar, and wind.[1] (See Table 6.)

Although the assessments often rely on different methodologies and levels of detail, they provide a general overview of the renewable energy resources currently assumed to be available in each member state. Most renewable technologies already are being used in a few places in the region, but they remain far from their enormous potential. Based on domestic conditions, not all technologies can or should be developed to the full potential indicated in Table 6 (see Section 5.2 for further discussion).

Hydropower resources are being used widely in member states such as Belize, Haiti, Jamaica, St. Vincent and the Grenadines, and Suriname; however, potentials remain, particularly for small-scale, run-of-the-river installations that can provide electricity access to remote populations. The region's potential for biomass, solar, and wind resources is extremely high, offering significant opportunities for development. Geothermal resources, available in 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). 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. Electricity generation from biomass has the advantage of being storable, which enables electricity production to be fired up and down and can help offset some of the intermittency of wind and solar generation in an integrated electricity system.

Modern biomass can provide an easily accessible energy source to the CARICOM region. The strong agricultural sectors in many member states provide opportunities to sustainably harness organic waste 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 bagasse (residue from sugarcane processing), sweet sorghum, coffee husk, rice straw, and coconut shells, as well as woody biomass. Like biomass energy, biofuels can be used for power generation as well, although they are used most commonly

Table 6. Renewable Energy Potential in CARICOM Member States, as of 2015

Country	Hydro	Wind	Geothermal	Solar	Biomass
			MW (unless indicated otherwise)		
Antigua and Barbuda	0	400	0	27	N/A
The Bahamas	0	229	0	60	1
Barbados	N/A	40	0	39.7	23.5
Belize	70	N/A	0	42	N/A
Dominica	17	30	1,390	45	N/A
Grenada	0.5	20	1,100	50	N/A
Guyana	7,000	N/A	0	575.8 million MWh/year	60.2 GWh
Haiti	896.5	27.3 GWh	0	1.7	8.2
Jamaica	33.4–56.1	122–1,313	0	650–1,876	192; 65 from waste-to-energy
Montserrat	N/A	N/A	940	1.5	N/A
Saint Lucia	0.15	40	170–680	36	1.2
St. Kitts and Nevis	0	6–23.4	300–1,280	16	4.2–14
St. Vincent and the Grenadines	10	8	100–890	23	0.9–4
Suriname	1,700	N/A	N/A	N/A	N/A
Trinidad and Tobago	N/A	50	N/A	308	N/A
CARICOM (regional minimum proven potential)	9,750.3	2,153	6,280	2,525.9	243.9

Note: "0" indicates that there is no installed capacity at present; N/A indicates that data were not available at the time of publication.
Source: See Endnote 1 for this section.

in the transportation sector. In particular, biodiesel derived from oilseed crops, such as jatropha, can be used as a substitute for diesel to fuel thermal power plants.

Modern biomass is already a central part of renewable development strategies in some Caribbean countries, particularly on the mainland. Belize has emerged as a leader in the use of bioenergy as a baseload energy source, and has built on its initial successes to develop a strategy for future expansion of its bioenergy capacity. Among the bioenergy resources in use throughout the region are bagasse (used in Belize, Barbados, Guyana, Haiti, and Jamaica) and biogas systems (in place in Barbados, Haiti, Jamaica, Saint Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago). Additional pilot projects are in place in Antigua and Barbuda, the Dominican Republic, Trinidad and Tobago, and elsewhere.

It is important, however, to consider the wider, sometimes negative, impacts of biomass and biofuel 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 97% reduction of the forest cover, with disastrous implications for agriculture, rural livelihoods, and resilience to tropical storms.[2] 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. It currently plays a limited role in the global electricity sector, with only 12 GW installed in 24 countries.[3] 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, and most deep geothermal reservoirs are technologically or economically unfeasible to exploit. In some CARICOM member states, however, 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. Geothermal accounts for 27% of electricity generation in the Philippines and 6.2% in the U.S. state of California.[4] A major advantage of geothermal power compared to many other renewable sources is that, where plentiful, it can be used as a baseload source of energy, with plants operating at an average capacity factor of 73% and top capacity factors above 90%, higher than for any other renewable or fossil fuel technology.[5] However, integrating geothermal energy into power grids will require greater flexibility in the dispatch of power plants fueled by other renewables and conventional sources in order to be system-compatible.

The most common use of geothermal energy is for heating and cooling. Because these systems can run on reservoirs with much lower temperatures, viable locations are much more common. About 80 countries worldwide already use geothermal energy for heating.[6] Where strong potential exists, geothermal can supply nearly all of a nation's heat energy, such as in Iceland, where it accounts for 90% of all heat.[7]

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, Saint Lucia, St. Kitts and Nevis, 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, which in turn would increase the economic viability of exploratory drilling. For 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 that geothermal projects can yield from regional interconnection, collaboration, and trade.[8]

There is currently no fully operative geothermal power capacity within CARICOM, and Guadeloupe is the only island within the broader Caribbean region to have a geothermal power plant in operation.[9] The high upfront capital needs, including for exploratory drilling, have been a significant barrier to deployment. However, investment and development plans have increased in recent years, and exploratory drilling and initial installations are under way in some countries. In July 2014, the IDB, the Japan International

Cooperation Agency (JICA), and the Caribbean Development Bank jointly signed a memorandum of cooperation to support the Eastern Caribbean in expanding renewable energy and energy efficiency, with an emphasis on geothermal energy.[10]

In September 2014, St. Vincent and the Grenadines launched a geothermal power plant project near Mount Soufriere, where it hosts a high geothermal reservoir. The project is supported by the New Zealand government, and plant construction is expected to be completed by mid-2018.[11] In December 2014, Saint Lucia received USD 2 million from the World Bank to start a Geothermal Resource Development Project, which the government plans to use for project exploration, development, and implementation.[12] The country's Ministry of Sustainable Development has begun aerial assessment and ground surveys of promising geothermal sites, with financial assistance from New Zealand.[13] In Grenada, field work and geochemical surveys of 12 promising sites had been completed as of February 2015, and sites are now being assessed for commercial-scale extraction.[14] In St. Kitts and Nevis, concessions for geothermal exploration and development by a public/private consortium in 2009 were attracting investment interest from the Caribbean Development Bank as of 2015.[15] And, as mentioned previously, Montserrat hopes to source 100% of its electricity supply from geothermal by 2020 and has secured USD 17.6 million from the U.K. government for exploratory drilling.[16]

3.1.3 Hydropower

Large hydropower comprises the majority of renewable power generation, both within CARICOM and worldwide. Globally, hydropower accounts for an estimated 16% of electricity production.[17] In many parts of the Caribbean, it represents an ideal option for power generation given the hilly topography and high rainfall. Several member states, including Belize, Haiti, and Suriname, already have significant installed hydropower capacity and generate a large share of their electricity from these resources, whereas some 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 extend and interconnect energy markets, nationally and beyond. Mainland member states such as Guyana and Suriname have particular incentives to look into this option.

***Large hydropower*:** Despite being a low-carbon, renewable energy source, large hydropower often has serious environmental and socioeconomic impacts.[18] The damming of rivers to create the large-volume reservoirs needed for power generation can harm human populations, natural ecosystems, and biodiversity. Globally, large-scale hydropower projects have led to the displacement of local populations and to adverse impacts on downstream water conditions, which affect the livelihoods of even 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.[19] Hydropower systems are also vulnerable to the impacts of climate change, as increasingly common drought conditions will reduce electricity output.

***Small hydropower*:** Small hydropower has many 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 impacts of large-scale hydro. Despite these benefits, small hydro has relatively high upfront costs compared to conventional energy sources and requires 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.[20] Consumers also must 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 such 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 otherwise would 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 attention in the CARICOM region. In Haiti, for example, MSW is estimated to be able to provide between 9.7 MW and 24.3 MW of power capacity, depending on the rate of waste collection.[21] However, the viability of MSW is severely restricted in 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.[22]

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. The use of deep sea cooling is particularly relevant for the tourism sector. Already, these technologies have been identified as a priority area for future focus under SIDS DOCK,* as they offer significant potential throughout the Caribbean region.

However, unlike most of the other renewable energy technologies examined in this section, marine energy technologies pose challenges to commercial viability. The costs of building and installing wave and tidal systems, including both the generation equipment and the underwater cables, can be prohibitively high.

* SIDS DOCK is a sustainable energy initiative comprising 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.

Additional factors that need to be considered when developing marine energy projects include 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. Consequently, most of the current global capacity exists in the form of pilot and demonstration projects.

Still, initial assessments demonstrate that the existing potential might be most adequate for off-grid solutions serving individual consumers, such as individual resorts. As marine energy technologies advance further, this may allow them to play a significant role in the future energy mix of CARICOM, as highlighted by pilot projects such as deep sea cooling in the tourism sector of the Bahamas.[23] With technologies maturing and costs decreasing, wave and tidal generation could become cost-competitive in some coastal regions. Still, the potential for OTEC in the region will remain restricted.[24]

3.1.6 Solar

All CARICOM member states possess strong solar energy potential and many opportunities to use solar technologies for power generation, heating, and cooling—making solar a crucial regional sustainable energy solution. Throughout the Caribbean, the resource thus far is mostly untapped, despite the fact that a suite of mature technologies to convert the sun's energy into electricity is booming worldwide, including in places with much lower resource potential.

Solar electricity technologies 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, capturing both direct and diffuse irradiation. Solar PV is better suited than CSP is to the conditions observed in most parts of the Caribbean.

In addition to providing electricity, solar energy is 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 of under two years in many cases. By the end of 2013, global solar water and space heating capacity reached 330 gigawatts-thermal.[25] More than half of this is in China, and the vast majority is used for water heating.[26]

For small-island states with high electricity costs, the attractiveness of solar water heating is clear. Cyprus is the world's leader in installations per capita, and Barbados's experience with the technology is considered a Caribbean renewable energy success story.[27] Duty-free equipment imports and tax incentives in Barbados have created a thriving market, and the country has installed 40,000 solar hot water systems on homes, businesses, and hotels, penetrating the market for residential buildings by 33%.[28] The success of this project was cited explicitly by the IDB in announcing a multimillion-dollar loan to Barbados for continued renewable energy development.[29]

The high component costs that traditionally have plagued solar technologies have declined significantly, with solar PV module costs falling nearly 80% between 2009 and 2013 alone, making solar cost-competitive with fossil fuels under certain conditions.[30] These conditions exist in most if not all CARICOM countries, and several member states recently have demonstrated first major successes using solar energy, including solar PV for rural electrification in Guyana and solar water heating in Barbados as well as Antigua and Barbuda.

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 318 GW installed globally by the end of 2013.[31] The costs of wind power can be as low as 4–7 cents per kWh in attractive locations, making it significantly cheaper than even the cheapest fossil fuel alternative.[32] According to a 2010 report from Nexant, wind has the potential to be the fastest-growing renewable energy technology in the CARICOM region over the next two decades.[33] A few CARICOM member states have begun developing capacity to harness the resource. Jamaica, for example, had 48 MW of installed wind power capacity in 2013 and, as of January 2015, had secured financing for an additional 36 MW.[34] St. Kitts and Nevis has 2 MW of installed wind capacity. Other member states are also exploring utility-scale wind infrastructure.[35]

Wind power is presently used mostly for centralized utility-scale generation. However, turbines come in many sizes, and 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 of under 250 kW in the region.[36] 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 greatly increase the value of the electricity, as landowners are able to sell excess power.

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 CARICOM region. Figure 25 compares the global range of generating costs for various renewable technologies to the range of residential electricity tariffs in CARICOM (between 4 U.S. cents and 33 U.S. cents per kWh).[37] For reference, the figure also notes current residential energy prices in CARICOM member states that demonstrate strong potential for a given renewable energy source. Although global generating costs and region-specific residential electricity tariffs are not directly comparable, they indicate on a basic level the cost-effectiveness of renewable energy technologies, especially in the context of a region with notoriously high electricity prices.

The cost-competitiveness of renewables in the Caribbean—even in conventional analysis that does not include so-called externalities such as pollution and resulting health costs—presents enormous opportunities for their expansion. The full advantage of renewables only becomes visible, however, in a detailed review of costs and benefits associated with various generation options. Readily available Levelized Cost of Electricity (LCOE) analysis enables policymakers to make fully informed decisions

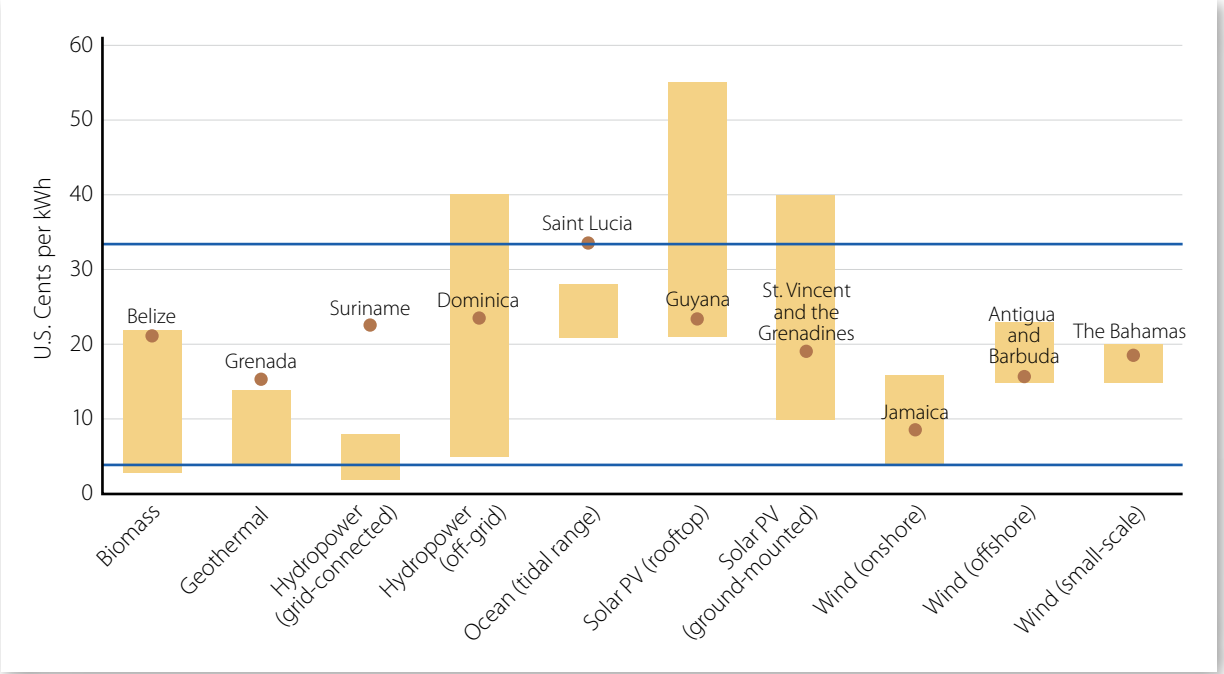


FIGURE 25. Global Power Generation Costs by Technology Compared to the Range of Electricity Tariffs in CARICOM Member States

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 (4–33 U.S. cents per kWh; the horizontal blue lines), and provides example tariffs in select countries with strong potential for that particular resource.
Source: State utility ministries, REN21 © Worldwatch Institute

on which development pathway to pursue. Unfortunately, these types of assessments are mostly lacking across the region.

Renewable technologies often have significant upfront exploration, development, and installment costs, which remain the most powerful barrier to renewables in many places, including in the Caribbean. If costs are passed on to consumers, these investments can mean short-term spikes in electricity tariffs. Over the entire life span of installed technologies, however, analysis in select parts of CARICOM and neighboring countries shows that certain renewable technologies are already cost-competitive, 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.

Moreover, despite the Caribbean's high electricity tariffs, electricity 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 typically 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 U.S. cents per kWh charged by T&TEC in Trinidad and

Tobago to the 33 U.S. cents per kWh charged by LUCELEC in Saint Lucia—do not internalize these significant costs.[38]

3.1.9 LCOE+

Building on traditional LCOE analysis, a full assessment of socioeconomic impacts across the region, spearheaded by CARICOM, could lead to more balanced understanding of the 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, such "LCOE+" analysis that integrates 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 that highlight the opportunities seen across the region.

3.2.1 Solar Water Heaters in Barbados

Barbados has emerged as a global leader in the deployment of solar water heaters. The 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 to significant emissions reductions savings of 428 kilograms of CO_2 per system per year—equivalent to more than 5.5% of national carbon emissions.[39] The government 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 that the technology poses to citizens.

3.2.2 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 the most promising options for development is the Wotten Waven site, for which successful tests were completed in June 2014 to ensure that an initial well was suitable for energy production.[40] The project will begin with 6–8 MW of production and has the potential to expand to 120 MW, which would allow Dominica to export power to Guadeloupe and Martinique.[41]

The multi-year project has not been without major setbacks, however. In 2013, Electricité de France (EDF), the world's largest utility company and a leading project partner, withdrew from Wotten Waven, citing low profitability opportunities compared to other investments such as the Eastern Caribbean Gas Pipeline, which would transport natural gas from Trinidad and Tobago to Barbados, Guadeloupe, Martinique, and Saint Lucia.[42] EDF's decision 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 and other renewable development. The importance of breaking from this regressive investment pattern has become increasingly apparent as other CARICOM states move to develop their geothermal endowments. (See Section 3.1.2.)

3.2.3 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 facility was commissioned in 2004 with an initial capacity of 20.7 MW and a cost of USD 26 million; the loan has since been refinanced through the Petrocaribe Development Fund.[43] Under the original 20-year agreement, Wigton sold electricity to the grid operator at a rate of 5.6 U.S. cents per kWh for the first five years, and 5.1 U.S. cents per kWh thereafter. These rates were too low for the wind farm to be profitable, however, and the terms were renegotiated to reflect an updated avoided cost level averaging around 10 cents per kWh over the amortized life of the project's debt. 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 feeding electricity to the grid in December 2010. The extension came at a cost of USD 49 million, also financed by Jamaica's Petrocaribe Fund.[44] Phase III of this project, awarded in late 2014, will add another 24 MW of installed capacity, bringing Wigton's total to 62.7 MW of installed renewable energy capacity.[45] As of January 2015, construction of an additional 34 MW of wind energy capacity by BMR Energy had been approved by the agency responsible, OUR. It is expected to begin commercial operation in early 2016.[46]

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 U.S. cents per kWh—officials stated that a price of 13–14 U.S.

cents per kWh would be necessary to make additional capacity viable at Wigton.[47] Because the Jamaican utility JPS currently sells electricity for 30–40 U.S. cents per kWh, a guaranteed price of 13–14 U.S. cents per kWh would be reasonable and could spur significant wind power development. For Phase III of Wigton and the BMR projects, the utility signed power purchase agreements (PPAs) for 13.3 and 12.9 U.S. cents per kWh, respectively.[48]

These initiatives depict a sampling of the many sustainable energy programs and projects currently in exploration or already under development across the region. Unfortunately, however, renewable energy deployment across CARICOM often is characterized by a lack of follow-through on developed strategies and plans. All renewable technologies have fallen victim to this trend on numerous recent occasions. Gaps between project planning and implementation hamper a broader and faster sustainable energy transition.

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.* 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 energy technologies are often more efficient because they minimize the transmission losses associated with moving power over long distances.

Numerous opportunities for energy efficiency exist at the household level. Buildings themselves can be made significantly more efficient through proper insulation, white roofing, and smart architecture and landscaping. In-home appliances also consume comparatively large volumes of electricity. Many CARICOM households rely on outdated appliances. A lack of strong efficiency standards keeps new appliances cheap in acquisition but expensive in operation. With growing economic development, a corresponding growth in energy demand from appliances and other household products, such as air conditioning systems, will need to be managed through efficiency measures.

Consequently, energy efficiency measures offer some of the most cost-effective tools for reducing CO_2 emissions. In CARICOM member states where few (if any) energy efficiency measures are in place, large gains in saving both energy and emissions can be made. Energy efficiency measures can help to save money due to reduced energy costs. A CO_2 abatement analysis for the Dominican Republic illustrates

* Energy efficiency, which results in the use of less energy to perform the same task, differs from energy conservation measures, which look to reduce overall energy use; however, for the purposes of this analysis, energy efficiency is used to describe both sets of energy reduction solutions.

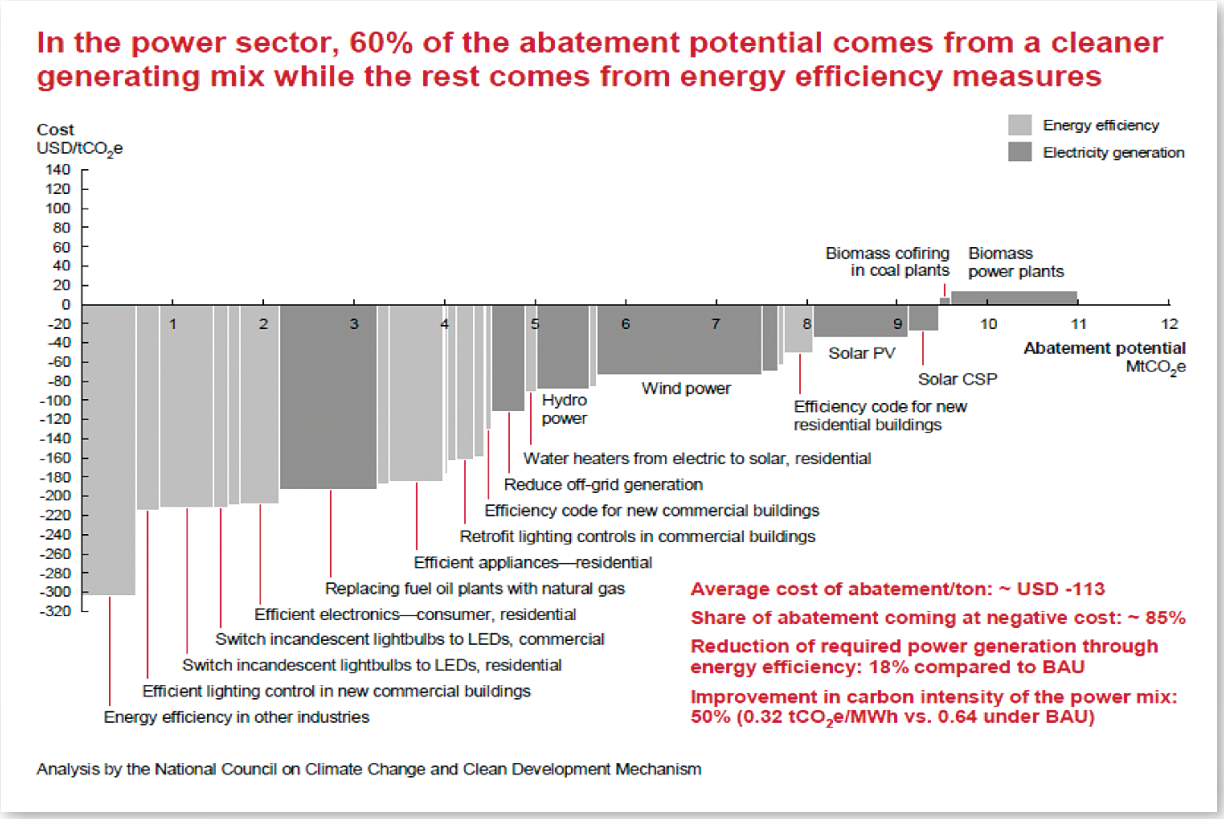


FIGURE 26. **Carbon Abatement Cost Curve Analysis for the Dominican Republic**

the cost- and emission-saving potentials of energy efficiency measures in an upper-middle-income, fossil fuel-dependent small-island state similar to Jamaica.[49] (See Figure 26.) Similar analyses in other CARICOM member states could help to inform decision making by identifying priority action areas. Although many CARICOM member states are relatively small, and therefore generate and consume comparatively little energy overall, an examination of energy intensity (energy consumption per dollar of GDP) can indicate the efficiency of particular energy systems. Preliminary analysis of energy intensity throughout CARICOM highlights significant disparity among member states.[50] (See Figure 27.) Not surprisingly, member states that have 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.

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

Despite the high energy costs for the tourism industry, hotels in most places have been slow to introduce energy efficiency or saving measures. This is even more puzzling because studies demonstrate that

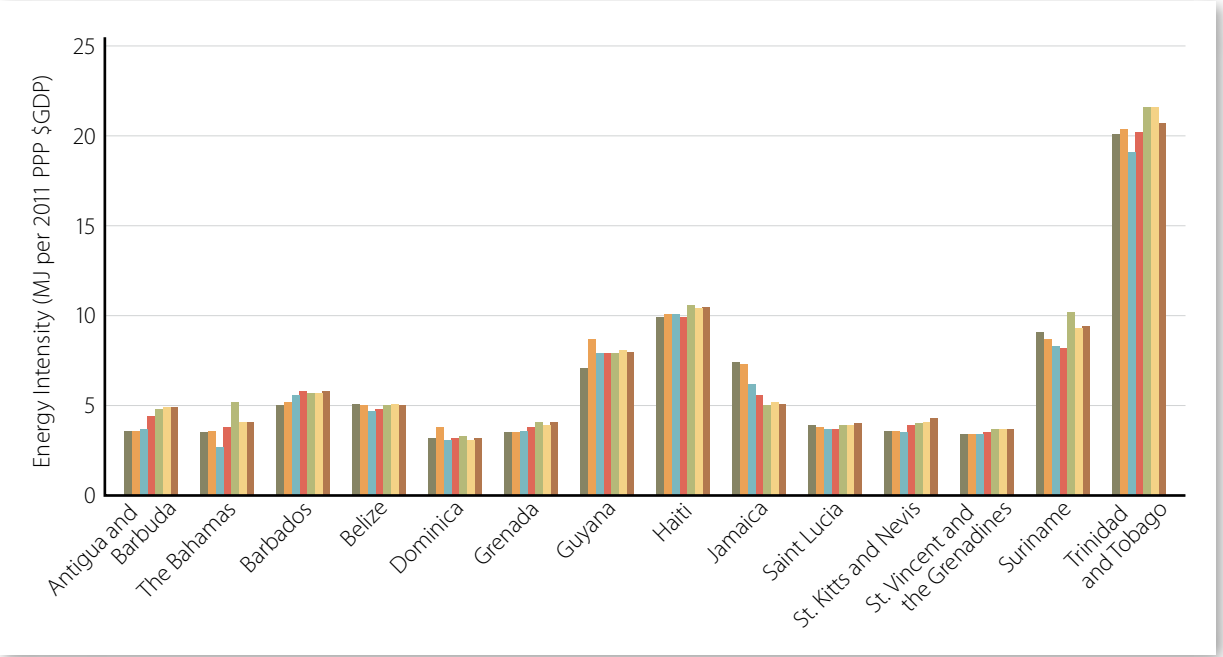


FIGURE 27. Energy Intensity of CARICOM Member States, 2006–12

Source: World Bank ©Worldwatch Institute

relatively small investments and practices can result in relatively high energy savings of up to 30%.[51] A project of the U.S. Agency for International Development's Energy Audits for Sustainable Tourism initiative, carried out between 1997 and 2002, reduced nightly energy use per guest by 12% in participating Jamaican hotels, cutting total energy consumption by more than 1.6 million kWh over the project period. The project resulted in efficiency savings of USD 616,555 over that period, resulting from an investment of just USD 175,000.[52]

Building on these findings, the Caribbean Hotel Energy Efficiency Action Program (CHENACT)—with technical and financial assistance from GIZ and the Caribbean Renewable Energy Development Programme (CREDP)—performed a detailed audit of energy efficiency and greenhouse gas emissions for 12 major hotels throughout the CARICOM region. The report not only highlighted a comprehensive list of unused efficiency sources, but also emphasized tailored high-, medium-, low-, and no-cost energy-saving opportunities, combined for annual cost savings in excess of USD 7 million and an average reduction in total electricity consumption of 63%.[53] Uptake of these strategies remains underwhelming, however, and likely will necessitate government-level policy interventions, or at least stronger promotion measures.

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 in place are tax incentives. For example, Trinidad and Tobago provides a 150% 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 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 large hotel resorts. 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.[54]

3.5 Renewables, Efficiency, 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 supply. 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 transmission and distribution 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 end-user 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 excess power back to the grid.

Grid investments are needed to reduce the high electricity losses of many CARICOM member states as well as to provide affordable and reliable electricity in the future. This process will need to be driven in large part by national governments and by the CARICOM Secretariat, because private investment in 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 eventually will need to be developed. According to some analysts, storage solutions start to become necessary as the electricity system approaches a 20% renewable share.[55] Although renewables such as geothermal, hydropower, and bioenergy do not face integration-related challenges to the same degree, islands that rely on more-variable renewable sources such as wind and solar will need to invest in storage technologies. These issues are being addressed in some 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 also may serve to back up variable generation from new renewables—an approach that is prevalent in Guyana's Hinterland Electrification Strategy.[56]

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 extended 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 in order to ensure that the significant investments that are required are economical.

Electricity interconnection in the Caribbean has many potential benefits. 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.[57]

Already, some CARICOM member states use sub-marine interconnection cables to link individual islands within a nation. These include two 33 kilovolt (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 sub-marine cable linking mainland Belize with San Pedro.[58] 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. These plans are challenged, however, by political opposition and by a lack of incentives for private sector participation.[59]

A pre-feasibility study conducted by the Energy and Climate Partnership for the Americas 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.[60] The Wotton Waven geothermal plant in Dominica likely has the potential to export power to Martinique and Guadeloupe via sub-marine transmission.

Several studies have been conducted on the feasibility and implications of electricity interconnection in the Caribbean. A 2010 preliminary study 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 a Dominican Republic-Haiti land interconnection.[61] 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.[62] A project funded by the IDB is performing pre-feasibility studies to evaluate the political, institutional, regulatory, technical, economic, environmental, and social implications of electrical interconnection in the "Northern Arc" countries (Suriname, Guyana, French Guinea, and two northern states in Brazil).[63]

Regional pipelines for natural gas also have been considered, and their potential assessed, as part of the development of a regional energy strategy. Although construction of the Eastern Caribbean Gas Pipeline was anticipated to begin in 2014, the project remains undeveloped.[64] 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 Data Gaps

The completion and communication of technical assessments for renewable energy, energy efficiency, and grid and storage solutions is the backbone of truly integrated energy planning. Unfortunately, an integrated system analysis is mostly lacking in the CARICOM region. Even in areas where individual technology assessments have been completed, the results are rarely accessible. 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 and creating the necessary "overlap" studies for different supply and demand studies in an integrated modern grid perspective. Priority gaps that, if addressed, would facilitate rapid progress include:

***Lack of widespread calculation, understanding, and communication of renewable energy's cost-effectiveness*:** Despite the cost-effectiveness of renewable technologies in the Caribbean region, many regional stakeholders continue to perceive these technologies as prohibitively expensive. This poses a significant barrier to development in a region already facing high electricity prices. A thorough LCOE+ assessment in each CARICOM state—comparing the costs of various generation sources and including the "true costs" typically excluded from conventional cost analyses—would help to identify and communicate the economic and social benefits of renewable energy development.

***Unavailability of renewable energy assessments and technology feasibility studies*:** Although many member states have conducted initial assessments of resource potential for several technologies, 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 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.

***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. For project development to move forward, however, assessments must be conducted at a higher resolution. Priority areas for more-detailed assessment include those with the best resources and those near population centers.

***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 such as solar and wind. Assessments of complementarity potential will facilitate smarter and more-integrated energy planning, and will indicate opportunities for the most efficient and cost-effective renewable energy deployment.

4 Existing Sustainable Energy Policy Frameworks in CARICOM Member States

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 automatically. The success of sustainable energy development in the region will depend largely on the effectiveness of policies and measures. Regional and national governing bodies must be proactive in implementing enabling policy frameworks that 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 the boom in sustainable energy technologies in recent years. The number of countries with support policies in place just for renewable power generation increased from 48 in 2005 to 138 by early 2014.[1] Developing countries and emerging economies recently have taken the lead and account for the majority of nations with concrete support mechanisms in place today.

No single policy or measure 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 that 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.*

The number of policies designed to incentivize renewable energy and energy efficiency has increased in CARICOM member states in recent years. Overall, however, 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.

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* 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).

4.1 National Energy Plans and Targets

Establishing an official long-term vision for sustainable energy development that lays out clear goals and priorities and that commits all government stakeholders to a common and cohesive strategic agenda is 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 step from when work began on the CARICOM Regional Energy Policy a decade ago.[2] (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.[3]

Table 7. National Energy Plans in CARICOM Member States, as of 2015

Country	Policy Document	Status
Antigua and Barbuda	Final National Energy Policy	In Draft (Feb. 2012) Renewable Energy Bill In Development for 2015
The Bahamas	The Bahamas National Energy Policy 2013–2033	Approved (Sep. 2014)
Barbados	The National Energy Policy of Barbados Draft National Sustainable Energy Policy	Submitted (Dec. 2006) Proposed (Sep. 2011)
Belize	Draft National Energy Policy Framework MESTPU Strategic Plan 2012–2017	In Draft (Nov. 2011) Submitted (Sep. 2012)
Dominica	Draft Sustainable Energy Plan of the Commonwealth of Dominica	Submitted (Apr. 2014)
Grenada	The National Energy Policy of Grenada	Approved (Nov. 2011)
Guyana	National Low Carbon Development Strategy	Updated (Mar. 2013)
Haiti	National Energy Sector Development Plan	In Draft (Feb. 2011)
Jamaica	Jamaica's National Energy Policy 2009–2030	Approved (Oct. 2009)
Montserrat	Montserrat Energy Policy, 2008–2027	Approved (Sep. 2008) (Update planned for 2015)
Saint Lucia	Saint Lucia National Energy Policy	Approved (Jan. 2010)
St. Kitts and Nevis	Draft National Energy Policy	In Draft (Apr. 2011)
St. Vincent and the Grenadines	National Energy Action Plan	Approved (Jan. 2010)
Suriname	Renewable Energy Policy of Suriname	Submitted (Nov. 2010)
Trinidad and Tobago	Framework for Development of a Renewable Energy Policy for Trinidad and Tobago	In Draft (Jan. 2011) Approved (Nov. 2011)

Source: See Endnote 2 for this section.

Setting realistic but 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 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 in order to commit to crucial project financing.

Many CARICOM member states have set specific targets for sustainable energy development across several categories, including renewable primary energy penetration in the overall mix, renewable electricity, energy efficiency improvements, and—in fewer cases—transportation and carbon emissions reductions.

4.1.1 Renewable Energy and Electricity Targets

Many CARICOM member states have set ambitious renewable energy goals that are comparable to, or even exceed, targets being adopted in other progressive world regions. Generally, countries aim to achieve a specific percentage of energy supply through renewables. For example, three countries—Dominica, Grenada, and Guyana—are targeting more than 90% renewable power in the coming decades.[4] (See Table 8.) Belize aims to reduce its fossil fuel dependence 50% by 2020, without specifying whether this is to be achieved through measures aimed at renewable supply, more efficient energy use, or both. The Bahamas, in addition to its overall renewable power target, also specifies a residential electricity self-generation target.

4.1.2 Energy Efficiency Targets

As of the end of 2014, seven CARICOM member states had either implemented or were considering national targets for energy efficiency improvements.[5] (See Table 9.) These targets should be considered as priority areas for action, as they are, by in large, more affordable and easier implemented than targets for renewable energy supply. Targets set for energy efficiency in CARICOM target either end-use efficiency improvements for consumer appliances or reduced rates of technical and non-technical electricity grid losses. For example, St. Vincent and the Grenadines aims to reduce electricity grid losses to 5% by 2020. Haiti, alternatively, targets 36% of households using improved efficiency cooking stoves.

4.1.3 Sustainable Transportation Targets

Seven CARICOM countries currently have concrete targets for the transportation sector.[6] (See Table 10.) Suriname is committed to achieving a minimum of 40 million liters of bioethanol production by 2015. Antigua and Barbuda as well as The Bahamas plan to significantly improve the efficiency of the transport sector, whereas St. Kitts and Nevis as well as St. Vincent and the Grenadines aim to reduce overall fossil fuel consumption. Grenada has set an extremely ambitious transportation sector target of 100% renewable fuels by 2030. Trinidad and Tobago specifies the number of vehicles it wants to see converted to CNG and aims to reduce the sector's CO_2 emissions.

4.1.4 Emissions Reduction Targets

At the close of 2014, five CARICOM member states had national targets in place for emissions reductions.[7] (See Table 11.) Antigua and Barbuda has adopted a target to reduce emissions to 25% below 1990 levels

Table 8. Renewable Energy and Electricity Targets in CARICOM Member States, as of 2015

Country	Renewable Energy Target	Renewable Electricity Target
Antigua and Barbuda	15% by 2030	20% by 2020
The Bahamas	30% by 2030	15% by 2020; 30% by 2030 10% residential self-generation by 2014
Barbados	10% by 2012 20% by 2026 (from 3.2% today)	29% by 2029
Belize	50% reduction in fossil fuel dependence by 2020	89% by 2033
Dominica	100% by 2020	25% by 2010 100% through addition of geothermal by 2020
Grenada	20% by 2020	10% by 2013 and 20% by 2017 (Grenada) 40% by 2011 (Carriacou and Petite Martinique) 100% by 2030
Guyana	None	90% through hydro development; 15,000 solar home systems installed (no date given)
Haiti	None	20% by 2017 28% by 2022 46% by 2027
Jamaica	20% by 2030	12.5% by 2015 20% by 2030
Montserrat	None	100% (geothermal and solar) by 2020
Saint Lucia	35% by 2020	5% by 2013 15% by 2015 35% by 2020
St. Kitts and Nevis	None	20% by 2015 100% by 2010 (Nevis)
St. Vincent and the Grenadines	None	30% by 2015 60% by 2020
Suriname	None	None
Trinidad and Tobago	None	5% of peak demand (or 60 MW) by 2020

Note: "None" indicates that no target had been set or announced by the date of research for this report.
Source: See Endnote 4 for this section.

by 2020. 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% below business-as-usual projections by 2020. In addition, while not setting a cross-sectoral national target, Guyana's Low Carbon Development Strategy details the Amaila Falls Hydropower Project. It aims to eliminate 92% of Guyana's energy-related emissions by the envisioned project completion in 2017. Trinidad and Tobago is committed to reducing the transport sector's CO_2 emissions by 10–15%, but has not specified a date by which this is to be achieved.

Table 9. Energy Efficiency Targets in CARICOM Member States, as of 2015

Country	Target
Antigua and Barbuda	20% improvement in energy efficiency by 2020
The Bahamas	None
Barbados	22% reduction in electricity consumption compared to business as usual by 2029
Belize	At least 30% Improvement in energy efficiency and conservation by 2033 (suggested)
Dominica	20% reduction in public sector electricity consumption by 2020; line losses below 10% by 2020
Grenada	None
Guyana	Removal of duties and taxes on energy-efficient CFLs and LED lights
Haiti	36% of households using improved cooking stoves by 2015 (kerosene/LPG instead of charcoal)
Jamaica	Energy intensity reduced to 6.3 million joules per USD of GDP by 2030 (from 22 million today)
Montserrat	None
Saint Lucia	20% reduction in public sector electricity consumption by 2020
St. Kitts and Nevis	20% reduction in projected electricity demand by 2015 (resulting in peak demand of 45.7 MW)
St. Vincent and the Grenadines	5% reduction in projected increase in peak demand by 2015, 10% by 2020 7% reduction in power losses by 2015, 5% by 2020 15% reduction in electricity generation by 2020
Suriname	None
Trinidad and Tobago	Currently no target, but is finalizing the administrative framework for a 150% tax allowance to be granted to commercial and industrial enterprises that achieve a target share (to be determined) of energy efficiency improvements.

Note: "None" indicates that no target had been set or announced by the date of research for this report.
Source: See Endnote 5 for this section.

4.2 Policies and Measures

Once a vision has been established—usually as a national plan, policy framework, or sectoral strategy that includes concrete sectoral and/or sub-sectoral targets—it is necessary to develop concrete mechanisms to support the development and deployment of sustainable energy technologies in order to meet these envisioned goals and targets. Although such measures have been widely implemented across the region, there remains a significant need for policy evaluation and implementation of additional measures.

Energy markets, whether sustainable or fossil-fueled, are driven largely by supporting or restricting policies, which (intentionally or not) always establish market rules, conditions, and an overall trading framework. Thus, governments 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.

4.2.1 Renewable Energy Support

All CARICOM member states are currently designing or have already implemented regulatory reform measures, fiscal incentives, or public financing mechanisms for renewable energy.[8] (See Table 12.)

Table 10. Sustainable Transportation Targets in CARICOM Member States, as of 2015

Country	Target
Antigua and Barbuda	50% improvement in transport efficiency in 15 years
The Bahamas	70% of vehicles to achieve fuel economy of 30–35 mpg in 5–10 years
Barbados	None
Belize	Participation in SIDS DOCK Diesel Fuel Replacement Program
Dominica	None
Grenada	100% renewable fuels by 2030
Guyana	None
Haiti	None
Jamaica	Promotion of ethanol and biofuels
Montserrat	None
Saint Lucia	None
St. Kitts and Nevis	15% reduction in fossil fuel consumption by 2015
St. Vincent and the Grenadines	15% reduction in fossil fuel consumption by 2020
Suriname	40 million liters of bioethanol production by 2015
Trinidad and Tobago	17,500 vehicles converted to CNG by 2017; 100,000 vehicles by 2020; 10–15% reduction in sector's CO_2 emissions (no date given)

Note: "None" indicates that no target had been set or announced by the date of research for this report.
Source: See Endnote 6 for this section.

Given the region's long history of monopoly control over electricity generation, transmission, and distribution, independent generators have struggled to gain a foothold in many member states. A successful transition to renewable energy will require the increased presence and participation of IPPs, both large and small and on- and off-grid. Recognizing this, some member states permit IPPs to operate, although with varying degrees of administrative and regulatory burden. In Antigua and Barbuda, as well as in St. Vincent and the Grenadines, independent production is allowed only if approved by the utility. In states where IPPs are 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, regulatory changes must take place in order to open markets to independent generators.

Standards or quotas on energy supply from renewable resources are a promising, but so far unutilized, opportunity for progress toward sustainable energy systems in the CARICOM region. Renewable Portfolio Standards (RPS) provide a regulatory framework to promote renewable energy resources by obligating electricity supply companies to source a share of supplied energy from renewables. Because many CARICOM member states retain significant ownership of domestic utility companies, RPS mechanisms can be implemented synergistically and regulated affordably.

Table 11. Emissions Reductions Targets in CARICOM Member States, as of 2015

Country	Target
Antigua and Barbuda	25% reduction from 1990 levels by 2020
The Bahamas	None
Barbados	None
Belize	None
Dominica	Achieve carbon-negative status by fully exploiting geothermal for domestic energy needs and exporting power to Guadeloupe and Martinique
Grenada	20% reduction from business-as-usual levels by 2020
Guyana	92% reduction by completion of Amaila Falls Hydropower Project
Haiti	None
Jamaica	None
Montserrat	None
Saint Lucia	None
St. Kitts and Nevis	None
St. Vincent and the Grenadines	None
Suriname	None
Trinidad and Tobago	10–15% reduction in transport sector emissions

Note: "None" indicates that no target had been set or announced by the date of research for this report.
Source: See Endnote 7 for this section.

RPS are currently used in Hawaii, where interim targets of 30% by 2020 and 70% by 2040 are designed to ease the transition of the state's Public Utilities Commission to a 100% supply from renewables in 2045. As an observer state in CARICOM, Puerto Rico already has taken strides toward sustainability using RPS. Legislation passed in 2010 mandates that 20% of electricity sales in the territory come from renewables by 2030, laying the foundation for a cost-effective and sustainable energy system.[9]

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 power sector worldwide. They are being used in more than 60 countries, more than half of which are categorized as developing nations.[10] Although FITs have been suggested at different levels of policymaking in several CARICOM member states, none have yet been fully implemented.

However, several member states have implemented net metering or net billing schemes, which allow small-scale electricity consumers to generate their own electricity and to 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.[11] Currently, only a small group of CARICOM member states offers 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 to the grid.

Table 12. Renewable Energy Support Policies in CARICOM Member States, as of 2015

KEY: N = None S = Suggested ID = In Development X = Implemented

REGULATORY POLICIES

Country	Feed-in Tariff	Net Metering/Billing	Renewable Portfolio Standard/Quota	IPPs Permitted
Antigua and Barbuda	S	X	S	X
The Bahamas	ID	ID	N	S
Barbados	ID	X	ID	X
Belize	S	S	S	N
Dominica	N	X	N	X
Grenada	S	X	ID	X
Guyana	N	S	N	X
Haiti	S	S	S	X
Jamaica	N	X	N	X
Montserrat	N	N	N	N
Saint Lucia	S	X	N	X
St. Kitts and Nevis	N	N	N	X*
St. Vincent and the Grenadines	S	X	N	X
Suriname	ID	S	N	X
Trinidad and Tobago	ID	N	N	S

FISCAL INCENTIVES AND PUBLIC FINANCING

Country	Tax Credits	Tax Reduction and Exemption	Public Loans/Grants	Green Grant Procurement
Antigua and Barbuda	X	X	S	N
The Bahamas	N	X	N	S
Barbados	X	X	X	N
Belize	S	N	N	N
Dominica	N	X	N	N
Grenada	ID	X	ID	N
Guyana	N	X	N	N
Haiti	S	S	ID	N
Jamaica	X	X	X	X
Montserrat	S	S	N	N
Saint Lucia	S	X	N	N
St. Kitts and Nevis	N	X	X	N
St. Vincent and the Grenadines	S	S	N	N
Suriname	N	S	N	N
Trinidad and Tobago	X	X	N	S

** Only self-generation from wind and solar PV is permitted through NEVLEC.*
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 8 for this section.

In May 2012, Jamaica's Ministry of Science, Technology, Energy and Mining issued the first 11 licenses of its net billing program, but about a year later, only 2 were fully connected to the grid due to administrative challenges.[12] Also hindering initial progress was the structure of the arrangement. The tariffs offered under the net billing scheme did not reflect the current electricity market and remained significantly lower than the price that the utility charged for electricity, therefore failing to provide a lucrative incentive. The Ministry of Science, Technology, Energy and Mining then revised the price differential, which led to an increase in applications from consumers. As of December 2014, the number of licenses issued increased to 259, totaling 4.1 MW of installed capacity.[13]

Net metering and net billing schemes also have been introduced in Grenada, Barbados, and Saint Lucia (the last two as pilots), although with limited success and similar challenges to those experienced during early implementation in Jamaica. To create effective incentives for generation, tariffs must be well designed. Although all four countries experimenting with net metering/billing have taken a significant step forward in implementing these schemes, it is important that the schemes be improved. Net metering and billing ultimately must seek to balance the welfare impact between utility providers and consumers while avoiding excessive increases in overall system cost.

Permitting IPPs and implementing net metering/billing or FITs are proven, highly effective regulatory measures to support larger additions of renewable capacity that could be replicated relatively easily across the CARICOM region, with their design based on international best practices.

Another internationally tested 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 CARICOM member states have implemented tax reductions or exemptions to provide incentives for renewable energy deployment, or are in the process of doing so. As one example, following up on promises made in his May 2013 budget address, "An Agenda for Economic Growth and Fiscal Sustainability," the Prime Minister of Saint Lucia has implemented 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 in many countries worldwide 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. Within CARICOM, they play an important role in Jamaica but nowhere else.

Creating robust and accessible avenues to financing for businesses and communities pursuing renewable energy is an essential complement to any comprehensive strategy for sustainability within CARICOM. These sources of financing can offset potentially prohibitive high upfront investment costs, allowing businesses and communities to realize the proven long-term cost-saving potential of renewable energy.

For example, in a series of environmental training courses, Jamaica introduced green grant and loan guidelines, training over 2,000 public sector officials on procurement procedures. These sessions act as a catalyst for private sector loan programs for renewable energy projects. Sagicor Bank in Jamaica offers a loan facility designed for residential and commercial application of renewable energy, covering up to 80%

of financing for residential projects up to USD 2 million and 70% for commercial projects up to USD 30 million.[14] In St. Kitts and Nevis, the government offers a low-interest public loan program for residential consumers targeting increased use of distributed generation solar PV. These programs have transformative potential for energy systems in isolated island states because they encourage the displacement of fossil fuel-powered backup generators common throughout CARICOM with renewable-based alternatives.

4.2.2 Energy Efficiency Support

Greater energy efficiency can be promoted effectively through government regulations, fiscal incentives, as well as initiatives aimed at raising public awareness.[15] (See Table 13.) Echoing trends in other developing regions, CARICOM member states have recently intensified their efforts to design and implement effective measures that reduce the energy intensity of their economies.

Guyana, for example, has promoted energy efficiency through a combination of tax exemptions, public demonstrations, and incentives for efficient lighting. With loan support from the IDB, Guyana provides financial incentives for the use of solar PV and integrated battery technology to displace inefficient kerosene lighting in 11,000 homes for its Hinterland Electrification Program.[16] Trinidad and Tobago plans to grant a 150% tax allowance to commercial and industrial enterprises that achieve a target share of energy efficiency improvement, although the specific target is still being determined.[17]

National building codes have been used to great effect worldwide to ensure that new construction follows the newest standards for temperature insulation and/or incorporates modern, energy-saving technologies. A number of countries have implemented mandates requiring new construction to include solar hot water heating, an interesting measure as it both promotes a renewable technology and increases the efficiency of a household. Solar water heating is a technology that already has taken hold in Barbados and is spreading across the region.

The promotion of energy labeling for consumer goods such as household appliances has had a significant impact on reducing energy use and further encouraging the design and purchase of less energy-intensive products in many countries worldwide. In combination with labeling, appliance efficiency standards can be adopted to enforce the use of products above a mandated energy efficiency threshold. Only recently have CARICOM countries started to implement mandatory energy labeling provisions and/or efficiency standards.

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.

The uptake of energy efficiency mechanisms in regional policy discussions has been accelerated, due in part to the launch of C-SERMS 1. The C-SERMS monitoring body, REETA, reports that 40% of the defined activities of C-SERMS 1 have been implemented.[18] These include the creation of educational modules on energy efficiency, private sector energy efficiency capacity development, and the approval of over USD 20 million in energy efficiency and renewable energy-related investments by the Caribbean Development Bank and affiliated financial institutions.

Table 13. Energy Efficiency Support Policies in CARICOM Member States, as of 2015

KEY: N = None S = Suggested ID = In Development X = Implemented

Country	National Energy Efficiency Standards	Tax Credits	Tax Reduction and Exemption
Antigua and Barbuda	S	N	N
The Bahamas	S	S	N
Barbados	N	X	X
Belize	N	N	S
Dominica	S	S	X
Grenada	N	N	S
Guyana	S	N	X
Haiti	S	S	X
Jamaica	ID	N	X
Montserrat	N	N	N
Saint Lucia	N	ID	X
St. Kitts and Nevis	N	N	N
St. Vincent and the Grenadines	N	N	S
Suriname	S	N	N
Trinidad and Tobago	S	N	X

Country	Public Demonstration	Prohibition of Use/Import of Incandescent Bulbs	Appliance Labeling Standards
Antigua and Barbuda	N	N	S
The Bahamas	S	X	S
Barbados	N	N	N
Belize	N	N	N
Dominica	S	N	S
Grenada	S	N	S
Guyana	X	N	S
Haiti	N	N	N
Jamaica	X	N	X
Montserrat	N	N	N
Saint Lucia	N	N	N
St. Kitts and Nevis	N	N	N
St. Vincent and the Grenadines	N	X (increased duties)	S
Suriname	N	S	N
Trinidad and Tobago	S	S	S

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 15 for this section.

Despite this progress, energy efficiency mechanisms remain under-implemented, even if compared to renewable energy support policies that themselves are only slowly taking hold. 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.

4.2.3 Support 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, fuel efficiency standards, and tax incentives, has been used to promote decreased dependence on fossil fuels in the transportation sector.[19] (See Table 14.)

Table 14. Transportation Policies in CARICOM Member States, as of 2015

KEY: N = None S = Suggested ID = In Development X = Implemented

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

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 19 for this section.

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 that apply a zero-rated value-added tax (VAT) to private or commercial vehicles manufactured to use CNG.[20] Although natural gas is not without emissions, it is a significant improvement from conventional petroleum, and 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 Saint Lucia, the government has implemented a duty and excise tax exemption of up to 5% on the importation of all vehicles operating on "sustainable fuels" as well as on the equipment required to convert conventional vehicles.[21]

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, 35 new CNG-powered buses were added to the fleet in 2015, and some 300 more will be converted from diesel.[22] 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

The existence of a policy alone is not enough. Its impact depends on its design and on the way in which it is implemented. The failure to implement enacted policies universally and fully may even result in impacts that are directly opposed to what was originally intended. Renewables are still 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 likely that investors and project developers will look to alternative markets that present more-secure investment and finance conditions. This issue is not unique to CARICOM. In Europe, cuts to FITs and other incentives, some of them even applied retroactively, are proving costly to numerous companies. They have the potential to erode confidence in what has been one of the most established renewable energy markets worldwide.

4.3 Governance and Administrative Structures

There are numerous cases across the CARICOM region and around the world where sustainable energy support policies, although well designed, failed because they were not supported by effective governance and administrative structures. Functioning institutions are an important ingredient for the successful deployment of sustainable energy, and ineffective institutions are a critical barrier to its growth. International experience suggests that governance and administrative reforms must play a central role in the development of any nation's energy sector. Unfortunately, many countries in the CARICOM region display a vast array of agencies and structures responsible for various aspects of energy sector governance (see Table 15), rather than a transparent, simple, effective system with precisely defined roles for participating energy sector agents under one clear mainstreamed strategy.

4.3.1 Responsible Agencies

A variety of institutional challenges persist in CARICOM. Crucial government agencies often compete for limited public resources. The energy sectors in many member states are in urgent need of additional human and financial resources. Because decisions and resulting developments in the energy sector strongly affect a broad range of other sectors as well as overall social, economic, and environmental development, a multitude of government agencies with overlapping (and sometimes opposing) mandates and priorities are—and need to be—involved in various aspects of energy planning.

Table 15. Key Energy Sector Institutions in CARICOM Member States

Country	Lead Agency Responsible for Energy	Designated Institution for Sustainable Energy	Regulator	Utility	Utility Ownership
Antigua and Barbuda	Ministry of Tourism, Economic Development, Investment and Energy	Energy Desk, Office of the Prime Minister	Government of Antigua and Barbuda	Antigua Public Utilities Authorities	State
The Bahamas	Ministry of Environment and Housing	Bahamas Environment, Science and Technology Commission	Utilities Regulation & Competition Authority	Bahamas Electricity Corporation (BEC); Grand Bahama Power Company (GBPC)	State (BEC); Private (GBPC)
Barbados	Division of Energy and Telecommunications, Prime Minister's Office	Renewable Energy and Energy Conservation Unit within the responsible ministry	Fair Trading Commission	Barbados Light and Power Company Ltd. (BL&P Co.)	Private
Belize	Ministry of Energy, Science & Technology and Public Utilities	None	Public Utilities Commission	Belize Electricity Ltd. (BEL)	State
Dominica	Ministry of Trade, Energy and Employment	Energy Unit within the responsible ministry	Independent Regulatory Commission	Dominica Electricity Services Ltd. (DOMLEC)	Private
Grenada	Ministry of Finance, Planning, Economic Development, Trade, Energy & Cooperatives	Department of Energy & Sustainable Development	None	Grenada Electricity Services Ltd. (GRENLEC)	Private
Guyana	Ministry of Natural Resources and the Environment	Guyana Energy Agency	Public Utilities Commission	Guyana Power and Light (GPL)	State
Haiti	Ministry of Public Works, Transportation, and Communications	None	None	Electricité d'Haïti (EDH)	State
Jamaica	Ministry of Science, Technology, Energy and Mining	Renewable Energy and Energy Efficiency Department within Petroleum Corporation of Jamaica	Office of Utilities Regulation	Jamaica Public Service Company Ltd. (JPS)	Private
Montserrat	Ministry of Communications, Works, Energy and Labour	None	None	Montserrat Utilities Ltd. (MUL)	State
Saint Lucia	Ministry of Sustainable Development, Energy, Science and Technology	Energy Policy Advisory Committee/Energy, Science & Technology Unit	Ministry of Public Utilities	St. Lucia Electricity Services Limited (LUCELEC)	State (public/private partnership)
St. Kitts and Nevis	Ministry of Public Works, Housing, Energy & Utilities (St. Kitts); Ministry of Communications, Works, Public Utilities, Posts, Physical Planning, Natural Resources and Environment (Nevis)	None	Public Utilities Commission	St. Kitts Electricity Co. Ltd. (SKELEC); Nevis Electricity Company Ltd. (NEVLEC)	State
St. Vincent and the Grenadines	Ministry of National Security, Air and Sea Port Development	Energy Unit	Utility provider VINLEC self-regulates	St. Vincent Electricity Services Ltd. (VINLEC)	State (public/private partnership)
Suriname	Ministry of Natural Resources	Energy Unit of the Ministry of Natural Resources	None	Energie Bedrijven Suriname (EBS)	State
Trinidad and Tobago	Ministry of Energy and Energy Affairs; Ministry of Public Utilities	Renewable Energy and Energy Team within the Ministry of Energy and Energy Affairs	Regulated Industries Commission	Trinidad and Tobago Electricity Commission (T&TEC)	State

Likewise, due to their wide-ranging and often cross-sectoral responsibilities, many government officials lack the detailed knowledge of sustainable energy technologies, their economics and financial requirements, and alternative mechanisms for their effective support. 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 efficient and up to date, 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.

Authority over final decisions in the energy sector needs to be clarified precisely, and all participating agencies should be aware and supportive of joint overall goals. Such mainstreaming is indispensable for creating modern sustainable development in and beyond the energy sector. Responsible agencies require the capacity and means to make smart decisions.

4.3.2 Data and Information Providers

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, these can be challenging to access. Few ministries responsible for energy issues have an Internet 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.

Initiatives like the Caribbean Information Platform on Renewable Energy (CIPORE) and the Caribbean Energy Information System (CEIS) were developed to collect and provide information on regional renewable energy development. However, these and similar initiatives face long-standing challenges related to limited financial resources and capacity, further exacerbating the ability of CARICOM member states to form meaningful sustainable energy policy. Important capacity-building measures, such as those sponsored by REETA for staff members of the Caribbean Development Bank (CDB) and affiliated financial institutions, serve a critical role in improving their capacity to handle technical, financial, and policy-related aspects of renewable energy and energy efficiency projects in the region.[23]

4.3.3 Utilities

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 policymakers trying to support the entry of renewable energy technologies, vertically integrated utilities tend to resist measures that allow consumers to connect distributed renewable energy systems and sell power to the grid. For renewable energy investors and developers, it can be very difficult to enter a market where a sole authority is responsible for building all new generating capacity. Consumers are obviously affected by these challenges, as they

suffer exorbitant electricity prices. Such challenges are further compounded in member states without an independent regulatory agency monitoring the electricity sector.

4.3.4 Administrative Procedures

Energy governance throughout the region is 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 can 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, Jamaica, 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.[24] Complex permitting requirements for small hydropower 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.[25] (See Figure 28.)

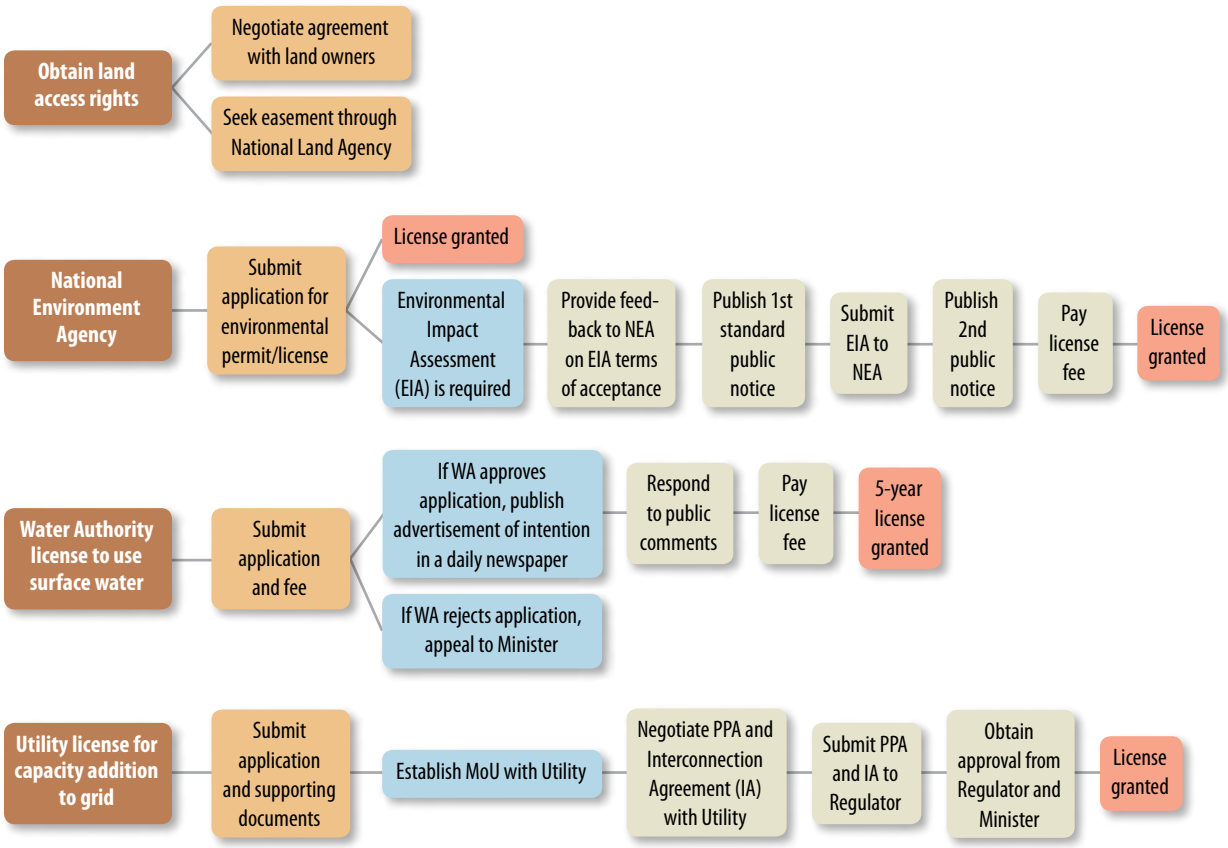

FIGURE 28. Observed Permitting Processes for Adding Small Hydro Capacity (100 kW to 25 MW) in Jamaica

4.3.5 Regional Initiatives

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, GIZ/REETA, SIDS DOCK, Carbon War Room, OLADE, UNIDO, 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. Examples of this important function include the current development of the "Eastern Caribbean Development Partners Group" coordination mechanism—coordinating action and sharing resources through regular meetings on thematic groups such as the environment, energy, and climate change.[26] 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 Greenhouse Gas Emissions

Regional targets such as those set in the context of CARICOM can unite individual member states of a regional union around a common goal and help to ensure that their respective national action plans and policies work as part of a cohesive whole. Existing sustainable energy targets in the Caribbean have been set at the national level. Therefore, the forms they take vary widely. Although this presents certain methodological and practical challenges when 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. When aspiring to provide a common, cohesive guiding vision to the region as a whole, it will be easier to build on what countries are already comfortable with and committed to, rather than starting from scratch.

5.1 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.[1] (See Table 16.) Despite their differences, these scenarios underscore the enormous potential for renewable energy technologies to have a significant positive impact on a number of critical sectors over the coming decades.

Table 16. Global Renewable Energy Potentials in Different Scenarios

Renewable Energy Potential	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*

Source: See Endnote 1 for this section.

Worldwide, several initiatives and regional organizations have developed targets for renewable energy and energy efficiency. (See Table 17.) The United Nations SE4ALL initiative has pledged to work toward three critical goals related to energy access, energy efficiency, and the share of renewables.[2] The EU has set a region-wide target of 20% renewables by 2020, to be met through binding country-specific commitments ranging from Sweden's target of 50% to Malta's target of 10%.[3] In West Africa, 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.[4] And SIDS DOCK, which has particular relevance for CARICOM member states because they are all members of the initiative, has set a variety of sustainable energy targets for small-island states.[5] Belize, for example, has officially adopted several SIDS DOCK targets, such as the Diesel Fuel Replacement Program, as a national objective.

5.2 Recommended Renewable Power Targets for CARICOM

Table 17. Examples of Regional/Global Renewable Energy and Energy Efficiency Targets

Organization	Target/Goal	Countries Covered
Sustainable Energy for All (SE4ALL)	• 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	• 50% of power generation from low-carbon sources by 2033 • 20–30% reduction in petroleum use in transportation by 2033 • 25% increase in energy efficiency by 2033	30 small-island states
European Union	• 20% of final energy consumption from renewables by 2020 • 20% increase in energy efficiency by 2020 • 10% biofuels in transportation by 2020	EU-27
Economic Community of West African States (ECOWAS)	**Grid-connected** • 10% peak load in capacity (excl. medium/large hydro) by 2020, 19% by 2030 • 35% peak load in capacity (incl. medium/large hydro) by 2020, 48% by 2030 • 5% of generation (excl. medium/large hydro) by 2020, 12% by 2030 • 23% of generation (incl. medium/large hydro) by 2020, 31% by 2030 **Off-grid applications** • 22% of rural population served by renewables by 2020, 25% by 2030 **Biofuels** • 5% ethanol share in gasoline consumption by 2020, 15% by 2030 • 5% biodiesel share in diesel and fuel-oil consumption by 2020, 10% by 2030	15 West African member countries

5.2.1 Proposed and Agreed Renewable Electricity Targets

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 all 15 CARICOM member states adopted regional targets for the share of renewables in CARICOM's electricity mix by 2017, 2022, and 2027. These regional targets were suggested in an early draft of this report. The methodology of how they were set is

explained in the following section.

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 most, if not all, member states, renewables could account for 100% of both current and projected power production within a relatively short time frame, if these resources were developed to their full potential. 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. (See Table 6.)

This methodology therefore first sets an overall regional target based on the available documented technical resource potential in all member states.[6] (See Figure 29.) 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 already 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 20% renewable power capacity by 2017, 28% by 2022 and 47% by 2027. (See Table 18.)

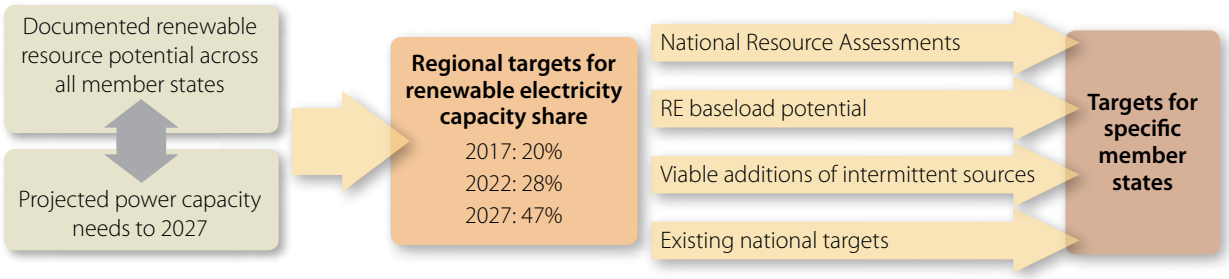

FIGURE 29. Methodology for Recommending Renewable Power Capacity Targets

Estimates of national renewable energy potential have been taken from a variety of sources and studies and compared to projected capacity needs calculated to 2030.[7] Because the characteristics of a given renewable technology determine the ways it can be used, the methodology suggested here 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.* Baseload power stations typically operate relatively continuously at high capacity factors. It is generally more economical to operate these

* 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 18. Proposed Renewable Energy Targets for the CARICOM Region

Horizon	Target Year	CARICOM Target
		(share of renewables in 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%		

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. While lacking the flexibility of dispatch possessed by baseload sources, intermittent renewables can serve an important role as a fuel-saving alternative to fossil fuel-based generation and provide power on a decentralized scale, which also reduces vulnerability to weather extremes. As the share of intermittent supply increases, however, so do the cost and complexity of managing supply and maintaining stability. On the other hand, producing electricity from wind and solar technologies has shrunk dramatically, and costs are now lower than those of fossil fuels in many countries worldwide as well as in the Caribbean, if installation, maintenance, and fuels are accounted for.

Renewable electricity targets suggested here—and approved by COTED—have been 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 time frame 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 then are 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 Suggested Country Shares

Based on the selected regional targets of 28% by 2022 and 47% by 2027, preliminary member state-specific targets for renewable penetration are proposed, reflecting a combined analysis of individual

assessments of available renewable energy baseload potential, viable additions of intermittent renewable energy resources, and existing country goals.[8] (See Table 19.) It is expected, however, that member state-specific targets will be further discussed and assessed within CARICOM, and that final national efforts will reflect this internal debate.

To achieve these targets, each CARICOM member state will need to make significant gains in renewable

Table 19. Existing and Proposed National Renewable Electricity Targets in CARICOM Member States

Country	Existing Renewable Electricity Targets	Proposed National Renewable Share of Installed Power Capacity to Meet Regional Target of 48% by 2027	Estimated National Renewable Share of Generation in 2027 to Meet Regional Target of 48% Capacity by 2027*
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	None	76%	85%
Dominica	25% by 2010 100% through 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 15,000 solar home systems installed	84%	90%
Haiti	None	46%	52%
Jamaica	20% by 2030	40%	40%
Montserrat	None	34%	100%
Saint Lucia	5% by 2013 15% by 2015 30% by 2020	69%	100%
St. Kitts and Nevis†	None	St. Kitts: 57% Nevis: 67%	St. Kitts: 100% Nevis: 100%
St. Vincent and the Grenadines	30% by 2015 60% by 2020	59%	81%
Suriname	None	52%	60%
Trinidad and Tobago	5% of peak demand (or 60 MW) by 2020	52%	29%

** Estimated generation shares are based on proposed capacity targets in neighboring column.*
† St. Kitts' installed capacity and generation figures include imported geothermal power from Nevis.
Source: See Endnote 8 for this section.

penetration. For many states, this will require strengthening existing national targets. Although existing national targets and CARICOM regional targets are not directly comparable due to methodological differences, existing national targets do provide a general picture of the ambition that many CARICOM states have shown in renewable energy planning at the national level.

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 An Ambitious Framework for Action on Renewables in Each Member State

This approach results in bold overall targets that would make CARICOM one of the most ambitious regions worldwide in sustainable energy development. Region-wide and supporting national targets under CARICOM provide a powerful long-term vision that makes the build-up of significant renewable energy capacity a central pillar of energy sector 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 renewable resources are inadequate to supply the demands of an entire country. Calculations made here clearly demonstrate that, given the ample biomass, geothermal, hydro, solar, and wind resources of the Caribbean, renewable energy technologies are capable of providing 100% (or nearly 100%) 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 already have achieved a renewable power share of approximately 50%, 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, power demand, and installed capacity can present economic obstacles to scaling up renewable energy development, these factors also present an opportunity to reach a 100% renewables share in a relatively short period of time.

In many cases, the proposed national targets are significantly higher than what might be expected based on current levels of renewable energy penetration and historic technology growth rates. Across the region, historic deployment has struggled to match the tremendous resource potential available for renewable technologies. The proposed national renewable electricity targets build on existing efforts and seek to provide an ambitious vision for harnessing the resources prevalent in each member state.

5.2.5 Methodological Challenges

Basing proposed shares for renewable electricity on projections of future demand 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 likely could surpass their suggested national commitment to meeting the regional targets. As member states make more ambitious domestic plans, these should be reflected in increased commitments at the regional level, rather than a reduction of other member states.

Due to time and information restraints, certain other factors and assumptions were not considered in the scope of this analysis, but they 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 also was 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 falls beyond the scope of this report.

In addition, this approach does not consider a timetable for decommissioning conventional power plants currently in operation. It is important to note, however, that even if renewables achieve a 100% share, fossil fuel generation likely will be maintained to some degree for emergency situations. The fact that most CARICOM member states rely heavily on diesel generators means that the backup power already exists to facilitate intermittent renewable energy technologies, making a quick transition technically feasible and less costly.

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 several years ago. Solar costs have since 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.

The analysis provided here also does not consider the potential impact of increasingly cost-efficient storage options as a mechanism for promoting the uptake of renewable energy technologies throughout the Caribbean region. The substantial endowments of intermittent renewable energy sources, such as solar and wind, in the region will make development of complementary storage systems a significant incentive to more fully exploit these resources.

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 was discussed in Section 3.

5.2.6 Recommendations for Moving Forward

Setting initial targets is only the first step in developing a regional energy vision. Senior energy officials within CARICOM already have indicated their intent to go beyond these initial goals and to set more ambitious targets. Although not formally accepted at the COTED, delegates there expressed a willingness to set an additional target of a 50% 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 are integrated into regional energy planning.

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 because 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 Annex A.)

Overall, filling significant data gaps in energy statistics for other sectors, 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.

Considering that CARICOM's transitioning economies must utilize flexible and dispatchable systems of energy generation involving both renewable and non-renewable energy sources, it is important to evaluate the contributive potential of renewable resources using a time-sensitive metric (MWh) rather than a simple capacity-oriented metric (MW). Only then will it become clear to what extent renewable resources can be integrated into the existing grids of these member states.

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. 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.

5.3.1 Worldwide Efforts to Reduce Energy Intensity

Worldwide, the pace at which energy intensity is declining slowed to 0.5% annually between 2001 and 2011 and slowed further to just 0.19% in 2013, down from more than 1% annually over the preceding two decades.[9] This, however, has only intensified efforts to improve energy efficiency and highlighted the increasingly important role that energy conservation plays 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% reduction

in primary energy consumption against projected energy use by 2020.[10] At the national level, Denmark is relying on energy efficiency improvements as a key factor to help meet its long-term target of 100% renewable energy in the national energy supply by 2050, one of the most ambitious such targets in the world.[11] China has implemented legislation targeting a 16% reduction in energy intensity from 2011 levels by 2016.[12] And Japan has passed energy efficiency measures targeting specific sectors, with the aim of reducing electricity demand by 30% from 2003 levels by 2030.[13]

5.3.2 Suggesting Energy Intensity as a Measurement for Energy Efficiency Efforts in CARICOM Member Economies

Unfortunately, energy efficiency is often difficult to assess, and various metrics exist to measure how efficiently energy is being used within a specific region, country, or sector. Different ways of accounting also are visible in the diverse formats in which energy efficiency has been presented worldwide. In some cases, targets have been applied across an entire economy, while in others they have been applied to specific sectors. Targets exist for reduced energy intensity, decreased energy consumption, fuel-efficient vehicles incorporated into the national vehicle mix, and lowered electricity demand.[14]

Choosing the appropriate metrics for measuring energy efficiency in CARICOM is of enormous importance. It is suggested here that CARICOM establish regional energy efficiency targets based on energy intensity. This metric already has been used to measure energy efficiency improvements at the regional level in the Asia-Pacific Economic Cooperation (APEC) countries, which are targeting a 45% reduction from 2005 levels by 2035, and at the national level for Jamaica's energy efficiency target.[15]

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.[16] This approach also directly correlates with CARICOM's goals of decreasing energy use where possible and encouraging 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 citizens makes an approach to energy efficiency based on reducing generation and/or consumption inappropriate and perhaps even counterproductive in some cases.

As with other approaches to assessing energy efficiency, using energy intensity as a metric does not come without challenges. Certain energy-intensive industries, such as energy production and mining, reflect heavily in comparative rankings regardless of the efficiency of their operations.[17] 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-intensive industries, such as Trinidad and Tobago. Even if Trinidad and Tobago makes extensive energy efficiency improvements, the country still will 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.

5.3.3 Proposed CARICOM Energy Intensity Target: 33% by 2027

Seven CARICOM member states already have set national-level energy efficiency targets, and two—Antigua and Barbuda, as well as Belize—have enacted domestic measures targeting energy efficiency improvements of roughly 30%. (See Table 9.) Although this is fewer member states than have adopted renewable energy targets, CARICOM'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.

The IEA projects that a moderate adoption of energy efficiency measures could result in an annual decrease in global energy intensity of 1.8% 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 a 2.4% annual decrease over the same period.[18]

Based on existing regional energy efficiency projections and objectives as well as observed global trends and international targets (SE4ALL, for example, aims to double the global rate of improvement in energy efficiency), this report suggests a preliminary CARICOM energy intensity reduction target of 33% from 2012 levels by 2027, to be applied evenly across all member states. These efforts would be in line with 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.

A 33% reduction in energy intensity across the region from 2012 to 2027 would make CARICOM a global leader and would have a transformative effect on the energy sectors and overall 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.

This preliminary regional target is regionally appropriate based on international metrics; however, it 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 will possess greater potential for significant improvements than others.[19] (See Sidebars 3 and 4 on buildings and on the use of smart grids and storage.) The openness to, and political feasibility of, adopting ambitious energy efficiency initiatives in the region also varies widely, which initially may constrain deployment in certain member states. Where potential for improvements in energy efficiency exceeds 33%, all efforts should be made to maximize efficiency through the adoption of national policies rather than reducing ambition elsewhere.

5.3.4 Necessary Policies and Measures

To facilitate this process and shape the development of effective energy efficiency measures, the CARICOM Secretariat and member states should first attempt to fill all critical information gaps and to develop a more detailed overview of sectoral energy use across the region. Currently, these data are often lacking or are not publicly available. Additional national-level assessments of energy use at the sectoral level will also be an important contribution to guide the future development of CARICOM energy efficiency strategies. Short- to mid-term energy efficiency targets and additional long-term targets beyond

Sidebar 3. Policy Recommendations for Improving Efficiency in CARICOM's Building Sector

Globally, the building sector accounts for nearly a third of global final energy consumption and a third of energy-related CO_2 emissions. Buildings therefore have a leading role to play in achieving global energy and emissions goals. Buildings in CARICOM's residential and commercial sectors account for significant and growing shares of overall energy consumption in Belize (23.3%), Grenada (25.4%), and Haiti (57.5%). (See Figure 13.) Thus far, efforts to improve energy efficiency support policies related to buildings in the CARICOM region have centered on appliances, lighting, and consumer products, and overall they not been sufficient to unleash the enormous energy- and money-saving potentials.

Efficiency policies in the building sector should be considered high-impact interventions, especially as these applications become more common and as the demand for electricity increases in the region. Dominica and St. Kitts, for example, collectively replaced over 600,000 incandescent light bulbs with CFLs in 2007 and 2014, respectively, while Jamaica and Barbados implemented energy labeling standards for appliances such as refrigerators and freezers in 2009 and 2010, respectively.

Such efficiency initiatives are politically appealing because they are low cost and have direct cost benefits to consumers. Overall, improving energy efficiency represents one of the cheapest and fastest ways to reduce the economic and environmental costs associated with a given generation system. However, appliances, lighting, and consumer products account for a comparatively small portion of total energy consumption by buildings in the residential and commercial sectors.

A 2011 Caribbean Renewable Energy Development Program (GREDP-GIZ) audit of energy efficiency in hotels found that appliances and lighting account for 17.3% of energy consumption, whereas air conditioning and water treatment account for 64.5%. Renewable energy technology improvements for these operational necessities are comparatively expensive, often with delayed returns on investment and less well-defined regulatory environments such as solar cooling systems and grid-independent solar PV systems. Encouraging private sector buy-in for these technologies will require strengthening regulatory policies and creating incentives for energy efficiency and renewable energy technology upgrades.

Implementing effective and targeted support policies can facilitate the development and deployment of suitable sustainable energy technologies to achieve these goals. Effective policies share three general characteristics:

- **Policies must be implemented as part of an appropriate policy mix.** Although certain policies have proven effective in rapidly increasing renewable energy deployment in certain contexts, policy design is not one-size-fits-all. Policymakers must identify a combination of policy measures that most effectively address existing circumstances, including technological maturity, affordable capital, ease of integration into the existing system, and the available local and national renewable energy resource base.
- **Policies must be sustained.** To provide energy investors and developers with the stability and reassurance they need to commit to sustainable energy projects, policies must be sustained over an appropriate period of time. Without the assurance that the policy landscape will remain fairly stable, would-be investors will view commitment as too risky.
- **Policies must be flexible.** Given the dynamism of renewable energy markets and technology developments, policies must be flexible enough to evolve in changing conditions.

Acting in coordination, the following policies can catalyze energy efficiency improvements in the building sector while promoting private sector participation.

1. **Initially focus on efficiency standards for technologies that are cheap and easy to deploy,** such as passive cooling methods, natural ventilation systems, and lighting. Promoting energy efficiency is one of the most effective ways to educate the public about energy issues and the impacts of energy consumption, thereby encouraging wider behavioral changes and energy savings.

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Sidebar 3. continued

2. **Streamline permitting procedures** for energy efficiency and renewable energy technology upgrades in buildings. Long and bureaucratic permitting processes can result in significant risk and expense, discouraging developers and investors from undertaking renewable projects. In 2009, Jamaica released a comprehensive and streamlined building code, subject to periodic review and providing flexible terms of compliance to improve building safety and emphasize energy conservation during construction and operation.
3. **Implement tax incentives** to encourage major customers to perform energy audits. Audits identify the simplest and most-effective ways to reduce energy consumption and costs in a given building or business. Several Caribbean countries have implemented fiscal incentives to promote their use. In Trinidad and Tobago, Finance Act No. 13 provides a 150% tax allowance for companies that carry out energy audits and install energy-saving equipment. The same law also guarantees 75% accelerated depreciation on all machinery needed to conduct energy audits for those companies that perform them.
4. **Fund case studies** such as the Energy for Sustainable Development in Caribbean Buildings Project (ESD), which identifies energy efficiency and renewable energy technology solutions for hotels and reports expected increases in energy efficiency of around 10–15% and savings of USD 400,000 annually per case study.
5. **Capitalize on reconstruction efforts** after natural disasters that are frequent in the region, such as efforts continuing in Haiti after the 2010 earthquake. These events offer significant opportunities to better integrate energy efficiency considerations into new construction and to retrofit damaged structures.

Source: See Endnote 19 for this section.

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.

Once areas of highest impact are identified in the CARICOM countries, the development of robust energy efficiency policies tailored for those sectors is critical to catalyzing similar effort throughout member state economies. ISO 50001 offers an internationally tested methodology that is versatile and responsive to the varied challenges facing public and private sector organizations with energy management responsibilities.[20] This framework provides management strategies to increase energy efficiency, reduce costs, and improve energy performance. Importantly, ISO 50001 can be integrated with pre-existing management system standards, allowing prescribed strategies to be tailored toward the specific efficiency targets set by each country.

5.4 Recommended Greenhouse Gas Emissions Reduction Targets for CARICOM

A regional target for greenhouse gas emissions reductions forms a third pillar of the regional vision being put forward by CARICOM. While the aggregate emissions of all 15 member states are negligible in comparison to total global greenhouse gas emissions, an ambitious CARICOM target for emissions reductions will encourage member states to make crucial improvements in adapting to ongoing climate changes as well as set a strong precedent for international mitigation action. It also will open the access to international climate financing, a way to receive substantial financial and technical resources for sustainable reform in the energy sector.

Sidebar 4. Smart Grids and Storage in the CARICOM Region

Historically in the Caribbean, electricity has been generated almost exclusively using fuel oils, with diesel being an especially important back-up energy source during blackouts. This method of generation is appealing to power providers because large- and small-scale power plants charged by fuel oils are quickly dispatchable—i.e., capable of adjusting output to demand and rapidly ramping up and down production.

Renewable energy technologies offer CARICOM member states an opportunity to wean themselves off hydrocarbon-based electricity production. However, some of these technologies, including solar PV, wind, and run-of-river hydropower, are not dispatchable, and therefore energy produced from these sources must be used as it is generated. Thus, electricity generation from fuel oil and increasingly natural gas is still utilized to dispatch electricity during periods "when the wind does not blow and the sun does not shine."

Grid storage development and the implementation of smart-grid technology will prove to be a game changer for renewable energy markets and will provide an important opportunity for the Caribbean to mitigate some of the risks characteristic of renewable energy technologies. These technologies can help to provide grid stability, increase renewable capacity potential, and assist grid operators in meeting electricity demand and strategically managing renewable energy integration.

Commercially available storage technologies that exist today include: battery technologies (lithium ion, sodium sulfur, deep-cycle lead acid, nickel cadmium, metal air, and flow batteries), compressed air energy storage (CAES), flywheels, capacitors, super capacitors, and pumped hydropower. In addition, technologies such as vehicle-to-grid offer the potential to use electric vehicles as a means of storage. Nevertheless, there are no clear commercial renewable energy storage winners to date, but advancements are sure to come as countries move to develop their post-2015 energy agendas.

Pumped hydro storage systems currently represent 99% of global installed storage capacity and will play a formative role in energy storage for CARICOM. These facilities can work in mountainous regions, where water is pumped from a lower reservoir (flooded mine shafts, underground cavities, etc.) into upper reservoirs during off-peak hours, and then released back to the lower reservoir through an electricity-generating turbine. Pumped-hydro storage is also feasible using the ocean as a lower reservoir, as implemented in Japan—with a generating output capacity of 30 MW.

Electrochemical storage systems, using batteries, are also a promising energy storage technology for CARICOM. They are especially appealing because most batteries are at advanced stages of technological maturity and can be implemented quickly and cheaply. Already, small-scale residential applications of battery technologies, such as lead-acid battery storage systems for solar panels in the Dominican Republic, are occurring. The high rates of return on investment for these systems hold promise not only for greater-scale residential application, but also for the commercial sector, such as hotels.

Lithium-ion batteries are another promising energy storage technology for the Caribbean region. Although they are 2–5 times more expensive than lead-acid batteries, lithium-ion batteries have longer lifespans, higher rates of storage efficiency, and greater energy load bearing capacity. For these reasons, lithium-ion batteries are ideally suited to commercial and industrial sectors, where battery reliability and physical size are valued.

In an economy-wide application of battery storage technology, the Caribbean island of Bonaire has utilized a nickel-based battery storage system installed by Saft, delivering 3 MW of continuous electricity supply for the entire island. Combined with the world's largest wind/diesel hybrid power plant housed on the island, Bonaire has a reliable back-up to its renewable electricity generation facilities and has since been able to ramp down its partial reliance on diesel during periods of intermittency from wind.

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Sidebar 4. continued

Grid integration studies are an essential component of any comprehensive "smart grid" strategy to establish baselines for renewable energy penetration for electricity generation. Advances in weather forecasting and big-data interpreting technologies, such as those utilized in Texas, can improve energy output modeling for solar and wind—reducing renewable sector risk for potential investors. Again in Texas, wind's 10% share of total electricity supply has been anchored by integrating complementary renewables, such as coastal wind, continental wind, and solar into the same grid. Scaling up production of electricity through multiple geographically diverse renewable plants also can minimize the risk of intermittent renewables by reducing second-to-second variations in output.

In February 2015, the IDB announced a USD 2.5 million smart grid pre-feasibility study for Barbados, designing a model financing instrument and deployment projects for wind and solar plants utilizing smart grid technology. It will be important to see the results and to explore the applicability of lessons learned in other islands. The Caribbean also must learn from experiences elsewhere, such as Hawaii's Kauai Island, where increases in utility-scale solar PV supply of up to 80% of overall demand (even at peak hours) have led to power fluctuations—but where grid-scale lithium ion batteries have been utilized successfully to stabilize the grid.

The incorporation of energy storage and smart grid technologies may allow electric utilities in CARICOM member states to better plan and expand their electricity infrastructure. Storage technologies can then reassure investors and IPPs who obtain power purchase agreements that their product (i.e., generated electricity) will be accepted and consumed. Mitigating the risk of renewable energy and planning smart grids is the future for an effective deployment of renewable energy technologies within the CARICOM region.

Source: See Endnote 19 for this section.

5.4.1 The Threat of Climate Change, and Worldwide Mitigation Efforts in the Energy Sector

Global emissions from the energy sector are one of the leading contributors to climate change, with fossil fuel combustion accounting for nearly 70% of all CO_2 emissions. This trend has improved somewhat in recent years, due in part to the uptake of climate-compatible development strategies in many leading countries. Emissions grew 1.2% in 2013, or at about half the average annual growth rate since 2000.[21] While this slowing growth is a positive first step, total emissions continue to increase, with CO_2 emissions from traditional fossil fuels reaching a new all-time high of 36 gigatonnes in 2013.[22]

The transition to sustainable energy supply and consumption will play a central role in mitigating climate change. Fast and substantial deployment of sustainable energy technologies today is an essential component for 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 75–80% of climate change-related costs.[23]

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 all are tied directly to climate change and gravely threaten the region's long-term security. Within CARICOM, these threats can be magnified. Haiti has been recognized as the world's most vulnerable nation to climate change.[24]

To mitigate the existential threat of climate change, 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 UNFCCC Conference of the Parties (COP). National and regional organizations have taken the lead in transitioning to climate-compatible development by adopting emissions reduction targets and supporting strategies.

The European Union once again stands out as a primary example of combined commitments made at the regional level, mandating a 20% reduction in greenhouse gas emissions by 2020 from all 27 member states.[25] At the national level, many small-island states already have established ambitious goals for emissions reductions, expressed recently in coordinated action through the Barbados Declaration.[26]

Within CARICOM, Dominica is seeking to become carbon-negative through renewable energy exports, and Grenada aims to reduce greenhouse gases 20% 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% below 2009 levels by 2020.[27]

5.4.2 Proposed CO_2 Targets for CARICOM

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, three targets for CO_2 emission reductions within the power sector are suggested here, all of which are set against business-as-usual projections made in 2012. (See Table 20.) 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.[28] (See Tables 20 and 21 and Annex A.)

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 21.

5.4.3 Necessary Steps to Achieve Greenhouse Gas Targets

Analysis of emissions reduction targets for CARICOM's power sector would benefit greatly from additional research quantifying emissions reductions potentials from other key sectors. To facilitate this process and to 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 would provide additional 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 would support the development of short- to mid-term emissions reduction targets and additional long-term targets beyond

Table 20. Proposed CARICOM Power Sector CO_2 Emissions Reduction Targets

Horizon	Target Year	CARICOM Target (CO_2 emissions reduction against 2012 business as usual)
Short Term (2 years)	2017	18%
Medium Term (7 years)	2022	32%
Long Term (12 years)	2027	46%

Table 21. Proposed Power Sector CO_2 Emissions Reduction Targets for Individual CARICOM Member States in 2027

Country	National Target (CO_2 emissions reduction against 2012 business as usual)
Antigua and Barbuda	62%
Bahamas	53%
Barbados	61%
Belize	62%
Dominica	100%
Grenada	100%
Guyana	82%
Haiti	44%
Jamaica	51%
Montserrat	100%
Saint Lucia	100%
St. Kitts and Nevis	100%
St. Vincent and the Grenadines	78%
Suriname	43%
Trinidad and Tobago	29%

Source: See Endnote 28 for this section.

2027, establishing CARICOM as a leader in the implementation of climate-compatible development strategies for the near and long term. 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. Efforts at capacity building for measuring, reporting, and verifying emissions and the impact of measures aimed at their reduction needs to be ramped up significantly.

6 Sustainable Energy for CARICOM: A Strategy to Achieve Regional Targets

CARICOM, and its individual member states, will need to take coordinated and strategic action to achieve the targets for renewables, efficiency, and emissions reductions recommended in Section 5; the commitments made as part of the CARICOM Energy Policy; and the overall goal of socially, economically, and environmentally sustainable development. The ambition demonstrated by CARICOM's 15 member states in adopting, at COTED 2013, the CARICOM Energy Policy and agreeing to a 48% renewables target for 2027 suggests a bright future for the Caribbean. To make it a reality, however, a great deal of work remains to be done. This section outlines how the transition to sustainable energy can be achieved.

6.1 The Importance of Coordinated Action Between CARICOM and Its Member States

Achieving CARICOM's energy targets and overarching development goals will require coordinated efforts on both the regional and national levels. On the national level, individual member states must implement domestic policy mechanisms and enact essential reforms to meet their contribution to the regional target. At the same time, CARICOM can play a crucial role in supporting and coordinating national efforts, ensuring that the progress of individual member states is guided, reported, monitored, and verified. (See Figure 30.)

Minimizing existing barriers to the quick and substantial development and deployment of renewable energy and energy efficiency technologies across the CARICOM region will require a coordinated and strategic approach consisting of multiple individual components that will carry the region forward, a step at a time.

6.2 A Work Program of Priority Initiatives, Policies, Projects, and Activities (PIPPAs)

The Caribbean Renewable Energy Development Programme (CREDP) has identified four important strategic goals that will be essential to removing existing barriers to renewable energy:

1. Information: Improve the region's energy information network by strengthening existing information systems and building awareness of renewable energy;

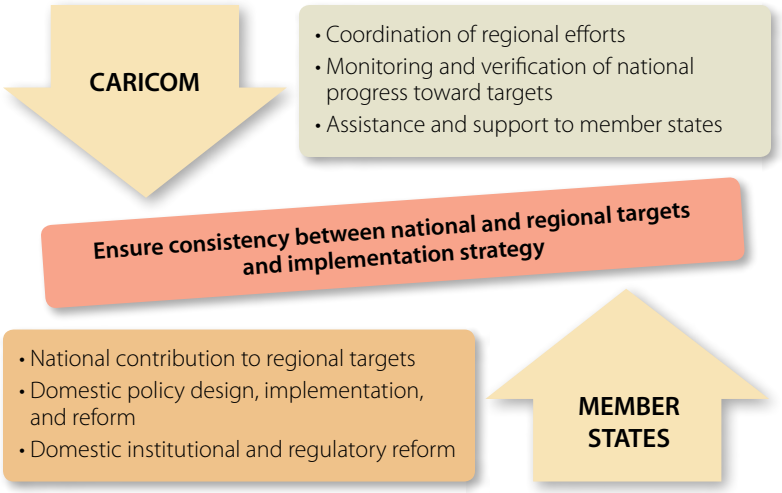

FIGURE 30.

Achieving Targets Through Coordinated Regional and National Efforts

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; and

4. Capacity: Build technical capacity among players in the renewable energy field, including project developers, financiers, engineers and technicians, policymakers, and planners.

The four strategic goals that CREDP identifies for renewables can be extended to include energy efficiency as well as climate. The following sections further explore these four goals in order to design a concrete and detailed work program that will enable CARICOM and its member states to reach their sustainable energy goals. The proposed work program suggests concrete priority initiatives, policies, projects, and activities (PIPPAs). It also identifies which of these "enablers" are to be undertaken at the regional level, at the national level, or at both.

Successful completion of each individual PIPPA would have a significant positive impact on the region and/or implementing member state. However, only the completion of the full slate of PIPPAs will allow CARICOM to meet and likely exceed its regional sustainable energy goals, including the energy efficiency, renewables, and climate goals proposed in this report. Further design and implementation of the work program should be orchestrated by CARICOM in continuation of the union's Energy Policy in order to ensure that no member state feels left alone on this challenging path. CARICOM is best positioned to lead and support a network of national actors and institutions united under a common vision for the region's energy sector.

6.2.1 Addressing Remaining Data and Information Gaps

Review of available information reveals critical analytical gaps that must be filled in order for a regional sustainable energy strategy to be developed further. Data gaps exist with respect to: the two main energy-

consuming sectors, electricity and transportation; greenhouse gas emissions; the potentials of renewables and energy efficiency; as well as policy and finance. (See Figure 31.) Filling the remaining regional data and information gaps will lay the basis for the design and implementation of a concise sustainable energy strategy for the Caribbean.

The main information and data enablers identified on the national level include technical assessments of renewable resources and energy efficiency potentials and their application in electricity system modeling. On-site feasibility studies need to analyze the community impacts, economic costs, environmental footprints, etc. of alternative energy pathways. It will not be enough to just undertake these studies. The results need to be broadly disseminated and used for intense stakeholder and public consultations. There is an important role for CARICOM to play in coordinating information gathering and communication.[1] (See Sidebar 5.) A regional assessment of the lessons learned in planning and implementing sustainable energy technologies would greatly improve peer-to-peer learning and exchange across the region. Table 22 details individual components of these main action areas.

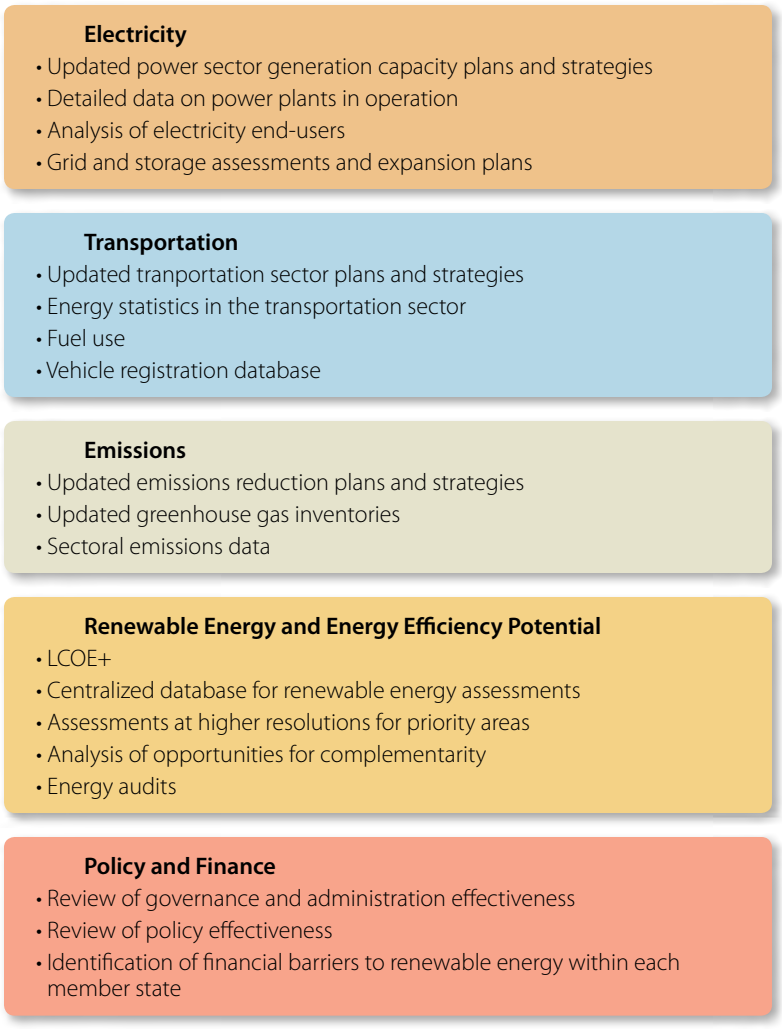

FIGURE 31.

Identified Energy Data and Information Gaps in CARICOM

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Sidebar 5. Creating Effective Information Systems and Knowledge Management

To date, a lack of reliable, thorough, and actionable data remains an obstacle to a swift sustainable energy transition in the Caribbean. For CARICOM to act as a dynamic coordination unit for region-wide initiatives and national actions, member states must commit to a process of data collection, coordination, and standardization. Currently, various information systems are deployed across the Caribbean, including The Caribbean Energy Information System (CEIS), the Caribbean Information Platform on Renewable Energy CIPORE, and the Regional Energy Information System (SIER). Operating collaboratively, these organizations have tremendous potential for advancing CARICOM's energy transition. This synergy will remain unrealized, however, until the lack of robust communication, research cooperation, data exchange, and uniform reporting standards between them is addressed.

A growing collection of global and regional organizations focused on energy information and analysis is readily available for consultation by CARICOM member states. The methodologies provided by these bodies range from precise situational modeling on nation-level energy resource endowments, grid characteristics, and energy demand trajectories to regional assessments of finance access, available technologies, and climate patterns. CARICOM can, and should, play a central role in collecting, harmonizing, and disseminating information available from these organizations to catalyze regional and national level efforts for sustainability.

Existing Energy Information Systems and Tools

CARICOM member states have access to the Stockholm Environment Institute-created Long-range Energy Alternatives Planning methodology (LEAP). While limited to the preparation of information, this model provides a macro-economic perspective on greenhouse gas mitigation based on state-level energy forecasting useful for climate negotiations through the UNFCCC. The Caribbean Community Climate Change Center (CCCCC) serves as the coordinating body for Caribbean climate change response, providing an online risk adaption forecasting tool through CCORAL.

Supplementing these tools, CARICOM also offers a suite of energy data collection and analysis services to member states to inform energy sector policymaking. The Caribbean Energy Information System (CEIS) uses local committee-compiled data to provide comprehensive analysis on energy endowments, end-uses, and transformations. This information is then distilled on forums for legislation, such as the Caribbean Information Platform on Renewable Energy (CIPORE), and for business through the Caribbean Information Platform on Petroleum (CIPPET) and the Caribbean Energy & Environment Business Information Platform (CEEBIP). Unfortunately, proprietary and cost issues have limited the transfer of information between CEIS and member states. As a result, CEIS is not always able to provide critical information to member states, exposing a shortcoming in this arrangement.

The Latin American Energy Organization (OLADE) offers a number of software-based toolkits to Caribbean energy planners. Among them, the Regional Energy Information System (SIER) collects, manages, and utilizes data from CARICOM member states on regional energy planning, incorporating statistical, socioeconomic, regulatory, and historical data to inform energy forecasting and to facilitate intraregional comparative analysis. OLADE's Energy-Economic Information System (SIEE) utilizes the same data to provide business climate-driven reports on the impact of energy forecasts on economic development in the region. This model is coupled with the National Energy Information System (SIEN), providing software-based systematization and processing of national energy data—customizable to energy chain structures of specific countries and utility providers using the tool.

The International Renewable Energy Agency (IRENA) also provides a repository for renewable energy knowledge through the Global Renewable Energy Island Network (GREIN) tool. This accessible database allows for the exchange of best practices for energy institutions and authorities for small-island developing states. IRENA has also developed a Global Renewable Energy Atlas, an Iinternet-based platform providing high-quality resource maps from technical institutes, aiming to serve as a catalyst for planning, policy development, and investment within small-island developing states.

Sidebar 5. continued

Organizations like the Low Emission Development Strategies Global Partnership (LEDS GP), the Clean Energy Solutions Center (CESC), and the International Partnership on Mitigation, Measuring, Reporting, and Verification all act as repositories for these tools, among many others. In addition to compiling these tools, they provide training webinars and expert consultation services on finding and applying tailored energy sector information methodologies for individual states.

Institutes like the Worldwatch Institute, the Carbon War Room, and the Rocky Mountain Institute draw lessons learned and best practices from these sometimes intimidatingly large bodies of information to create targeted and stakeholder-accessible content. These range from short policy briefings and energy profiles to in-depth roadmap strategy documents—like the report you are currently reading.

Coordinating, Integrating, and Harmonizing Data and Information

Moving forward, it is essential that the CARICOM Secretariat and its member states work to develop a robust regional information system that provides harmonized data on renewable energy, energy efficiency, and greenhouse gas emissions. Implementing this system will be challenging, because not all CARICOM member states collect the same type of data, and for those that do, there may be disparities in the quality of similar types of data. Effective comparative analysis, however, relies on such data being standardized.

Modeling potential outcomes from implementation of new technologies, energy systems, and policies is a top priority of an actionable regional energy information system. However, due to the variability of economic, geographic, and demographic factors in CARICOM member states, no one system can accurately calculate these outcomes for the entire region. Energy planning under these circumstances therefore requires a "coherent regional architecture" of decentralized energy information and analysis. Providing member states with support from trained personnel as well as country-appropriate tools for data collection, information management, and energy forecasting would be a giant step forward.

This information system must also be adaptable enough to satisfy the needs of a wider audience. Data that are both detailed and reliable must be available for energy system engineers and technical experts. However, these data must also provide "digestible" information useful for policymaking and operational duties of professionals outside the energy sector. This can be best provided using intuitive and user-friendly computing platforms with uniform criteria for data collection and reporting. This is particularly important for environmental impact assessments, which conventionally have relied on parameters that can be expressed only quantitatively—meaning that they are often ignored.

Operating in a vacuum, one toolkit may not always provide enough data to catalyze informed regional and national policymaking. Forums like the Regional Energy Information Forum and the Workshop on Energy Balance and Planning Models promote standardization of relevant data sources by coordinating and integrating various toolkits deployed across the Caribbean. Once coordinated and standardized, these data sets are a powerful input for energy sector management frameworks like ISO 50001 (see Section 5.3.4)—essential for realizing cost reduction, performance, and efficiency opportunities in the energy sector.

The SIDS DOCK Virtual Knowledge Network provides an institutional mechanism to facilitate informed regional and national policymaking through information sharing on technology, policy, legislation, and best practice. One platform through which this is achieved is the recently created Caribbean Center for Renewable Energy and Energy Efficiency (CCREEE), which combines comprehensive technical support on analytics-driven data with financial resources to support implementation of low-carbon project activities for sustainable energy-related issues.

6.2.2 Creating Effective Finance Mechanisms

Many CARICOM member countries lack sufficiently well-maintained and accessible financing tools for sustainable energy enterprise. The absence of these resources hamstrings the region's opportunities to capitalize on its tremendous potential for renewable energy and energy efficiency. Although increasing

Table 22. Recommended Priority Initiatives, Policies, Projects and Activities (PIPPAs): Information and Data Gathering

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Regional/National/Both
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, buildings, 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	Communicate key findings regarding grid and storage capabilities and introduce energy management systems	•	•	•	•	•									B
2	**Conduct and Communicate Electricity System Modeling**														
2.1	Facilitate country-specific LCOE+ modeling of all-inclusive electricity generation scenarios (including renewable energy, fossil fuels)	•													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 the national level	•	•												N
4	**Coordinate Information Gathering and Communication**														
4.1	Identify a set of key energy indicators	•													R
4.2	In cooperation with existing initiatives (CEIS, CIPORE, OLADE), fill identified gaps in energy system data	•	•	•											R

Table 22. continued

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Regional/National/Both
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
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

international finance resources are available—through funds that are private and public, bilateral and multilateral, and including international support mechanisms for sustainable energy as well as climate—much remains to be done on the national and regional levels to improve the investment climate for sustainable energy enterprise.

Main areas of improvement include the better coordination and communication of member states' interests to providers of international assistance, and vice versa. CARICOM also can advise governments on how to better utilize available resources to promote sustainable energy. CARICOM should address the identified factors by working with experienced international actors—including development and commercial banks—to design and implement innovative financing mechanisms for sustainable energy projects. This effort begins by identifying and developing financing tools for regional high-impact areas such as geothermal, smart grid technology, and energy storage. Table 23 lists subcomponents of these important action areas.

Once implemented, these measures will demonstrate to the international community that CARICOM is a reliable destination for climate finance, improving regional leverage and also allowing CARICOM to act as a strong voice in international climate negotiations.

6.2.3 Implementing Policies and Measures

A review of existing support policies for renewable energy and energy efficiency in CARICOM member states (see Tables 10 and 11) makes clear that, while some states have begun to implement policy components of a sustainable energy system, more must be done. Targeted legislation on standards for building codes, appliance labeling, and fuel efficiency are a convenient starting point for member states

At the regional level, CARICOM must support the integration of renewables into the transportation sector through efficiency standards on shipping, air travel, and public transit. With significant regional potential for biomass energy, CARICOM also should coordinate the creation of a regional biofuel market. All of these policy measures must be reviewed continually to ensure their effectiveness and continued implementation. Table 24 lists subcomponents of these important action areas.

Table 23. Recommended Priority Initiatives, Policies, Projects and Activities (PIPPAs): Finance

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Regional/National/Both
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 in cooperation with CDB and national development banks	•													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
9.4	Identify and communicate sources of funding for regional research, development, and innovation (RDI) in sustainable energy	•	•												B
10	**Utilize Government Resources to Promote Renewable Energy**														
10.1	Identify and implement high-impact opportunities for public procurement for renewable power generation and energy efficiency	•													N
10.2	Identify and implement high-impact opportunities for public procurement for sustainable transport options	•	•	•	•	•	•	•							N
10.3	Establish publicly backed demonstration projects	•	•	•	•	•	•	•							N
10.4	Support the development of public-private partnerships	•	•	•	•	•	•	•	•	•	•	•	•	•	B

as they are low-cost to implement. Designing these standards with fiscal incentives, such as rebates and tax exemptions, can further accelerate their adoption. To incentivize generation from renewable energy technologies, member states should guarantee IPPs access to electricity grids, establish net metering and billing systems, adopt fiscal incentives such as tax credits, and develop dedicated renewable energy electrification programs for unserved areas.

Table 24. Recommended Priority Initiatives, Policies, Projects and Activities (PIPPAs): Policy

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Regional/National/Both
11	**De-Monopolize Grid Access and Encourage IPP Generation**														
11.1	Facilitate dialogue among key stakeholders (e.g., policymakers, utilities, end-users) to identify action plan for enacting reform	•													R
11.2	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
12	**Set Regional Standards**														
12.1	Identify priority areas where regional standards can be set (e.g., building codes, technology standards, fuel efficiency standards, R&D, etc.)	•													R
12.2	Design and enact regional standards in collaboration with member states	•													R
12.3	Ensure that domestic policy reflects and enforces regional standards	•	•												N
13	**Incentivize Renewable Generation Through Regulatory Reform**														
13.1	Develop template for member states to systematically identify the most effective policy mix	•													R
13.2	Develop model legislation	•													R
13.3	Promote the adoption of net billing as agreed at COTED	•													R
13.4	Identify and implement renewable energy support policies. (Options for designing the appropriate policy mix include: establish a feed-in tariff, adopt a production tax credit, establish net metering/net billing, utilize auctions/tendering, develop dedicated rural electrification programs focused on renewable power)	•	•												N
13.5	Identify and implement policy mechanisms specifically targeting areas/ populations with limited access to electricity	•	•												N
14	**Support Energy Efficiency Through Targeted Legislation**														
14.1	Identify key sectors for efficiency improvements	•													R
14.2	Identify opportunities and strategies for demand-side management	•													B
14.3	Develop and enforce national building codes that promote energy efficiency	•	•												N
14.4	Mandate appliance labeling and efficiency standards	•													N

Table 24. continued

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Regional/National/Both
14.5	Offer fiscal incentives (e.g., rebates, tax exemptions) for energy audits and purchasing of energy-efficient products	•													N
15	**Implement Policies to Support the Growth of Renewable Energy in the Transportation Sector**														
15.1	Develop standards for inter-member state transport (e.g., shipping and air travel)	•													R
15.2	Conduct feasibility studies for alternative transportation systems	•													R
15.3	Coordinate the creation of a regional biofuel market	•	•												R
15.4	Establish support for public transportation	•	•												N
15.5	Create mandates and market incentives to promote fuel-efficient and alternative-fuel vehicles	•	•	•	•										N
16	**Ensure Policy Effectiveness**														
16.1	Identify key policy effectiveness indicators	•													R
16.2	Track, assess, and communicate effectiveness of policy framework across member states	•	•	•	•	•	•	•	•	•	•	•	•	•	R
16.3	Track effectiveness of domestic policy implementation	•	•	•	•	•	•	•	•	•	•	•	•	•	N
16.4	Ensure consistent policy implementation	•	•	•	•	•	•	•	•	•	•	•	•	•	N

Recommendations made for identifying and implementing regional and national energy policies are not always equally applicable throughout all CARICOM member states. Based on a detailed assessment of unique local conditions, policy development should focus on the most critical areas within each member state. (See Table 25.)

6.2.4 Building Regional Capacity

While important steps have been made toward advancing capacity in the Caribbean for development of a sustainable energy system, important knowledge gaps and barriers to institutional effectiveness remain. Duplication of effort and a lack of coordination mean that capacity is often wasted, and knowledge gaps persist. To avoid this, institutions and energy sector stakeholders must develop shared databases, networks, and collaboration frameworks to guide institutional structure and operation. Capacity-building efforts must focus on identifying opportunities for mutually beneficial partnerships for renewable energy and energy efficiency, regulatory system simplification, and promoting R&D of sustainable energy solutions region-wide. (See Table 26.)

Table 25. Priority Actions in the Area of Policies and Mechanisms, Indicating Level of Implementation

KEY: No significant action taken | Some action taken but more needed | Significant action taken, no action needed

	CONCRETE POLICIES AND MECHANISMS				
Country	**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					
Saint Lucia					
St. Kitts and Nevis					
St. Vincent and the Grenadines					
Suriname					
Trinidad and Tobago					

6.3 Highlighted Priority Areas

Focus areas of particular importance to member states are transportation, regional energy trade, and the water-energy-food nexus. Addressing the respective challenges of member states and exploiting opportunities will be critical to realizing the ambitious targets for sustainability laid out by CARICOM.

6.3.1 A Regional Approach to Transportation

Transportation is a fundamental aspect of all economic sectors within CARICOM. Changes in domestic transportation policy are likely to cause a knock-on effect to subsequent areas of the domestic economy, such as tourism and trade—which subsequently can affect the regional economy. However, transportation policies often are pursued because of the widespread domestic benefits they can bring. Formulating regional transport policy can help the region identify systemic inefficiencies and respond to them through integrated and equitable policy.

Perhaps the best example of a regional, cross-country transportation policy is the European Union's common regional transport policy, which plays an important role in driving trade and economic growth in Europe. The EU policy recognizes five modes of transport: air, road, rail, maritime, and inland waterways.[2] A transport policy aims to address each of these modes with different tenets, which can include but are not limited to:

Table 26. Recommended Priority Initiatives, Policies, Projects and Activities (PIPPAs): Capacity Building

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Regional/National/Both
17	**Coordinate International Initiatives in the Region**														
17.1	Compile past and ongoing international studies and projects across member states	•													R
17.2	Identify areas of duplicated effort and critical gaps	•													R
17.3	Work with outside actors (GIZ/CREDP, REETA, IRENA, etc.) to ensure that key needs are being met within the region	•	•	•	•	•	•	•	•	•	•	•	•	•	R
18	**Build Capacities with Key Supporting Stakeholders**														
18.1	Assess current human, institutional, and education/training/research capacity within CARICOM to identify key gaps	•													R
18.2	Create shared database of existing regional training materials, available training tools and curricula, education programs, etc.	•													R
18.3	Encourage development of regional professional networks, including a database of trained renewable energy and energy efficiency professionals	•													R
18.4	Facilitate training and education programs for key stakeholder groups, including: policymakers, financial institutions, job force, private sector	•	•												R
18.5	Establish renewable energy and energy efficiency technology centers throughout CARICOM (locations based on national resource potential and technological experience)	•	•	•	•										B
19	**Improve Institutional Effectiveness**														
19.1	Develop guiding framework for appropriate energy institution structure and operation	•													R
19.2	Assess effectiveness of existing energy institutions	•													N
19.3	Improve structure and operation of existing energy institutions based on regional recommendations and national assessments	•	•	•	•										N
20	**Support and Manage Regional Electricity Interconnection and Storage Options**														
20.1	Conduct feasibility studies examining interconnection scenarios	•	•												R
20.2	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
21	**Mainstream Renewable Energy**														
21.1	Integrate renewable energy and energy efficiency across government planning processes	•													N

Table 26. continued

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Regional/National/Both
21.2	Ensure the participation and coordination of all government branches and departments	•													N
21.3	Establish an effective platform for inter-ministerial dialogue	•													N
22	**Simplify Regulatory Compliance**														
22.1	Survey regional project developers to identify onerous regulatory barriers	•													R
22.2	Assess efficiency of existing regulations	•													N
22.3	Enact regulatory reform that prioritizes efficiency and simplicity (e.g., establish a one-stop shop for renewable energy project development)	•	•	•	•										N
22.4	Communicate regulations to project developers and stakeholders	•	•	•	•										N
23	**Maximize Societal Benefits of Sustainable Energy**														
23.1	Identify opportunities for mutually beneficial partnerships between cultural industries and the renewable energy sector	•													B
23.2	Develop programs to ensure that women benefit from sustainable energy and can participate fully in the energy transition	•													B
24	**Promote Capacity in Research, Development, and Innovation (RDI)**														
24.1	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
24.2	Develop R&D training programs in collaboration with regional STI associations	•	•												R

- A need for some kind of change due to inefficiencies in current practice;
- Identification of better mobility: reducing transportation times, increasing transport options, reducing inefficiencies, etc.;
- Making the form of transportation safer for users, workers, and other citizens;
- Creating cleaner transport that acknowledges realistic targets; and
- Establishing uniform protocols for mutual benefits without political bias across national boundaries.

Each tenet requires thorough research and data collection to establish targets and thus legislation.

In the Asia-Pacific region, two APEC transport initiatives with direct environmental influence are: 1) the Cooperation Program of Clean Energy Shipping, which encourages the development of LNG-fueled ships (the use of which can reduce nitrous oxide emissions by up to 90% and CO_2 emissions by 20%), and 2) the Carbon Footprint Proposal: Developing a Common Methodology for Ocean-Going Vessels, which aims to develop a supplementary policy tool and methodology to measure carbon emissions and energy intensity of ocean-going vessels. The aim is to advance APEC's goal of a 45% reduction in energy intensity region-wide.

The challenge in establishing a regional transport policy that crosses national boundaries is that individual governments must be willing to give up some power in controlling national transport infrastructure. Over a 25-year period, the EU had to overcome numerous political obstacles that were both frustrating and time-consuming before a legal agreement was reached in May 1985. Subsequently, multiple "white papers" have been produced in forming the current transport policy. The CARICOM region may not face such a daunting challenge because it is a much smaller economic community and has established robust trade agreements through protocol IV of the CARICOM Trading Policy.

The U.S. approach to an overarching transportation strategy relies on robust data collection and continual analysis. New transportation policy, or changes to it, follows an established step-by-step approach with numerous factors.[3] (See Figure 32.) Because the United States is a comparatively homogenous entity that is able to establish overarching policy with which individual states must align, such an approach works relatively well. Although the Caribbean can employ a similar methodology, its approach will need to be more nuanced to consider the specific characteristics of member states. Larger countries, such as Jamaica and Trinidad and Tobago, have more vehicles than smaller countries like Saint Lucia or Dominica. And some member states already have in place measures, such as ethanol blending mandates, that could affect the efficiency with which a prescribed methodology is deployed.

Regardless of the overall approach that CARICOM takes in developing a regional transportation policy, data collection will be required on multiple levels. Basic areas for data collection may include:

- *Market shares of specific transportation types*: Certain vehicle types may be more dominant in some member countries than others. For example, smaller member states with more robust hotel and tourism sectors may have more buses and vans than residential vehicles.

- *Travel times*: If a policy initiative aims to focus on efficiency, it should consider the degree to which vehicles travel at more-consistent speeds over longer distances (higher levels of fuel efficiency) versus making multiple smaller trips or being stuck in congestion (lower levels of efficiency).

- *Environmental concerns from each sector*: In some member states, sectors such as tourism and manufacturing may already have in place policies to address the environmental impact of their respective practices. In such cases, transportation initiatives should seek to leverage existing work and to act as a supplementary force.

- *Comprehensive freight haulage breakdown*: To establish effective metrics for evaluating progress and developing plans, it is important to fully understand the varying levels of cargo weight, types of transport, and types of goods being moved in each member state.

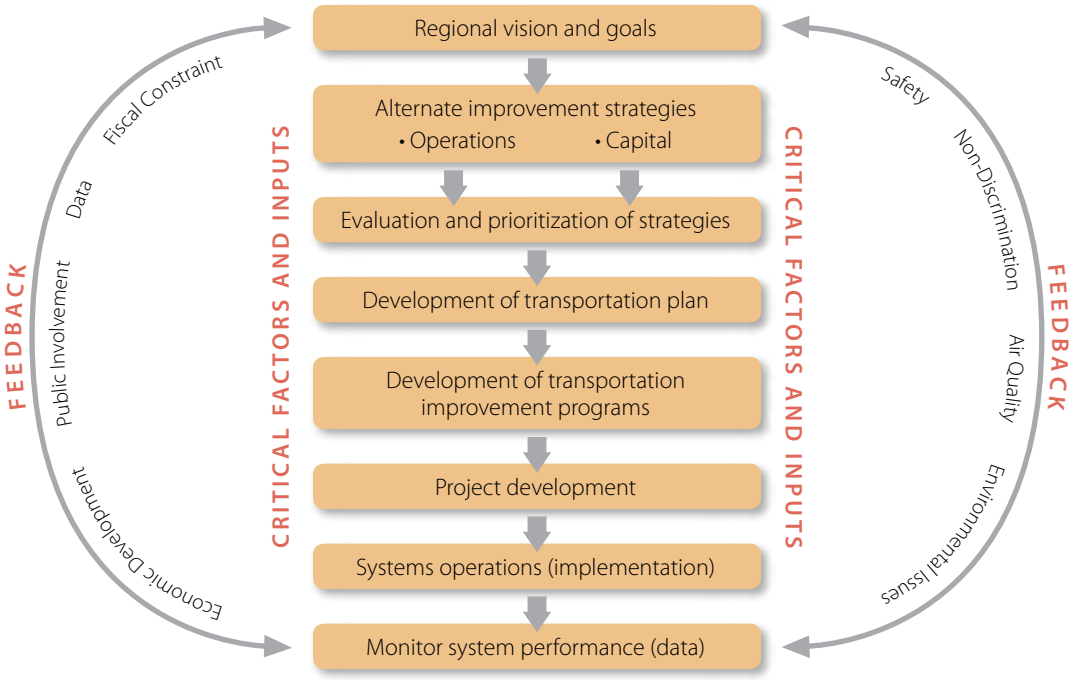

FIGURE 32. Overview of Transportation Planning in the United States

Source: U.S. DOT

- *Comprehensive personal vehicle breakdown*: One of the largest challenges that CARICOM faces in developing a regional transport policy is a lack of understanding of the fleet composition in each member state. Data-gathering efforts should strive to obtain exhaustive data on engine type, emissions quality, fleet age, and current levels of fuel efficiency.

- *Public consultation to identify and address existing/urgent problems*: Each member state's local population is best-equipped to provide insight and feedback regarding the impact of local transportation.

The transportation sector comprises various modes of transport, and each CARICOM member state utilizes these to varying degrees. Some member states may not support specific modes of transport because these are not efficient for domestic transportation needs. Regardless, energy-saving potentials from the integration of renewables into the transportation sector are significant and should be exploited. When crafting an overarching transportation strategy, CARICOM should investigate relevant data for four main sub-sectors: freight, rail, air, and maritime.

Freight

Freight transportation across the Caribbean may be improved by introducing "cabotage," or the process of eliminating empty journeys of a trip by carrying cargo between routes that initially would have been empty. The EU has successfully implemented this policy, such that, for example, a Danish truck crossing into France to deliver freight to Bordeaux is scheduled to pick up a return load from Lyon. Cabotage enables the truck to carry freight between Lyon and Bordeaux, where it otherwise would have been

empty. This could be particularly useful with island-hopping trade between CARICOM member states.

The safety of drivers can be improved by enforcing maximum driving times and minimum rest times, and ensuring an appropriate training and licensing system, applicable in all member states. Standards for vehicle inspections and maintenance improve reliability and also promote safety, along with safety standards for vehicles by enabling crash testing certification.

All new personal vehicles also should conform to an established emission standard. This includes both traditional greenhouse gas emissions as well as airborne pollution that has the potential to cause health problems, such as particulate matter and carbon monoxide. Engine standards and incentivizing low mpg or alternative fuel vehicles can greatly reduce dependence on imported petroleum.

Electric vehicles may have significant potential in CARICOM member states. A traditional drawback of electric vehicles is the short range of travel as compared to a combustion engine. However, because of the small size of many CARICOM member states (relative to EU countries and the United States), long-distance driving is not necessary in the region.

Rail

Because many CARICOM member states are island nations, a uniform rail transportation policy may not be the best approach in terms of allocating resources and time. However, in the region's larger islands or land-based countries, rail could be a viable solution for addressing long-range travel while also reducing greenhouse gas emissions associated with inefficient gasoline- or diesel-run vehicles.

Air

Nearly all economies in the CARICOM region depend heavily on the tourism industry. When planning air-based transportation, it is critical to recognize the role that aviation plays in bringing in tourists. Air safety is paramount, and the use of a single, seamless management system for air traffic control has been successful in the EU, as well as restrictions on aircraft and airport noise.

Maritime

Because many CARICOM member states are island nations that rely heavily on imported goods, particularly oil, a regional maritime policy could be extremely beneficial for the region. Many maritime policies enforce pollution measures on ships and minimum requirements for ports. The EU, for example, is phasing out the use of single-hull vessels for transporting oil. Double-hull vessels can transport more cargo per unit of fuel and are thus more efficient and environmentally friendly. Solar-powered ferries utilized for transit in Saint Lucia may hold potential for intra-regional transit of cargo and people throughout the Caribbean.

As noted earlier, data collection remains a large challenge for CARICOM member states. In some cases, relevant ministries simply lack the personnel, training, or technical resources to carry out robust and sustained data collection and analysis. The use of expert consultants with significant experience in the transportation sector therefore would be highly beneficial.

6.3.2 Regional Energy Trade Agreements

Because global energy markets are periodically subjected to price shocks and unpredictable events, regional energy trade agreements have become a vital foreign policy objective for small countries and regions pursuing energy security. These agreements allow member states to reduce exposure to the volatility of international energy markets through guaranteed terms of preferential payment. So far, most, but not all, CARICOM members have sought individually to address the high cost of imported petroleum products by aligning with Venezuela in the Petrocaribe Agreement.

Although this agreement serves to insulate CARICOM member states from rising and volatile oil prices in the short run, it also reduces intra-regional trade of energy resources and leaves CARICOM highly dependent on terms that Venezuela may not be able to maintain. Establishing a regional trade agreement for CARICOM's abundant endowment of renewable energy resources presents a better path for energy independence and continued economic development in the Caribbean.

Reviewing the energy trade-related structure and content of currently enforced regional trade agreements—such as the North American Free Trade Agreement (NAFTA), APEC, and the Latin American Southern Common Market (MERCOSUR)—offers important insight on how other agreements currently under development can keep energy reliable and affordable, cover multiple energy sources and sectors, and be expanded.

With regard to energy trade-related investment, NAFTA provides a framework of provisions not covered by the GATT/WTO. These provisions require that member states:

- Adopt the principle of national treatment to investment by NAFTA parties, equal facilitation for domestic and foreign investors on establishment acquisition, expansion, management, conduct, operation, and sale of investments;

- Provide "most favored nation" (MFN) standard of treatment for foreign investors;

- Provide a minimum international standard of fair and equitable treatment to investments by investors of other parties; and

- Not attach on investments a broad range of performance requirements (prohibited on expropriation or nationalization).

Used in the Caribbean context, these conditions for a regional energy trade agreement will allow member states to attract investment for developing their abundant and appealing domestic energy endowments while retaining energy system ownership and a sufficient portion of the resultant profits.

CARICOM also can learn from MERCOSUR, which, using an interconnected grid and pipeline services, promotes regional energy security and reliability. Based on reciprocity, MERCOSUR member states have gained negotiating strength and energy security through coordinating common external tariff and trade policy for external states and the harmonization of macroeconomic and sectoral policy. MERCOSUR has also created decision-making bodies to regulate and coordinate national energy policies among member states.

Meanwhile, CARICOM can look to APEC as a model for the integration of renewable energy into regional energy trade. APEC has established various innovative working groups to support regional energy security, including the Energy Working Group (EWG), which provides expertise on efficiency and conservation, energy data and analysis, and new and renewable energy technology. These groups facilitate the development of emissions mitigation mechanisms, provide a forum for public-private dialogue on energy policy (the EWG Business Network), and promote information-sharing networks on energy efficiency, performance, and policy (the Peer Review Mechanism on Energy Efficiency, or PREE). In preparation for potential future disruptions in energy supply, APEC established the Energy Security Initiative in 2000. This program provides monthly oil data, maritime security coordination, real-time emergency information sharing, and contingency planning for oil supply emergencies.

In the Caribbean context, replicating these efforts will be critical to de-risking a transition to renewable energy by allaying concerns over the intermittency of some renewable energy technologies, such as solar PV and wind. The transformative potential of regionally self-sufficient energy technology production chains is beginning to be explored in the Caribbean. Solar water heating units, for example, have become a robust industrial sector in Barbados. Having saturated the domestic market, the country's solar water heater companies are now expanding into the Caribbean market through sales and exported manufacturing processes in Trinidad and Saint Lucia.

6.3.3 The Water-Energy-Food Nexus

Caribbean small-island developing states are extremely vulnerable to extreme weather events, which will become more frequent and intense due to the impacts of climate change. Water, energy, and food (WEF) resources and infrastructure are particularly in danger. Historically, CARICOM member states have addressed this challenge separately.

Sustainably developing WEF resources in SIDS through nexus-inspired strategies poses unique challenges and opportunities, but it has not yet been the focus of major research. In the CARICOM region, large quantities of energy and food must be imported, which often leads to high trade deficits and foreign debt. Fresh water is a scarce resource in many places as well. Production and consumption patterns in the WEF sectors are economically, socially, and environmentally unsustainable, and their interplay exacerbates the problems.

Climate change (fostered by the high carbon footprint of WEF practices), as well as land limitations, mono-dimensional economies, economies of scale, and other circumstances, make addressing the nexus more pressing and challenging in SIDS than in larger nations.

Research has shown that climate-compatible technologies and practices (and the policies promoting them) exist for simultaneously making improvements in all three WEF areas, with additional positive impacts on overall development. At the center of a WEF nexus-based approach to climate change is agriculture. When done sustainably, agriculture has transformative potential for mitigating threats to each of these factors. Practices such as using naturally produced fertilizers, planting trees on farms to reduce erosion, and urban farming all hold huge potential for shrinking the carbon footprint of agricultural activities while actively mitigating climate impacts.[4]

Efforts undertaken within the larger C-SERMS initiative should analyze regional WEF and climate trends, as well as linkages among them. In addition, coordinated activity among member states should identify future WEF needs, risks, and opportunities and design climate-compatible development pathways, as well as engage a diverse, high-profile stakeholder group to draft a shared vision that aims at advancing WEF resources in a harmonized manner.

Nexus-inspired strategies for the sustainable development of these resources are ideal for application in the policy framework of CARICOM because of member states' dire need for change in WEF resource management.

New momentum for climate-compatible development in the Caribbean can be created through addressing the WEF nexus by bringing together different interests behind a shared vision. This can encourage more action in climate mitigation and adaption by combining the potential impacts that each of the countries can make through a joint regional policy framework for climate action.

6.4 Greater Coordination of Regional Initiatives

C-SERMS is just one of many Caribbean-based initiatives focusing on the region's challenges. Successfully addressing the full range of barriers will require "all hands on deck." The many important programs and initiatives dovetail nicely with the broader aims of the CARICOM Energy Unit, the ongoing Caribbean Sustainable Energy Forum (CSEF), and CARICOM's Caribbean Energy Policy. With so many varied agencies, resources, programs, activities, and events, a robust coordinating mechanism becomes necessary. The Energy Unit's C-SERMS initiative can act as a central platform for collaboration, information sharing, and resource coordination to maximize outcomes, as shown in Figure 33.

The following is a list of initiatives, priorities, and activities that simultaneously are addressing various regional challenges. It is in no way exhaustive, but it does demonstrate the urgent need for robust coordination to help reduce redundancy, ensure that resources are used and applied efficiently and where they will have the most positive impact, and increase the regional dialogue and shared learning necessary to ensure that member states advance together.

***Renewable Energy and Energy Efficiency Technical Assistance (REETA) project*:** Through financing from GIZ, REETA aims to build on the CREDP, implemented from 2003 to 2013. Broadly, this project seeks to develop regional and national stakeholder capacity to meet political, organization, and technical challenges of CARICOM's emerging renewable energy and energy efficiency markets. REETA's focus areas include:

- Energy Policy Technical Assistance, which includes a regional database and update of the CARICOM Energy Unit website to inform policymaking and harmonize regional energy efficiency policy setting.

- Human Capital Building, which includes projects to develop training courses through cooperation with UTECH and BRIDGE, as well as internship exchange between the University of the West Indies, the UNFCCC, and the Regional Culture Committee.

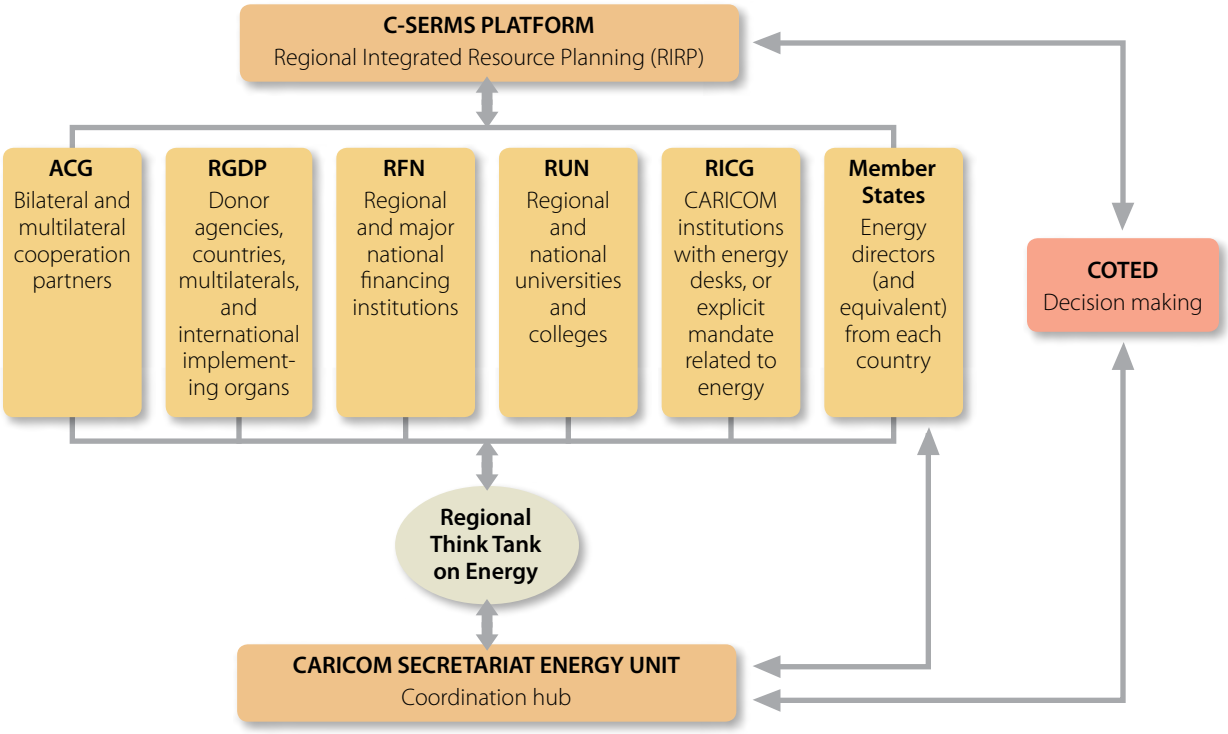

FIGURE 33. C-SERMS Energy Unit Platform

- Identification, development, and financing of Regional Model Projects, including solar ferry transit in Saint Lucia, waste-to-energy schemes in Grenada, and hydropower in Guyana.

***Co-financing for Renewable Energy and Energy Efficiency (CORE)*:** The Japan International Cooperation Agency (JICA) and the IDB have joined together to develop a co-financing mechanism that addresses fossil fuel dependence and increasing climate change impacts in the Caribbean and Central American regions. In March 2014, both parties agreed to increase the amount of JICA co-financing from the original USD 300 million to up to USD 1 billion of concessional term co-financing resources, as well as to extend eligible countries to the uppermost middle-income countries.

***IDB Technical Cooperation (TC)*:** This initiative aims to help reduce fossil fuel dependence in CARICOM member states by supporting their efforts in setting and achieving the Regional Sustainable Energy Targets. More specifically, IDB TC aims to support CARICOM members in developing an implementation roadmap/program for promoting renewable energy and energy efficiency.

***Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE)*:** The purpose of this initiative is to promote renewable energy and energy efficiency in Caribbean countries in order to support the development of a low-carbon economy. It also will enhance regional institutional capabilities for transforming the energy sector to be more efficient and low-carbon, and provide comprehensive technical and implementation support in sustainable energy-related issues. Lastly, CCREEE will mobilize financial and technical resources to support the implementation of low-carbon project activities. The Austrian

Development Agency has provided a significant portion of start-up funding, and in-kind staffing and other technical support also has been pledged by the United Nations Industrial Development Organization (UNIDO), SIDS DOCK, and the Clinton Climate Initiative.

The information and recommendations contained in this report are based on an analysis of the numerous sustainable energy development activities already under way within CARICOM. Moving forward, it is crucial that these existing initiatives and the knowledge that they have generated be integrated and expanded as the next slate of relevant projects, initiatives, policies, and activities is 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, which commenced in 2004,* 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 the OAS, and the REETA program started in 2013 and planned till 2018—a number of important products have supported renewable energy development. To help establish a baseline of relevant work being done in the region, Table 27 provides a summary of key outputs from various initiatives over the past decade.

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 to 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 ensure that no member state will have to do this alone, but instead will be supported by a network of actors united under a common vision for the Caribbean energy sector. Although 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 outlined here will result in effective and efficient sustainable energy development, making CARICOM a global sustainable energy leader.

6.5 Designing National Implementation Plans

The PIPPAs recommended and outlined here represent a strategic program for making a sustainable energy transition a reality. Each member state, with the support of CARICOM, must now begin the process of translating the ambitious regional commitments into tangible action at the regional and national level.

The success of the CARICOM Energy Policy and realization of the energy transformation that it

* The UNDP component of CREDP ended in 2009, whereas the GIZ/REETA project extends through 2016.

Table 27. Key Outputs of Existing Sustainable Energy Initiatives in the CARICOM Region

Initiative/Project	Implementing Body	Relevant Output	Comments
CARICOM Energy Programme/C-SERMS	CARICOM Secretariat	• Quarterly regional coordination meetings among relevant sustainable energy partners/projects/initiatives • CARICOM Energy Week • Framework Document for Research, Development & Innovation in Sustainable Energy in CARICOM • C-SERMS Platform	Where relevant, to be available at www.cc-energyprogramme.org
	CREDP/ UNDP/GIZ	• Caribbean Information Portal on Renewable Energy (CIPORE) • *Baseline Study of Energy Policies and Legislation in Selected Caribbean Countries* • Standards and assessment instruments for Technical Vocational Education and Training (TVET) assessors and trainers for solar water heating installation and maintenance • *Energy Week in the Caribbean – A Guide for Organizers*	www.cipore.org To be available at www.cc-energyprogramme.org www.credp-giz.org
Eastern Caribbean Energy Labeling Project (ECELP)	CREDP/GIZ	• *Customer's Guide – Energy Efficiency of Household Appliances* • *Retailer's Guide – Energy Efficiency Labels for Household Appliances* • Flyers on energy efficiency standards and labels for appliances, labels, and illuminants	All at www.ecelp.org
Caribbean Renewable Energy Capacity Support (CRECS)	CARICOM Secretariat	• Model electricity and energy sector laws and primary and secondary laws at national level with renewable energy (RE) focus • MSc. RE programs at UWI • Communication strategy development for energy-related program in the Caribbean – *Guidelines for Implementers* • Model Caribbean sustainable energy public awareness program • Network of R&D Institutions to support RE • Strategy for the promotion of solar water heating in CARICOM member states	All to be available at www.cc-energyprogramme.org
Caribbean Sustainable Energy Programme (CSEP)	CARICOM Secretariat/ OAS	• *Caribbean Educator's Guide to Sustainable Energy Education and Awareness* • *Teachers' Resource Booklet for Integrated Instruction in Sustainable Energy* • *Learn and Save Booklet* • *Financiers' Guide to Sustainable Energy Lending in the Caribbean* • *Energy Efficiency Guidelines for Office Buildings in Tropical Climates*	All to be available at www.oas.org/dsd
Caribbean Policy Research Institute (CaPRI) Renewable Energy Project	CaPRI	• Country-specific database for potential investors on technology options, costs, and performance characteristics of typical RE systems • Country profiles related to the RE-investment environment, including databases on RE-related policies, regulation, incentives, and availability and suitability of financing	All works in progress

Table 27. continued

Initiative/Project	Implementing Body	Relevant Output	Comments
Caribbean Policy Research Institute (CaPRI) Renewable Energy Project *(continued)*	CaPRI	• Cost-benefit analysis tool to identify viable/ near viable technologies and analyze the impact of financing conditions on viability, to raise awareness among financiers and potential adopters of RE technologies • Tool for policymakers to analyze the impact of alternative policy options on RE project viability	All works in progress
CARILEC Energy Efficiency and Renewable Energy Project	CARILEC/IDB	• Model power purchase agreement	www.carilec.com
Renewable Energy and Energy Efficiency Technical Assistance (REETA) Project	CARICOM-GIZ	• Project pipelines of CDB or affiliated financial institutions include five bankable projects focusing on RE or energy efficiency • Capacity building training and workshops for CBD and affiliated financial institutions • Regional advisory services for the integration of RE in national grids	
UN ECLAC Renewable Energy Project		• Identification of fiscal and regulatory barriers in selected Caribbean countries: The Bahamas, Guyana, and Suriname	
SIDS DOCK	SIDS DOCK	• *Strategy Paper for Policy Harmonization* • *National Financing Mechanism Guidebook* • SIDS Appropriate Sustainable Energy Technology Assessment • SIDS Public Education and Awareness Program	To be available at www.sidsdock.org
Sustainable Energy Technical Assistance (SETA)	OECS/CDB	• OECS Sub-regional Energy Efficiency Strategy complemented by National Energy Efficiency Strategies and Action Plans • Model legislation including regulations and rules for energy management	Works in progress; to be available at www.oecs.org

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

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. Three priority steps for CARICOM are recommended: 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. (See Table 28.) Together, these three steps will help ensure that as national, regional, and international actors embark on the PIPPAs 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 28. Suggested Steps in Designing National Implementation Plans for the Transition to Sustainable Energy in the CARICOM Region

Goals/Objectives and Specific Measures to Implement	Scope
Develop Frameworks for National Implementation Plans	
Ensure coordinated progress toward achieving CARICOM Energy Policy goals by developing a standardized template for member states to enact new national implementation plans where none exist, or to update existing plans to meet regional goals	Regional
Facilitate process by which regional targets are translated into national targets	Regional
Communicate and train national policymakers on using the developed framework methodology	Regional
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	Regional/National
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	Regional
Identify appropriate platform for collaborative measuring, reporting, and verification (MRV) by CARICOM and individual member states	Regional/National
Develop and implement a systematic process for tracking and assessing national progress	Regional/National

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20. International Organization for Standardization (ISO), *Win the Energy Challenge with ISO 50001* (Geneva: June 2011).

21. IEA, "CO2 Emissions from Fuel Combustion," *IEA Statistics* (Paris: 2014), www.iea.org/publications/freepublications/publication/CO2EmissionsFromFuelCombustionHighlights2014.pdf.

22. Global Carbon Project, "Carbon Budget 2014," 21 September 2014, www.globalcarbonproject.org/carbonbudget.

23. World Bank, *World Development Report 2010: Development and Climate Change* (Washington, DC: 2010).

24. Mehmet Burk, "The Fingerprints of Climate Change on Two Extreme Natural Disasters," InterAction, 4 December 2012.

25. European Commission, "Commission Provides Input for Submission on EU Emissions Reduction Target Under Kyoto Protocol," press release (Brussels: 15 February 2012).

26. Alliance of Small Island States (AOSIS), *The Barbados Declaration on Achieving Sustainable Energy for All in Small Island Developing States (SIDS)*, presented to the Ministerial Conference on "Achieving Sustainable Energy for All in SIDS – Challenges, Opportunities, Commitments," Bridgetown, Barbados, 7–8 May 2012.

27. Ibid.

28. Table 21 is a Worldwatch calculation using the ESMAP-META tool and given business-as-usual energy consumption growth.

6 Sustainable Energy for CARICOM: A Strategy to Achieve Regional Targets

1. Sidebar 5 based on Devon Gardner, *Information Systems and Analysis Tools for Sustainable Energy Planning within CARICOM: A Comparative Assessment* (Georgetown, Guyana: CARICOM, January 2014).

2. European Commission, *Roadmap to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System* (Brussels: 2011).

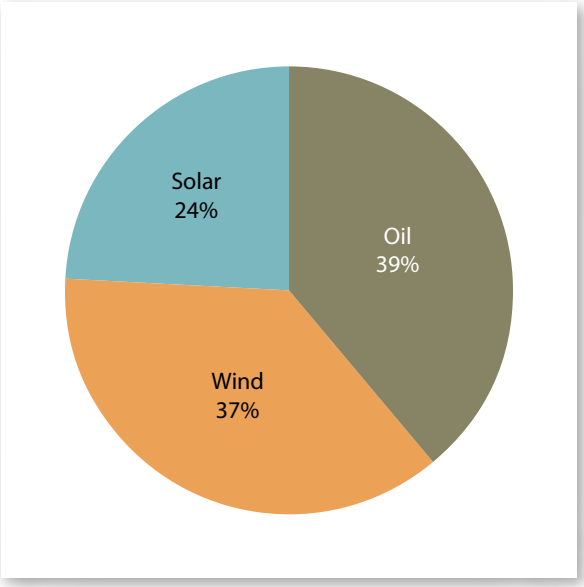
3. Figure 32 from U.S. Department of Transportation, *DOT Strategic Plan 2014-2018: Transportation for a New Generation* (Washington, DC: 23 February 2015).

4. Danielle Nierenberg and Laura Reynolds, *Innovations in Sustainable Agriculture*, Worldwatch Report #188 (Washington, DC: Worldwatch Institute, December 2012).

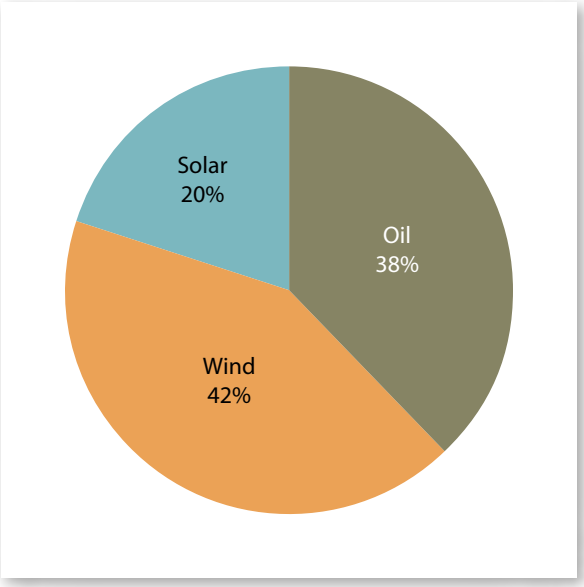
Annex A

CARICOM Member State Energy Capacity Projections and Sectoral Emissions Forecast

Antigua and Barbuda Installed Capacity by Source, 2027 (287 MW)

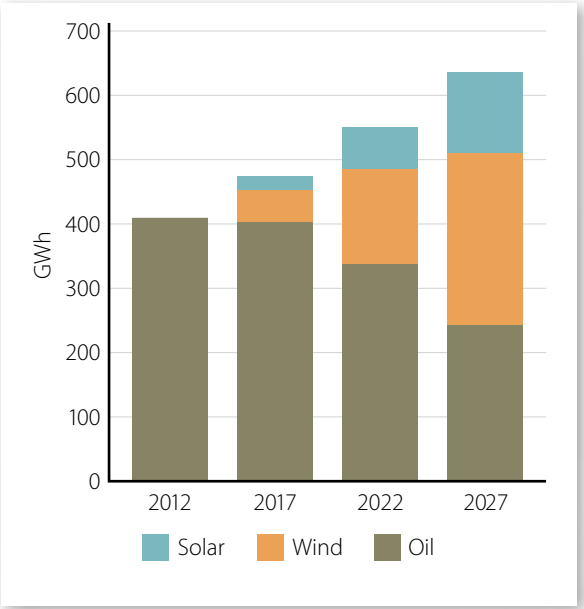


Antigua and Barbuda Net Generation by Source, 2027 (636 GWh)

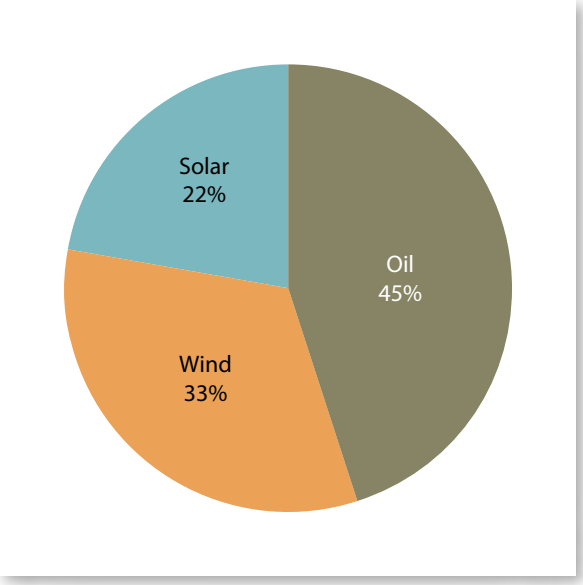


Antigua and Barbuda Installed Capacity by Source

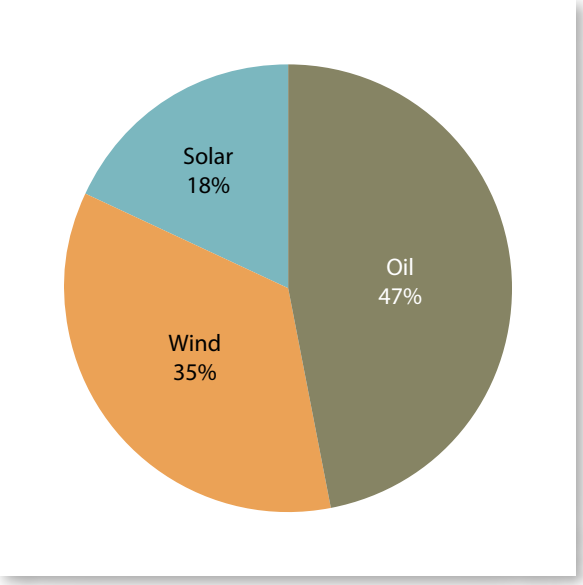
Antigua and Barbuda Net Generation by Source



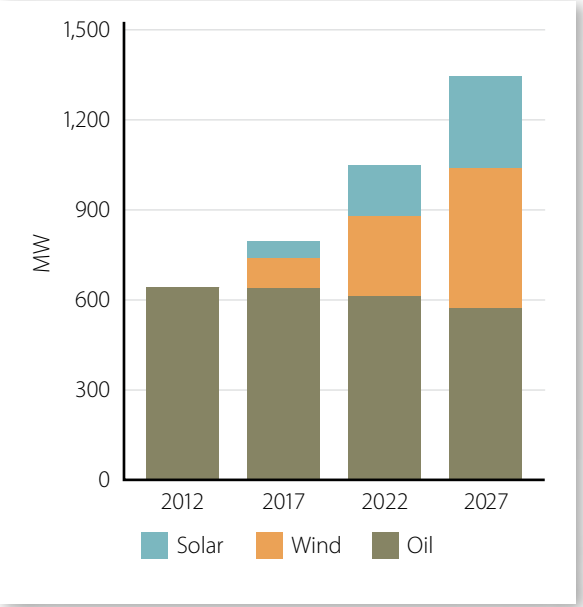
The Bahamas Installed Capacity by Source, 2027 (1,405 MW)



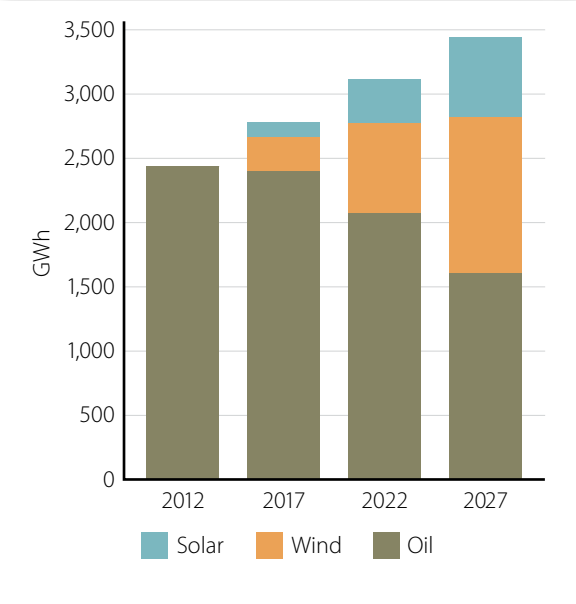
The Bahamas Net Generation by Source, 2027 (3,445 GWh)



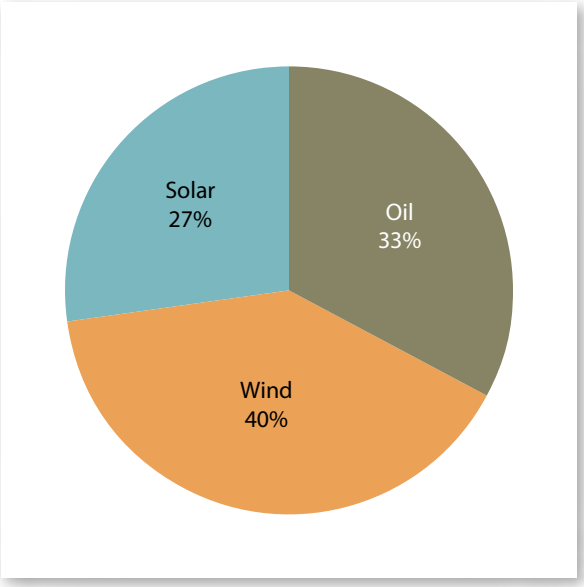
The Bahamas Installed Capacity by Source



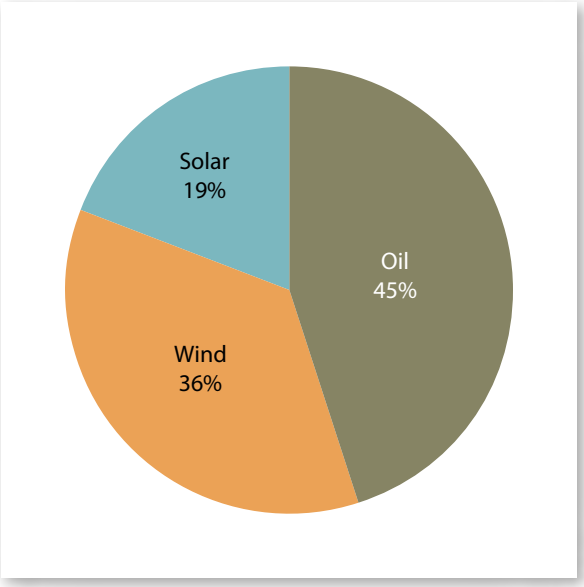
The Bahamas Net Generation by Source



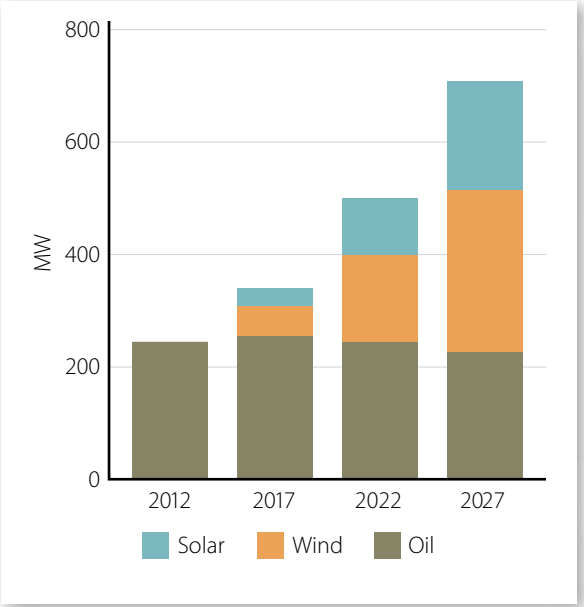
Barbados Installed Capacity by Source, 2027 (708 MW)



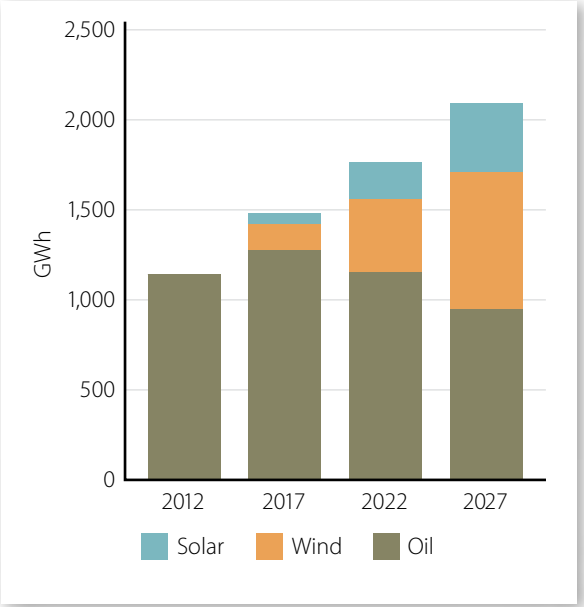
Barbados Net Generation by Source, 2027 (1,843 GWh)



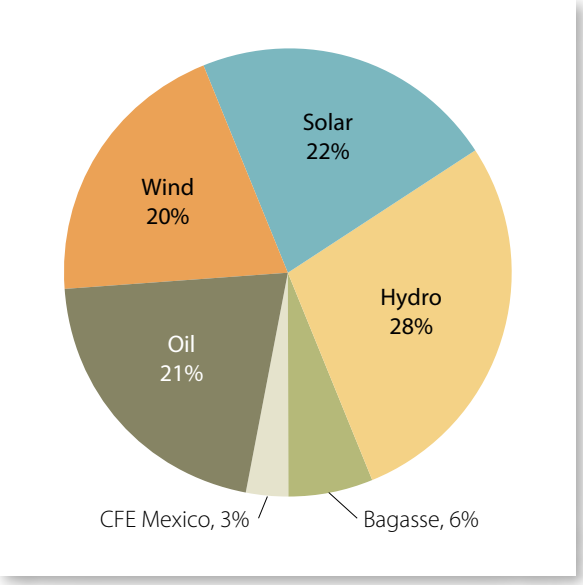
Barbados Installed Capacity by Source



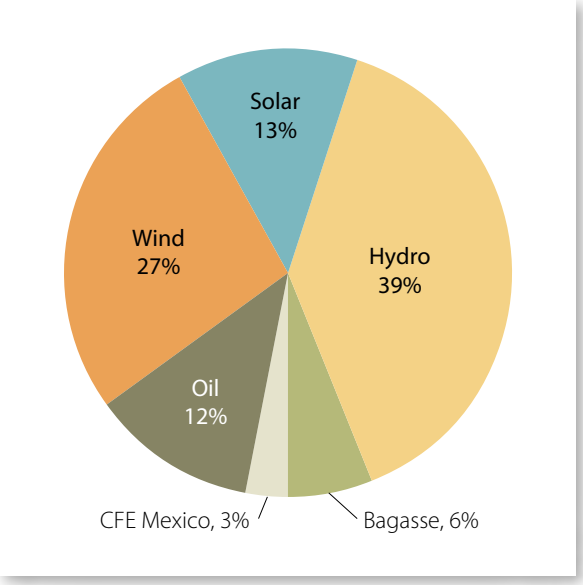
Barbados Net Generation by Source



Belize Installed Capacity by Source, 2027 (264 MW)

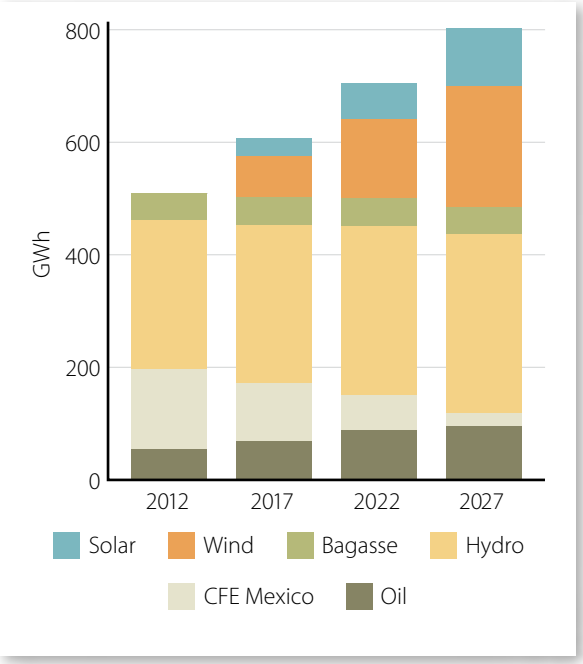


Belize Net Generation by Source, 2027 (803 GWh)

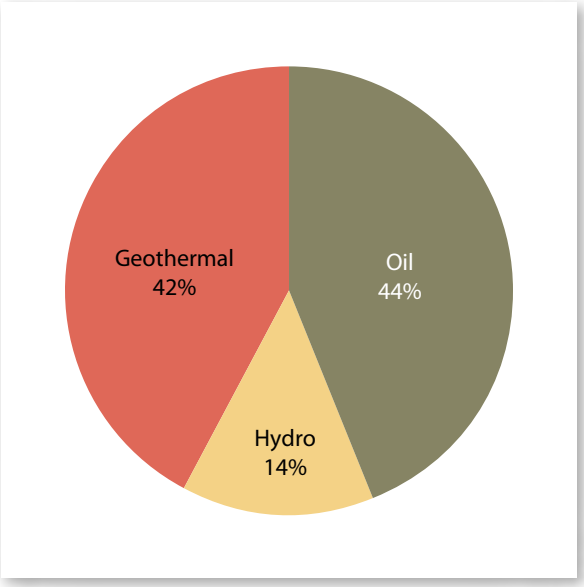


Belize Installed Capacity by Source

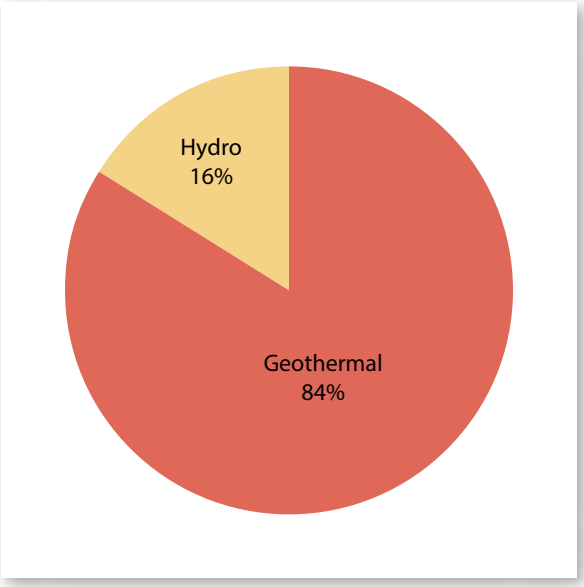
Belize Net Generation by Source



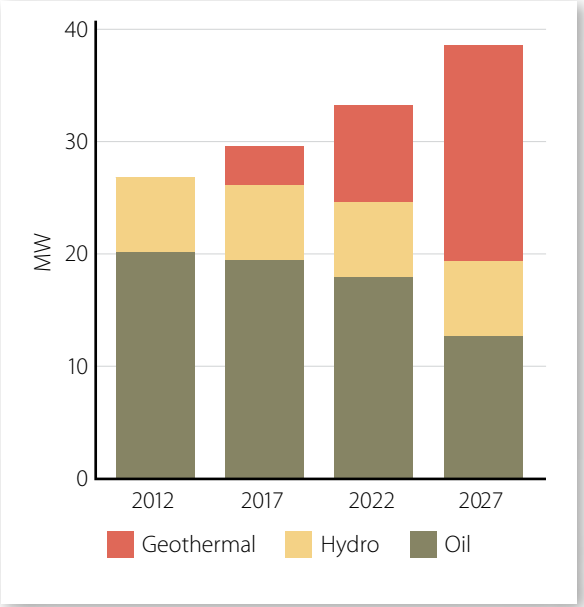
Dominica Installed Capacity by Source, 2027 (46 MW)



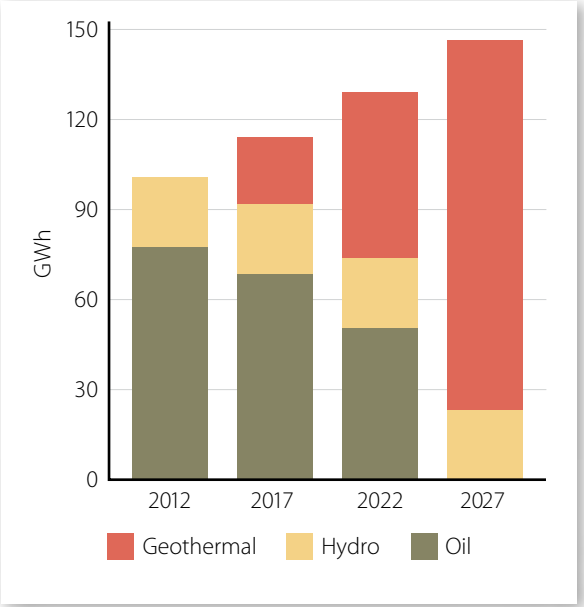
Dominica Net Generation by Source, 2027 (146 GWh)



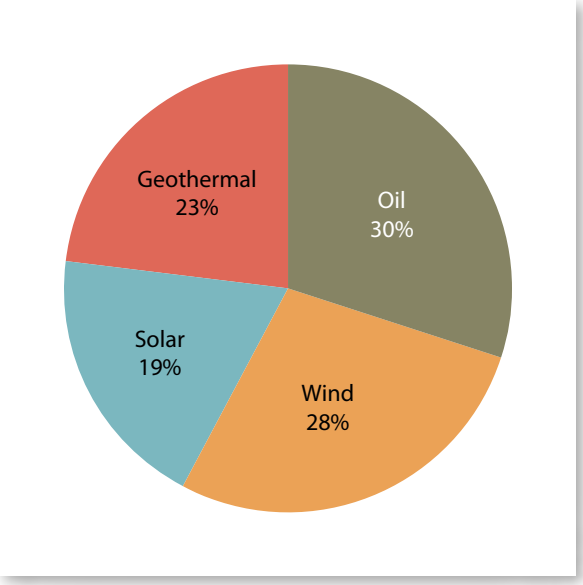
Dominica Installed Capacity by Source



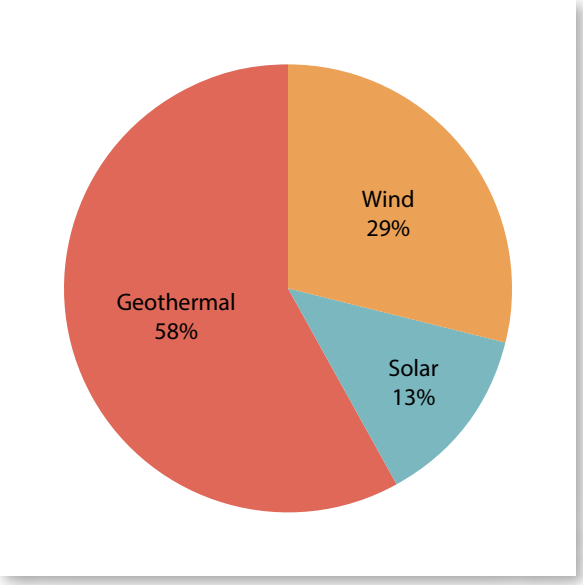
Dominica Net Generation by Source



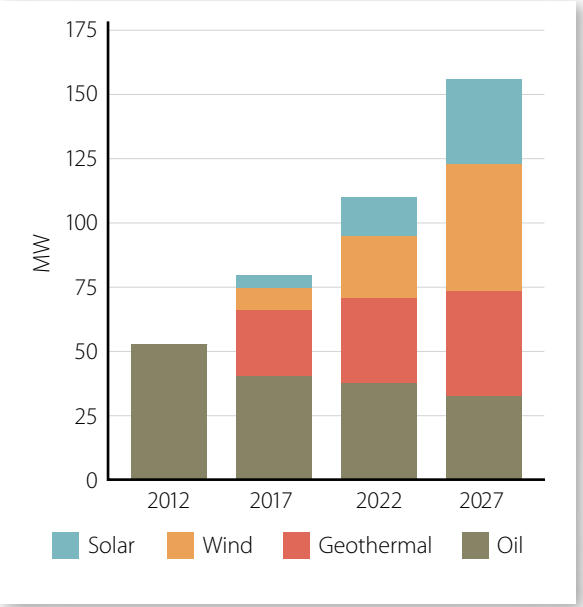
Grenada Installed Capacity by Source, 2027 (176 MW)



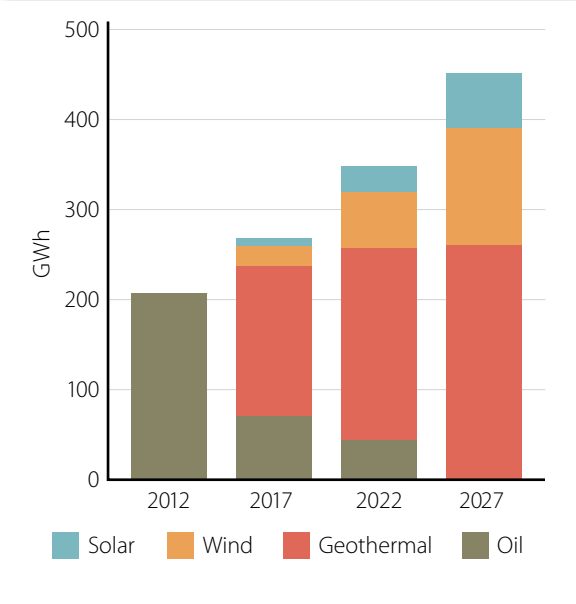
Grenada Net Generation by Source, 2027 (451 GWh)



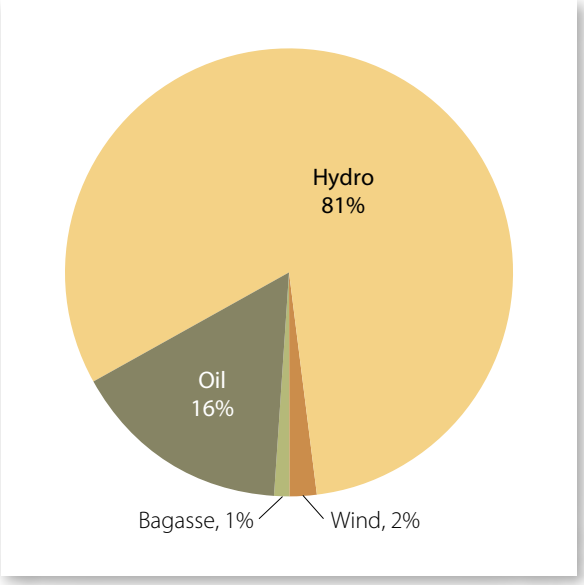
Grenada Installed Capacity by Source



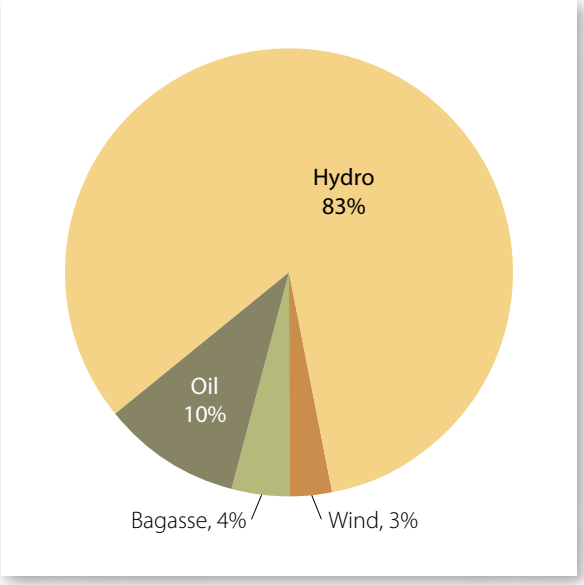
Grenada Net Generation by Source



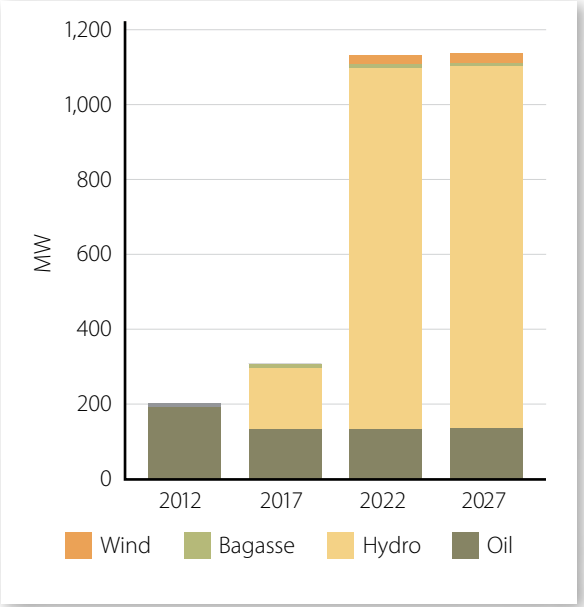
Guyana Installed Capacity by Source, 2027 (1,195 MW)



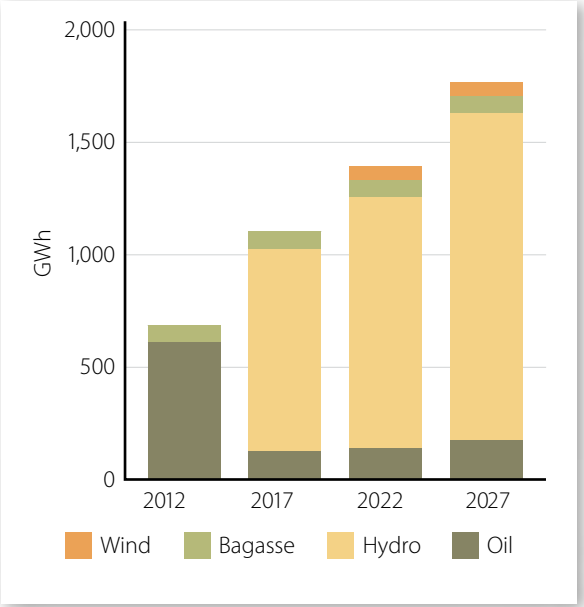
Guyana Net Generation by Source, 2027 (1,766 GWh)



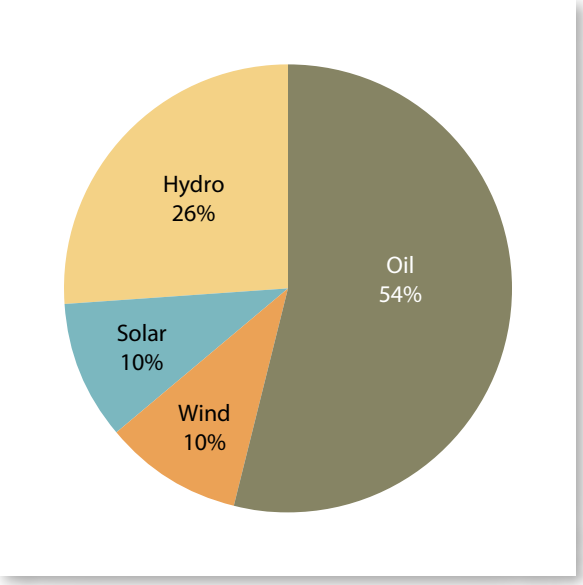
Guyana Installed Capacity by Source



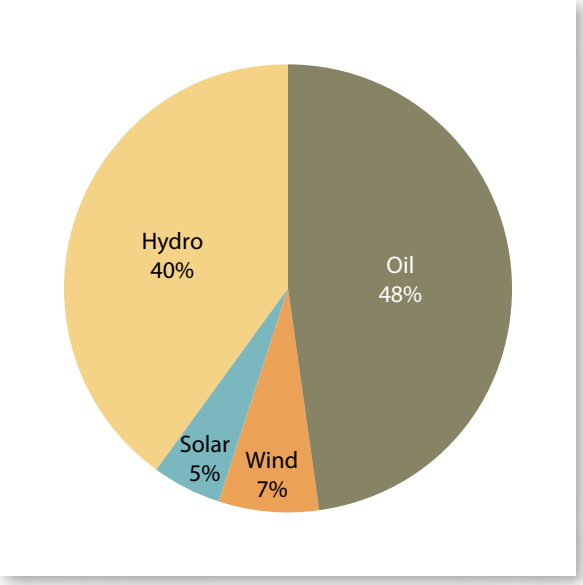
Guyana Net Generation by Source



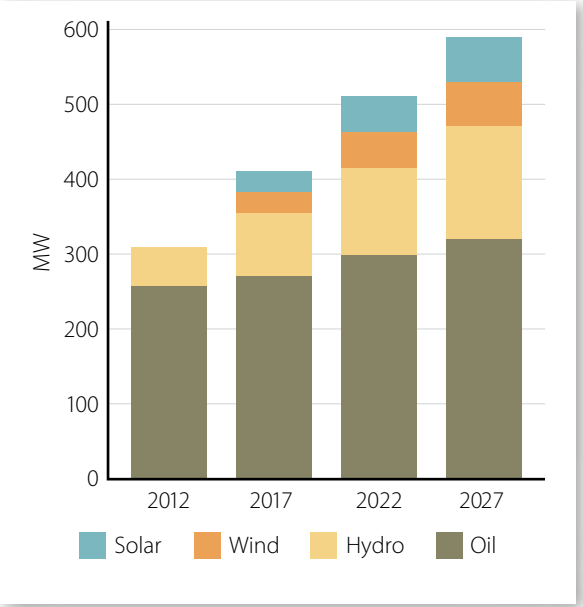
Haiti Installed Capacity by Source, 2027 (590 MW)



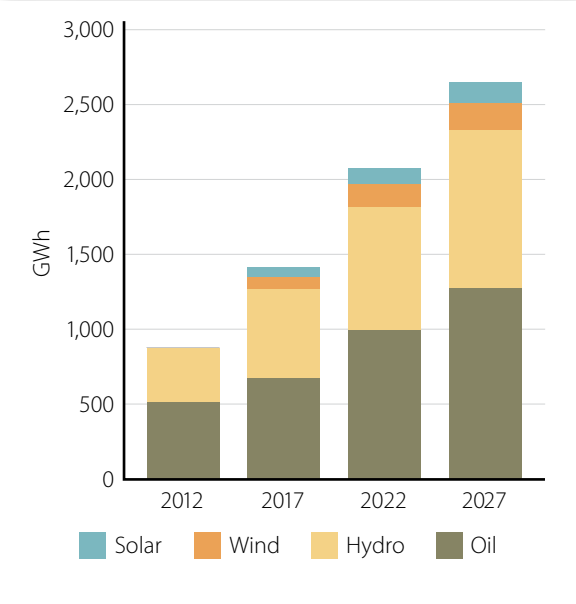
Haiti Net Generation by Source, 2027 (2,650 GWh)



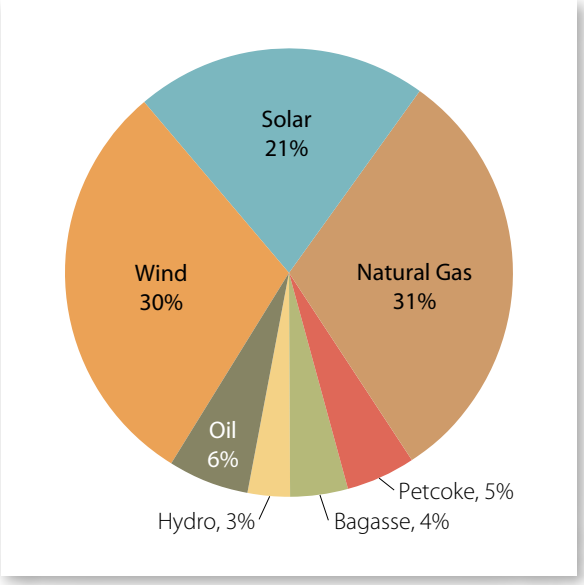
Haiti Installed Capacity by Source



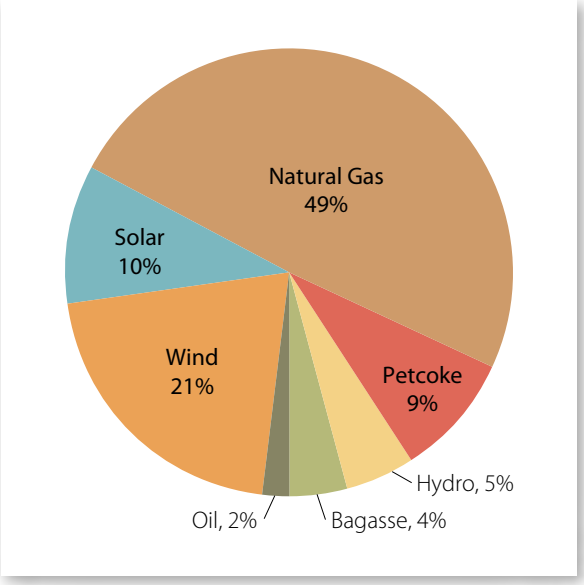
Haiti Net Generation by Source



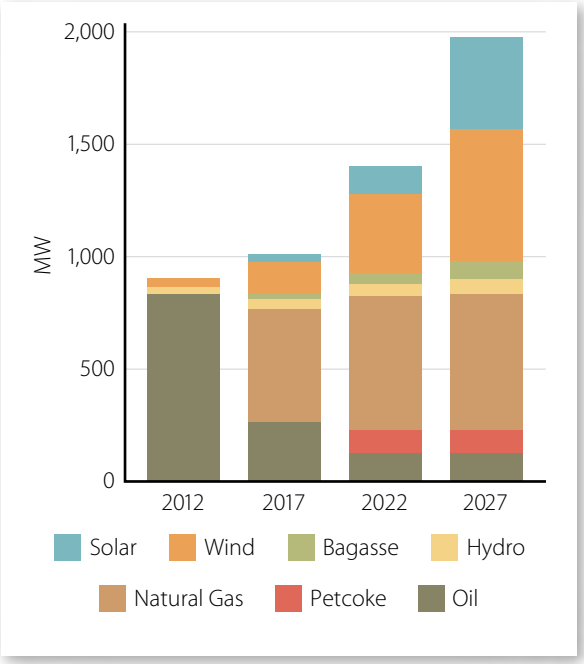
Jamaica Installed Capacity by Source, 2027 (1,976 MW)



Jamaica Net Generation by Source, 2027 (8,609 GWh)



Jamaica Installed Capacity by Source



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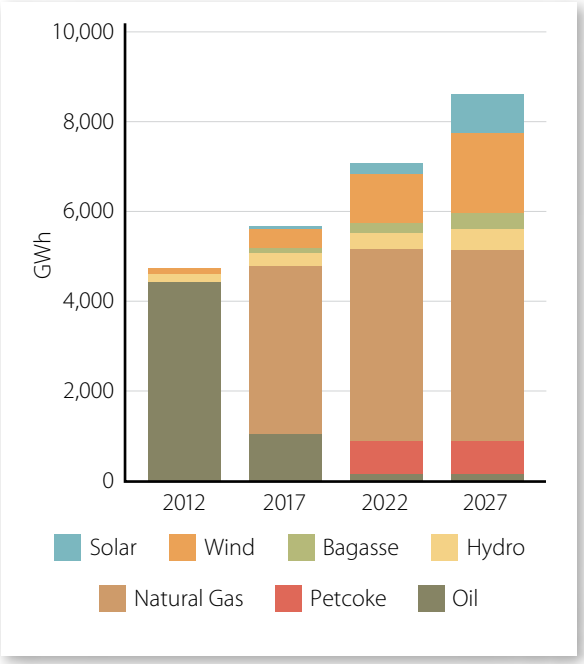
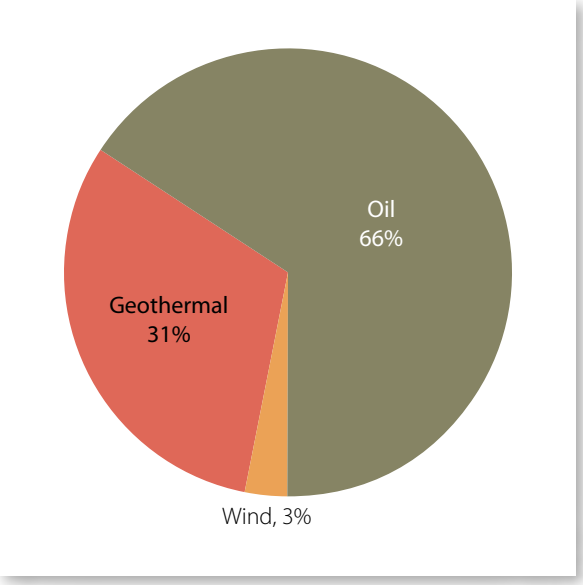
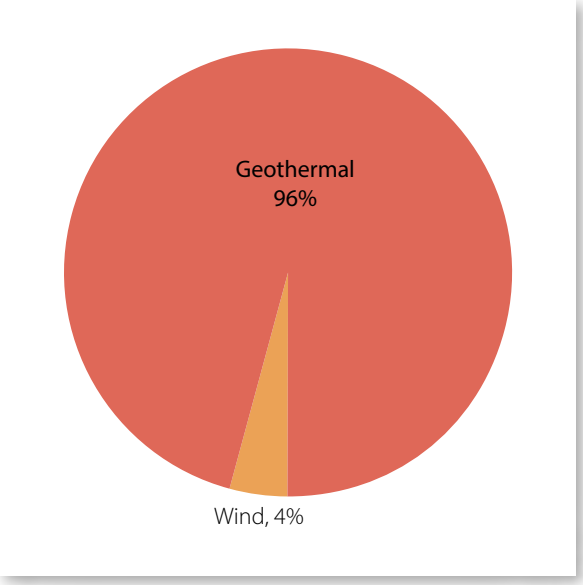


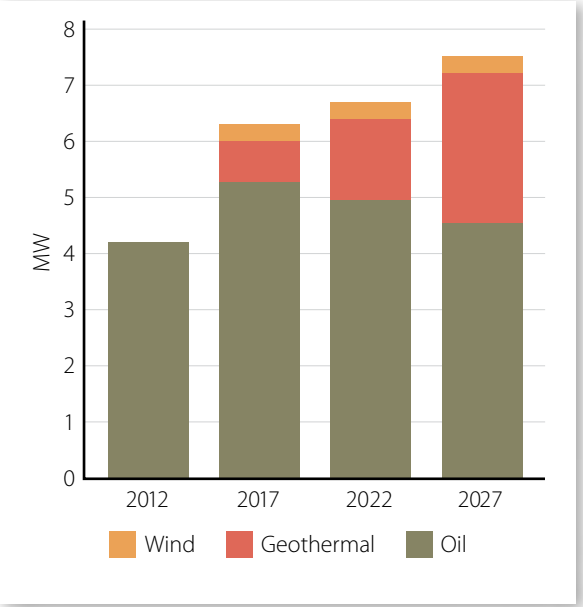
Montserrat Installed Capacity by Source, 2027 (8.63 MW)



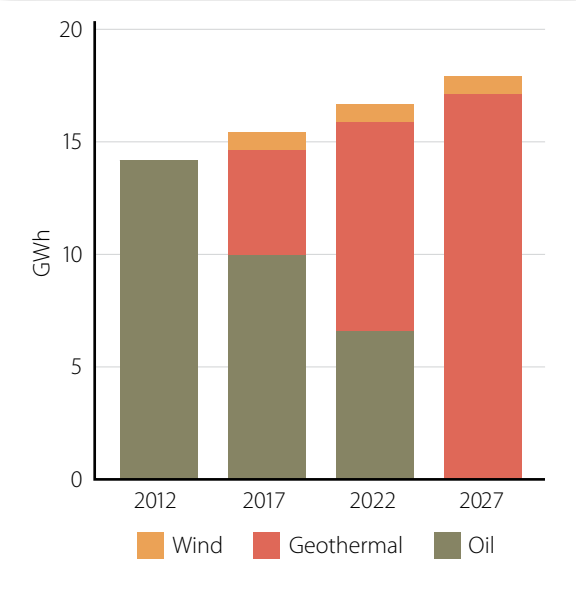
Montserrat Net Generation by Source, 2027 (18 GWh)



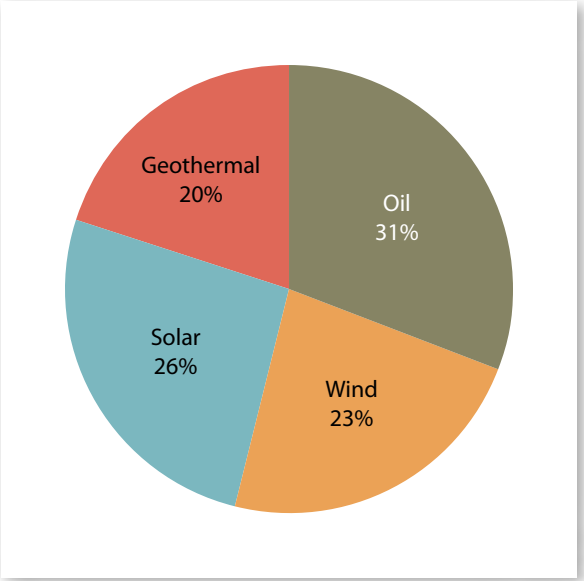
Montserrat Installed Capacity by Source



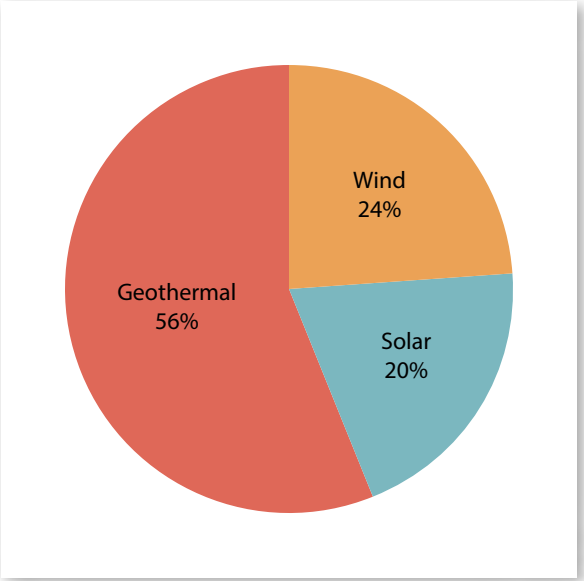
Montserrat Net Generation by Source



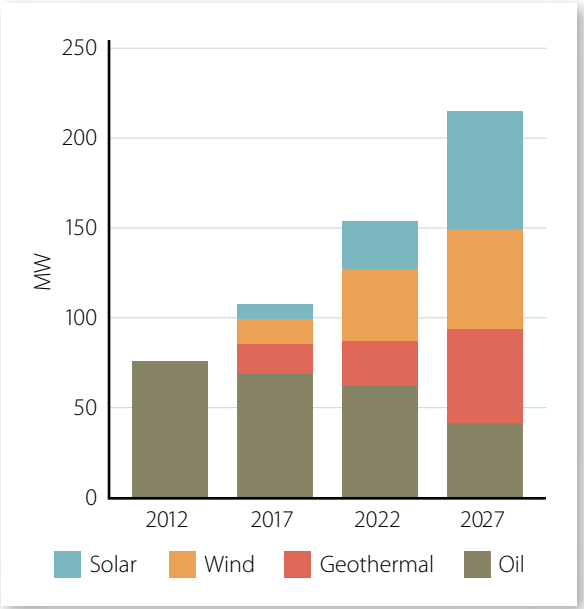
Saint Lucia Installed Capacity by Source, 2027 (250 MW)



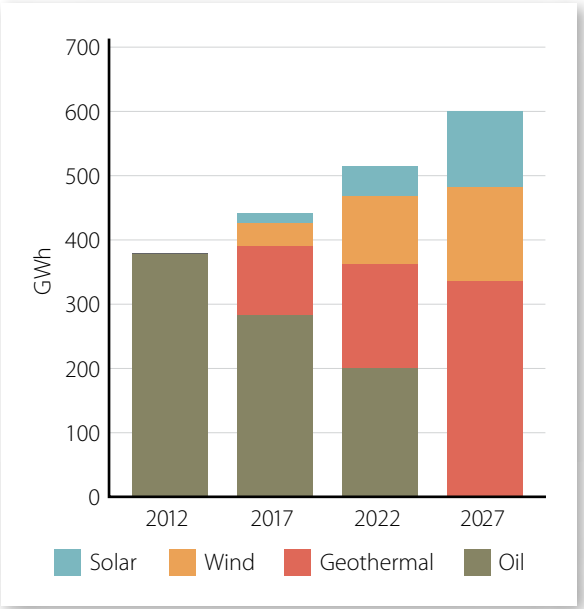
Saint Lucia Net Generation by Source, 2027 (601 GWh)



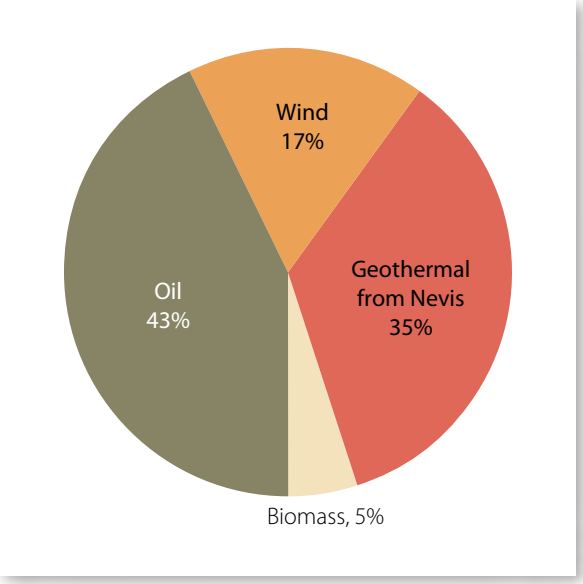
Saint Lucia Installed Capacity by Source



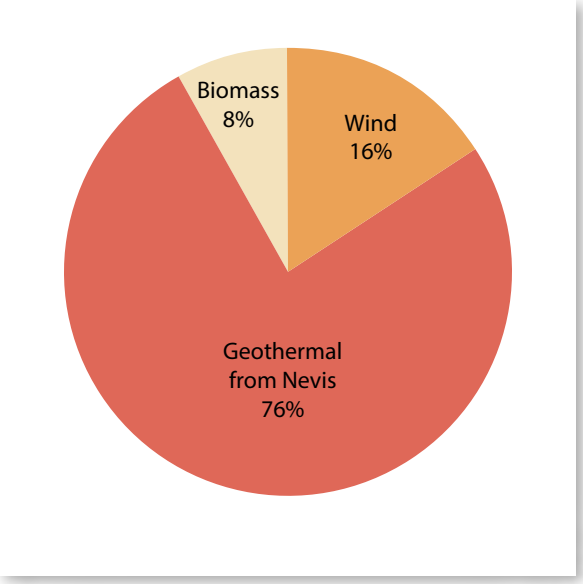
Saint Lucia Net Generation by Source



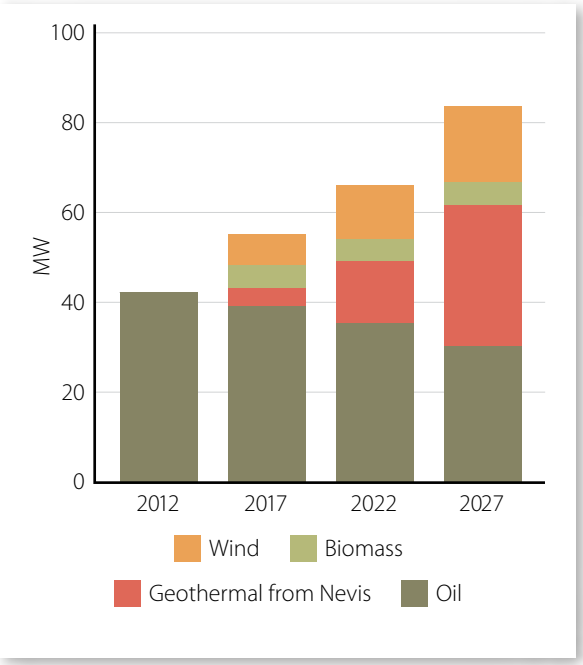
St. Kitts Installed Capacity by Source, 2027 (89 MW)



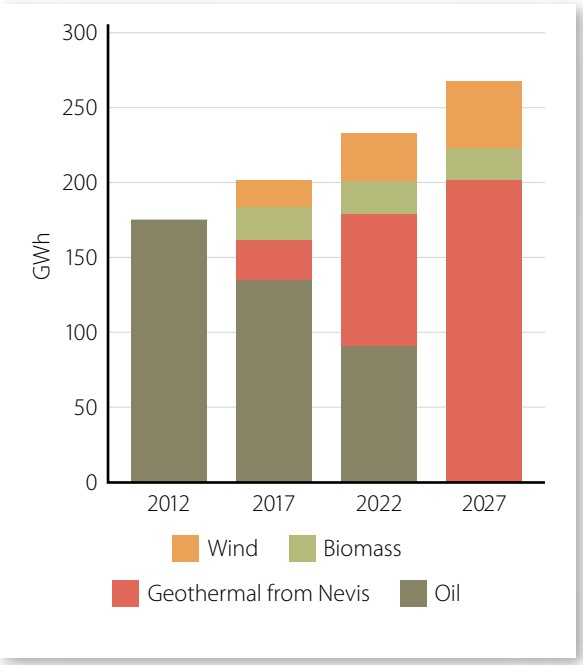
St. Kitts Net Generation by Source, 2027 (268 GWh)



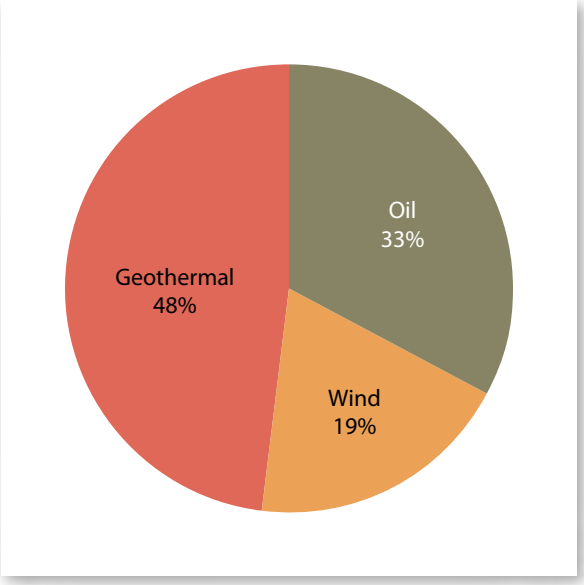
St. Kitts Installed Capacity by Source



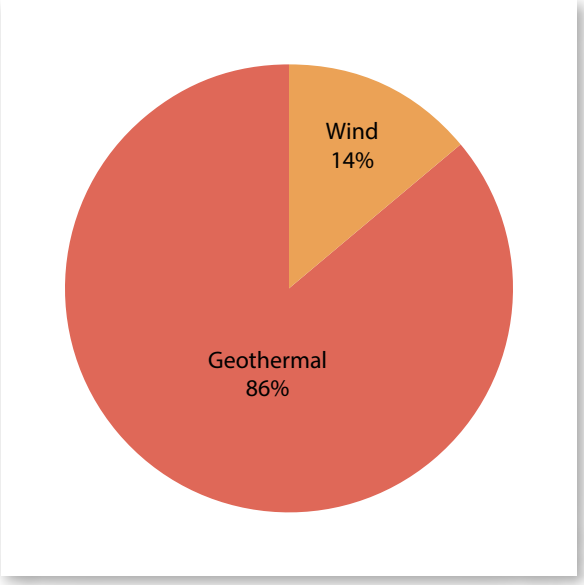
St. Kitts Net Generation by Source



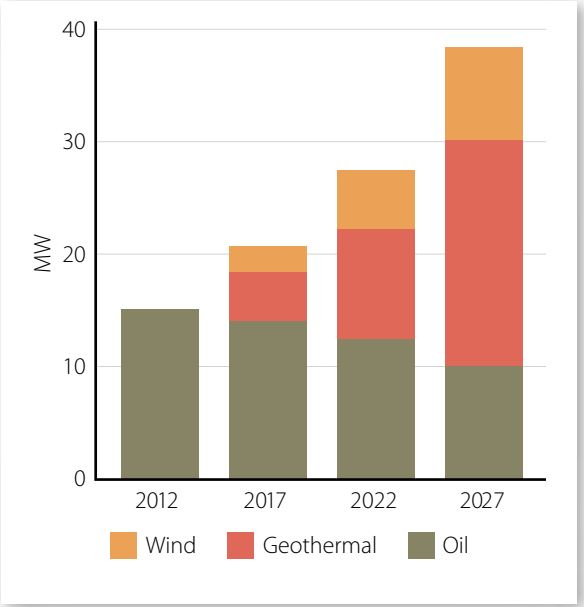
Nevis Installed Capacity by Source, 2027 (39 MW)



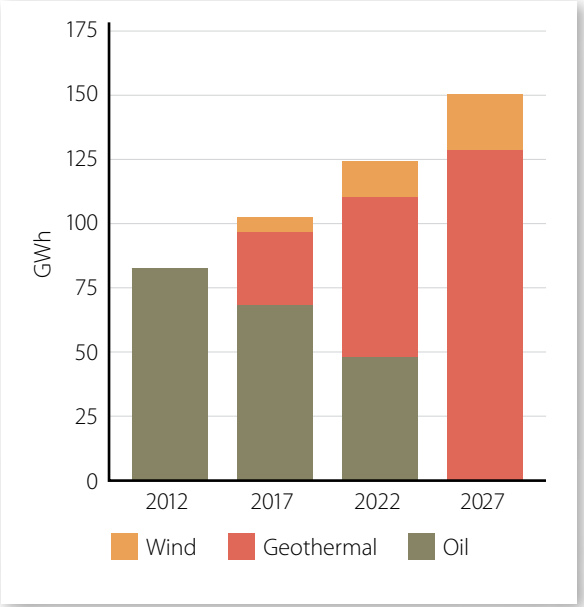
Nevis Net Generation by Source, 2027 (150 GWh)



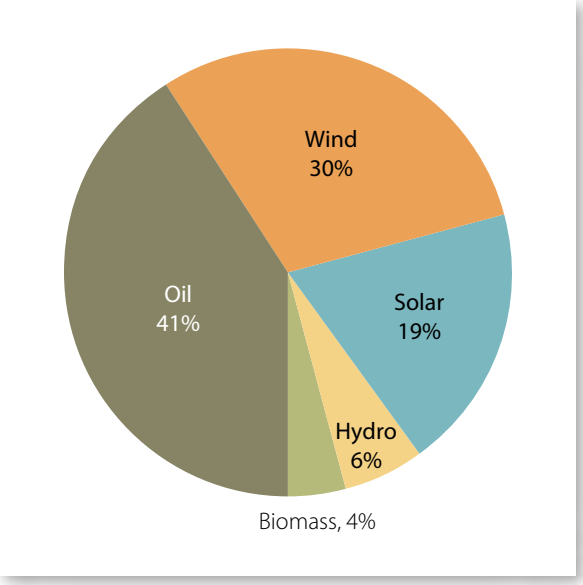
Nevis Installed Capacity by Source



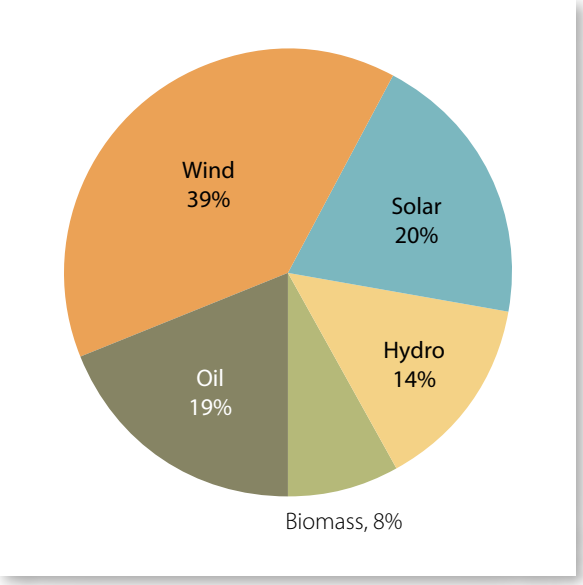
Nevis Net Generation by Source



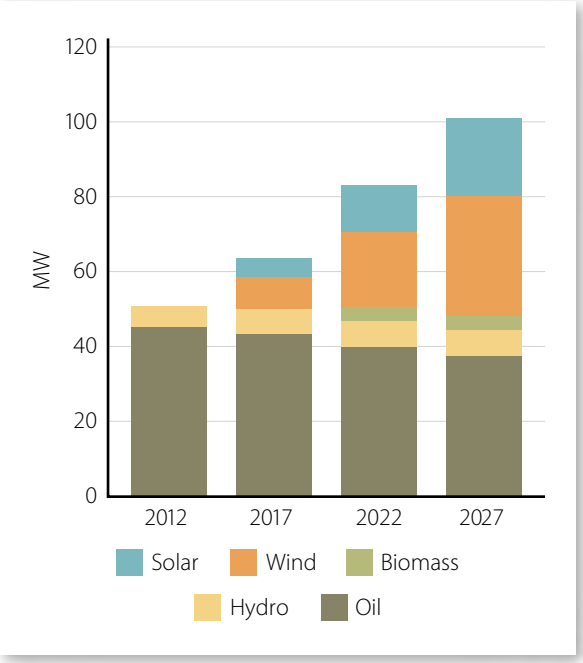
St. Vincent and the Grenadines Installed Capacity by Source, 2027 (108 MW)



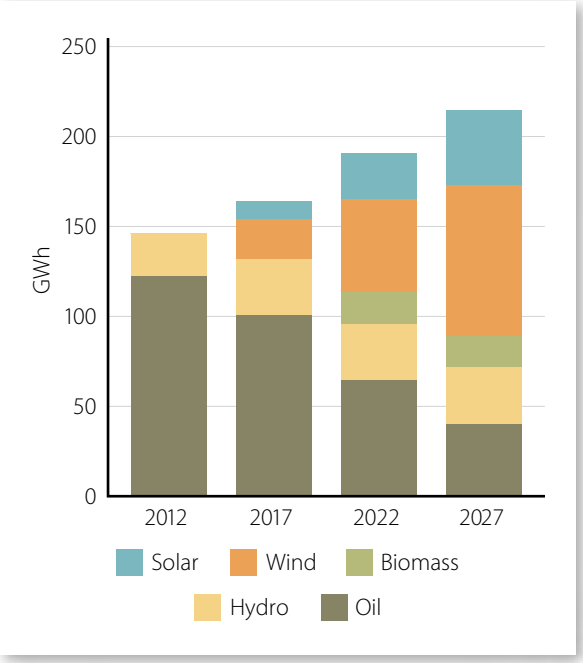
St. Vincent and the Grenadines Net Generation by Source, 2027 (214 GWh)



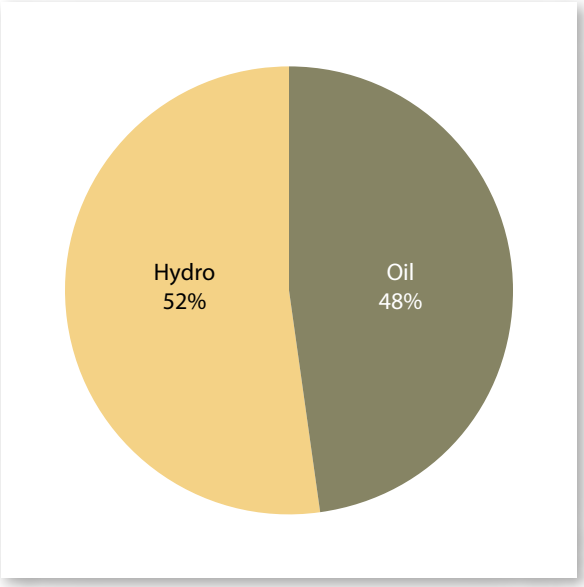
St. Vincent and the Grenadines Installed Capacity by Source



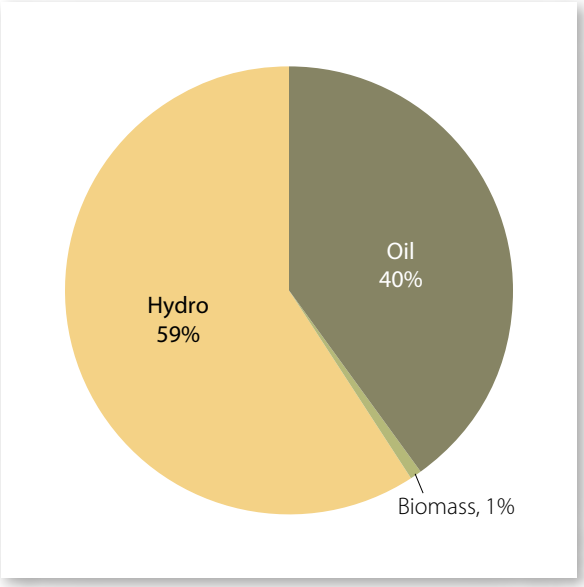
St. Vincent and the Grenadines Net Generation by Source



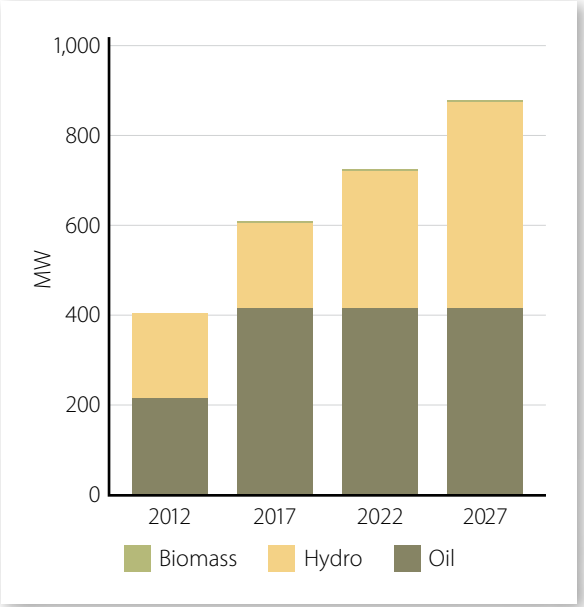
Suriname Installed Capacity by Source, 2027 (877 MW)



Suriname Net Generation by Source, 2027 (3,500 GWh)



Suriname Installed Capacity by Source



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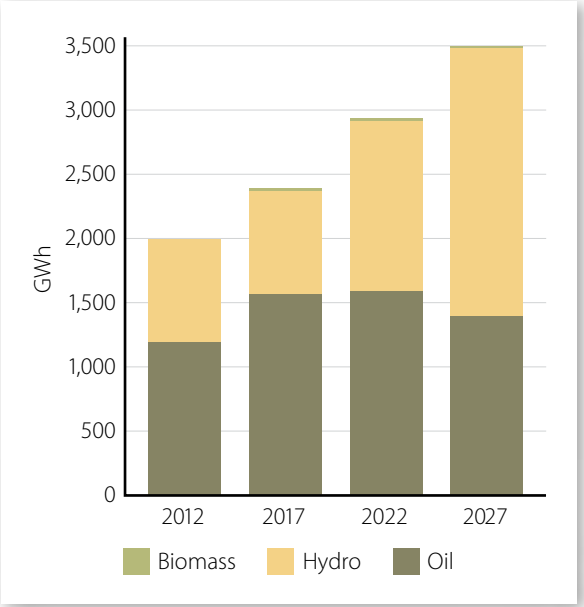
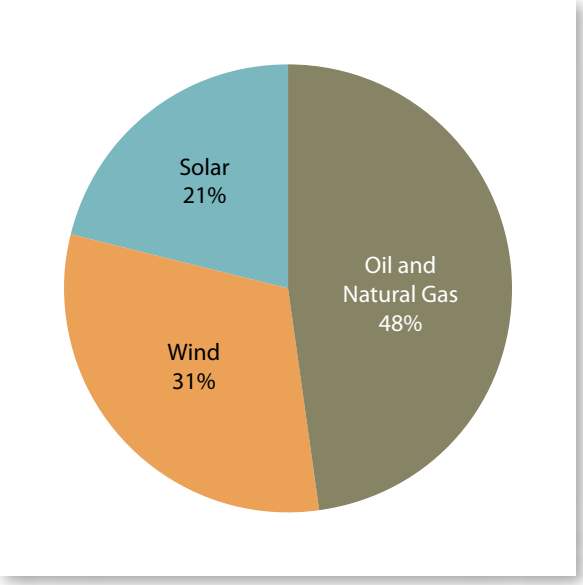
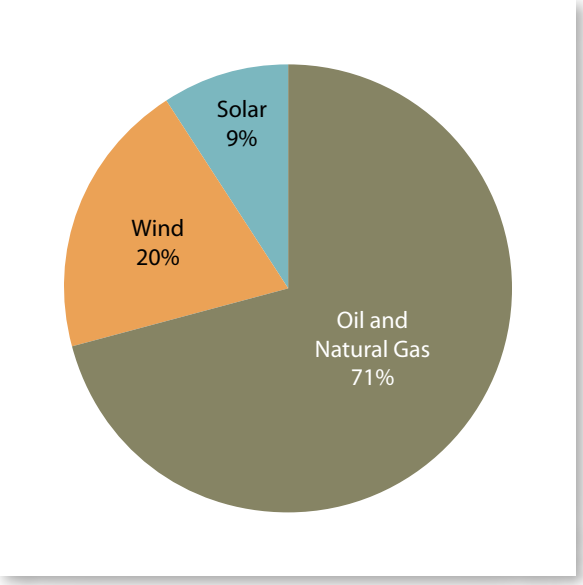


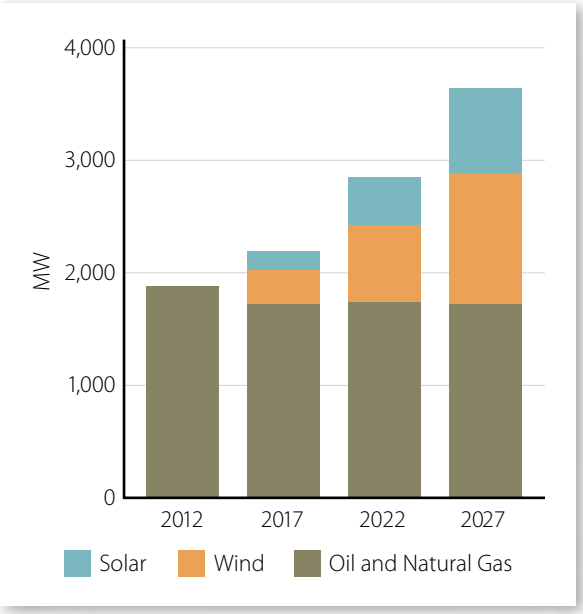
Trinidad and Tobago Installed Capacity by Source, 2027 (3,674 MW)



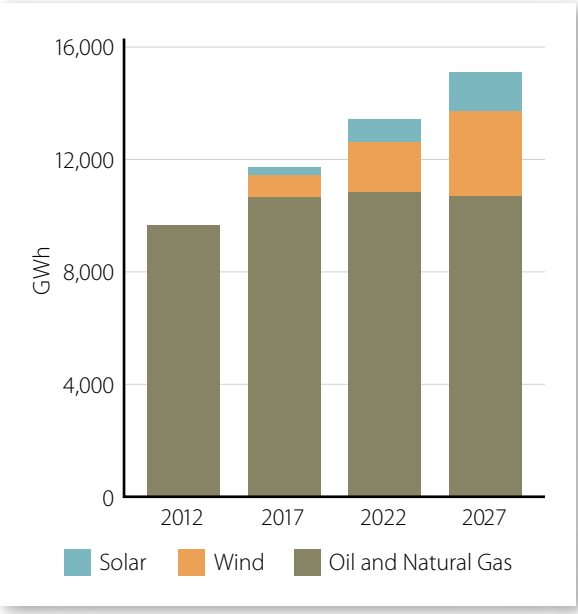
Trinidad and Tobago Net Generation by Source, 2027 (15,094 GWh)



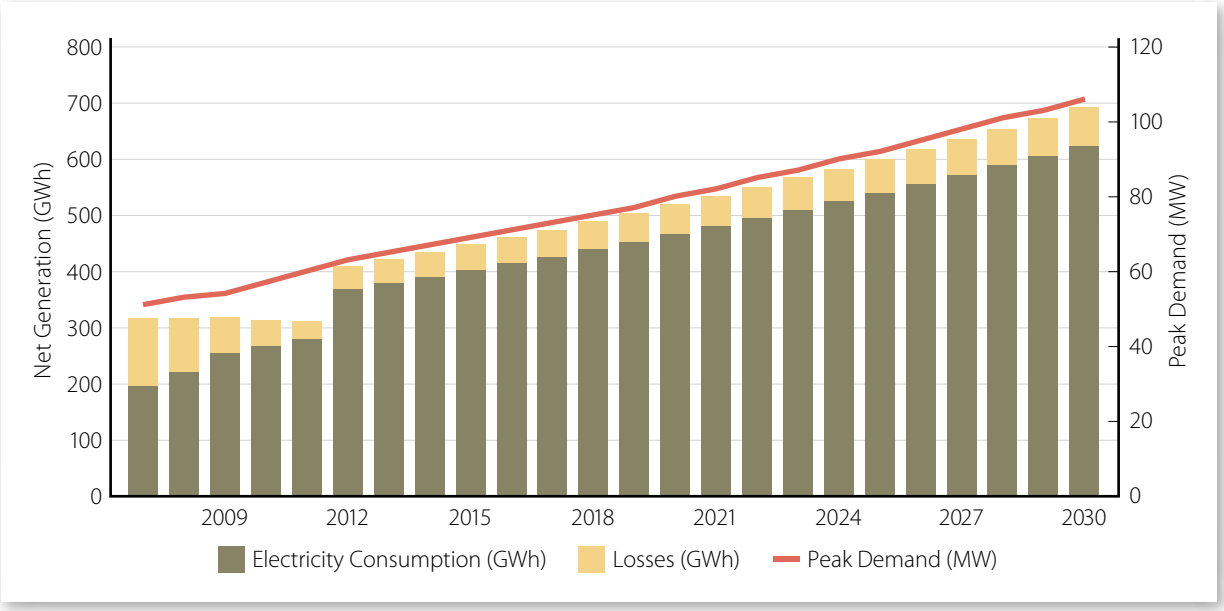
Trinidad and Tobago Installed Capacity by Source



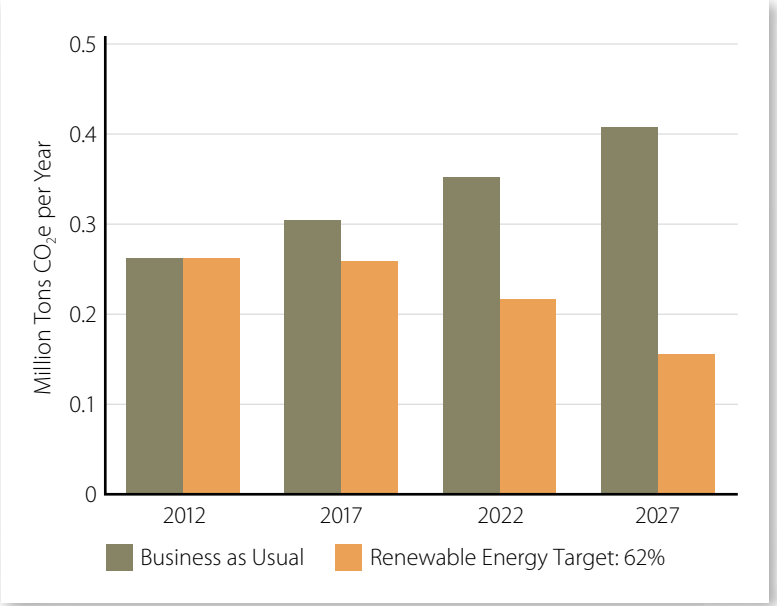
Trinidad and Tobago Net Generation by Source



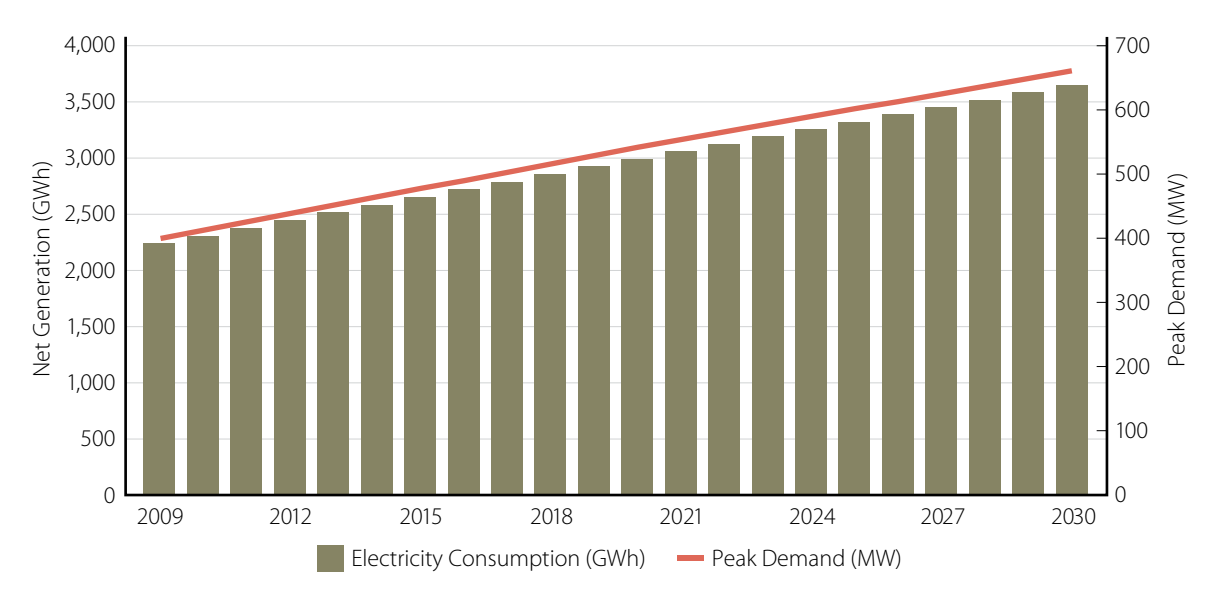
Antigua and Barbuda Electricity System Forecast, 2007–2030



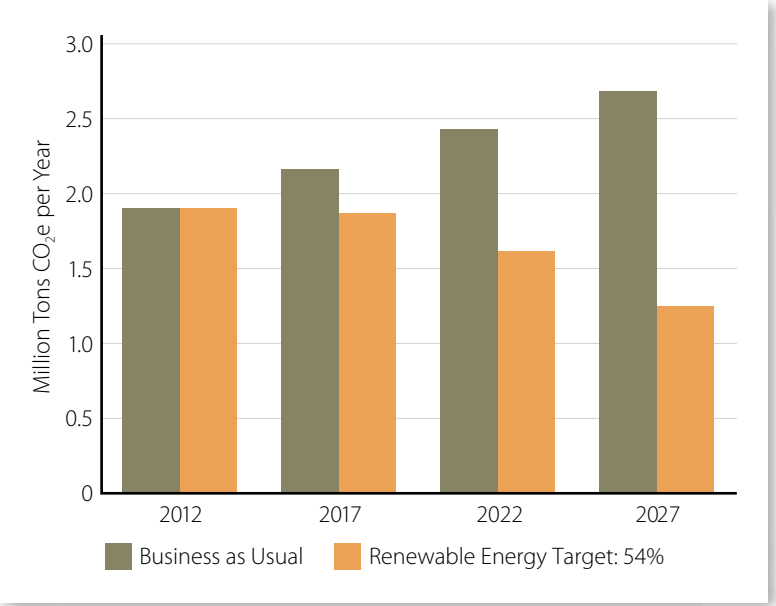
Antigua and Barbuda Electricity Sector Emissions



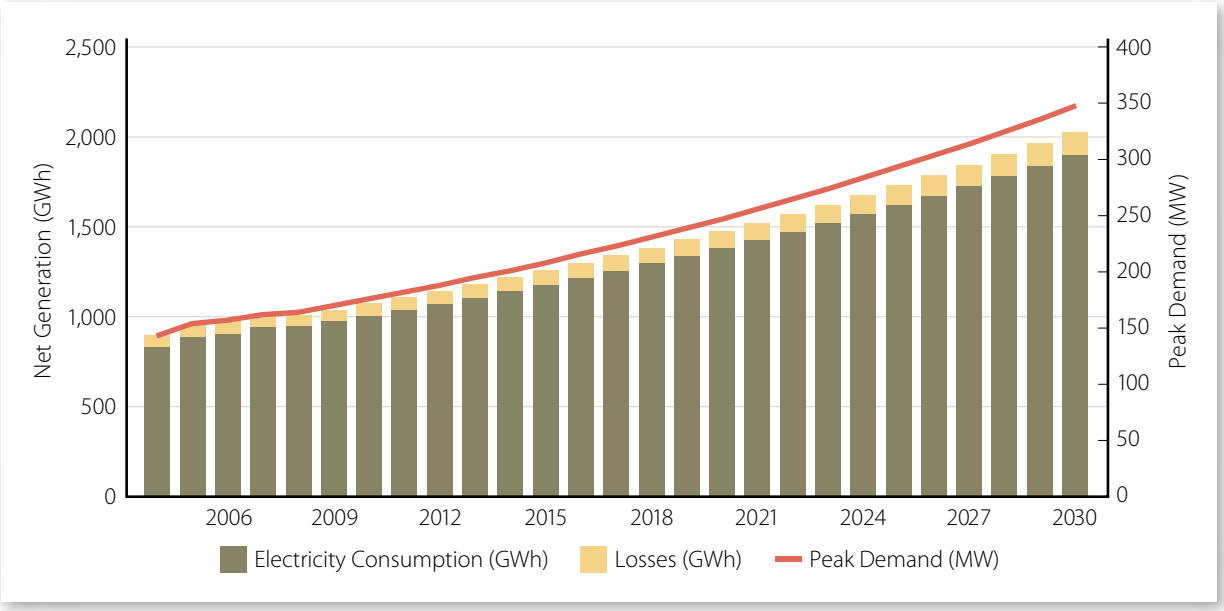
The Bahamas Electricity System Forecast, 2009–2030



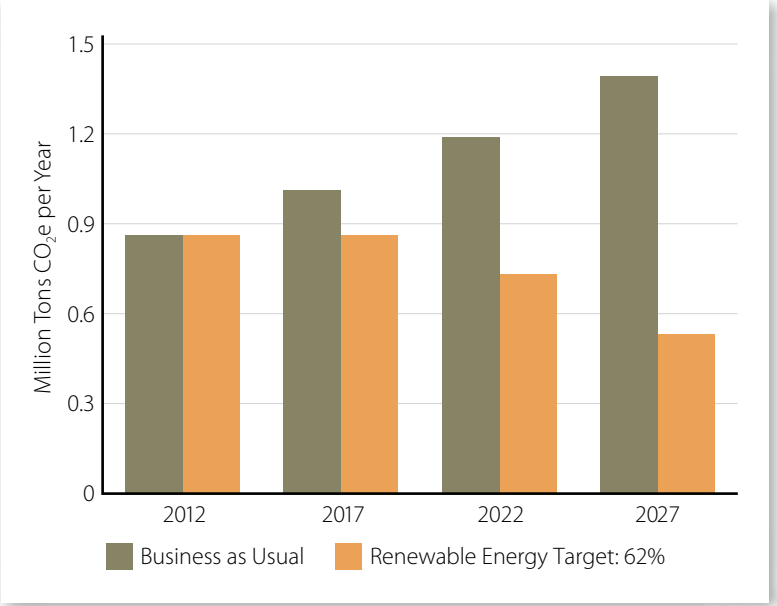
The Bahamas Electricity Sector Emissions



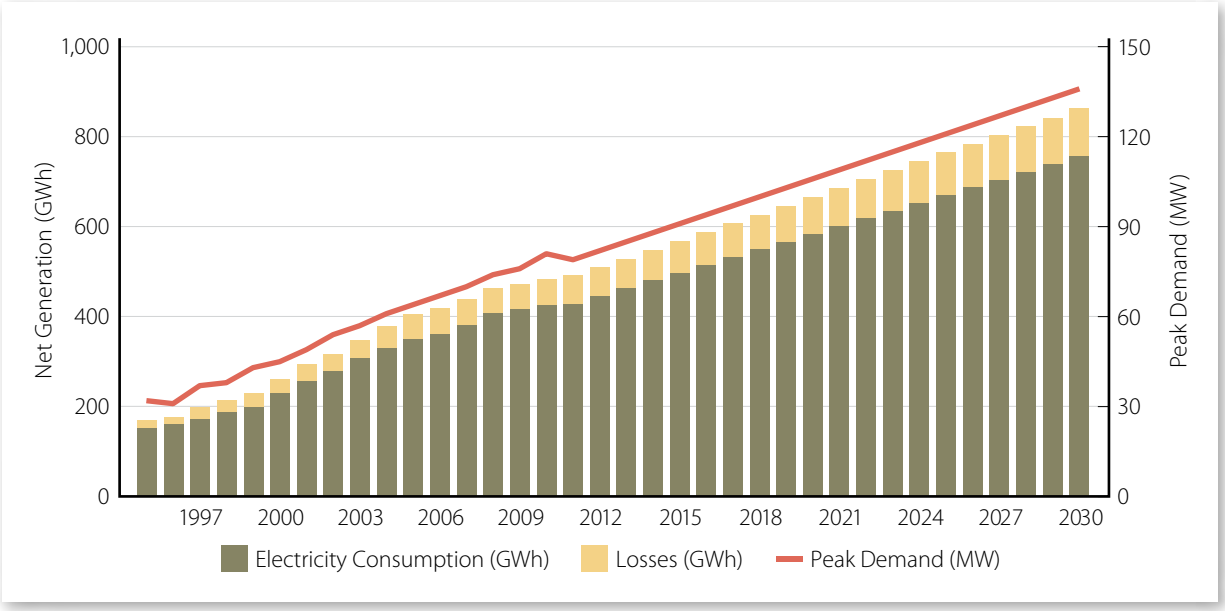
Barbados Electricity System Forecast, 2004–2030



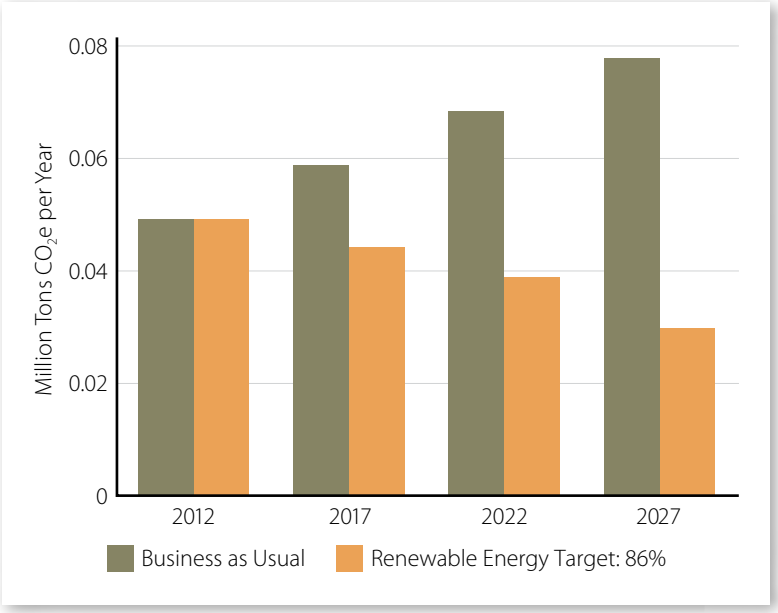
Barbados Electricity Sector Emissions



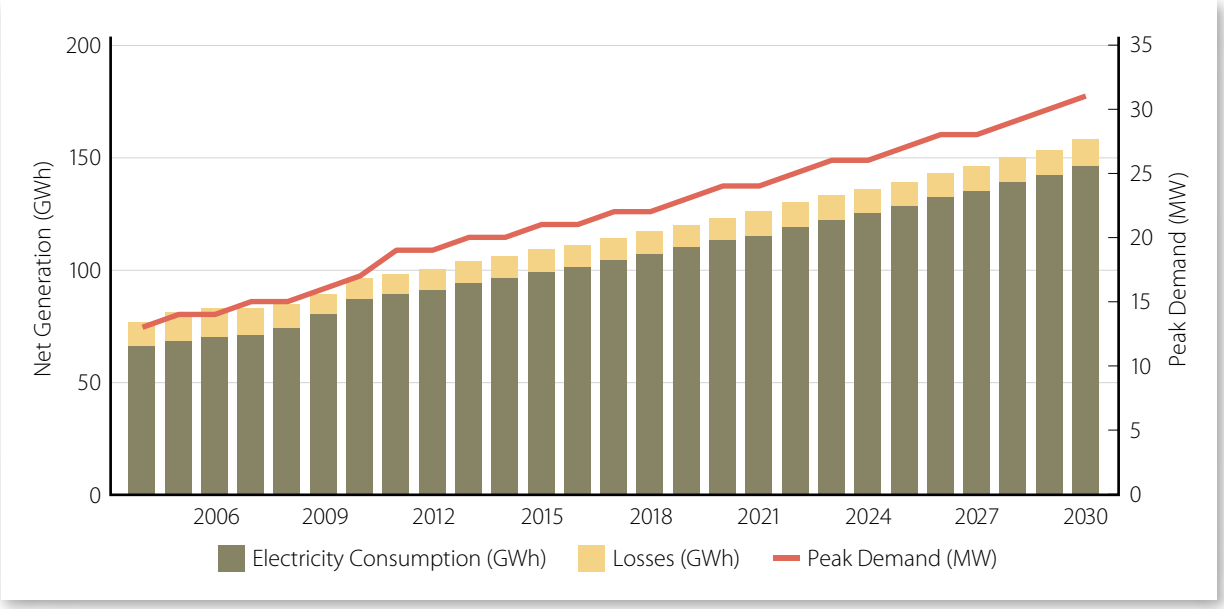
Belize Electricity System Forecast, 1995–2030



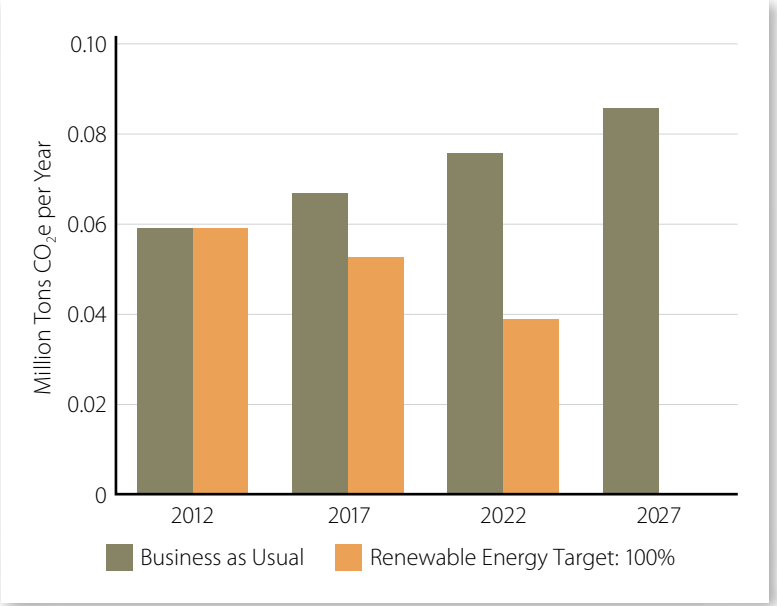
Belize Electricity Sector Emissions



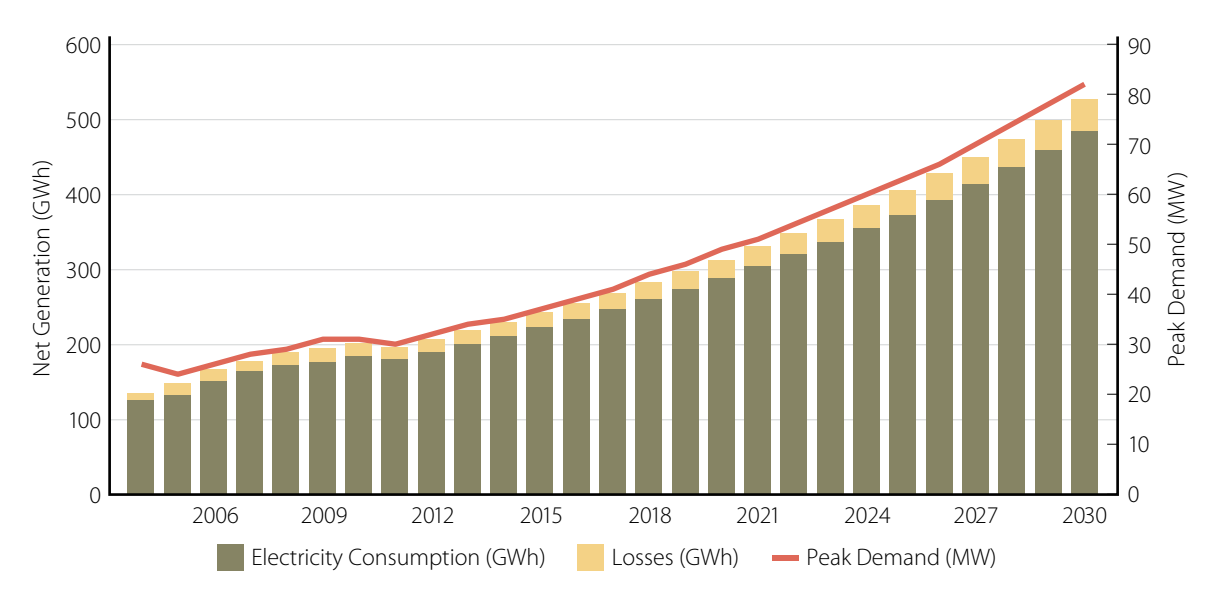
Dominica Electricity System Forecast, 2004–2030



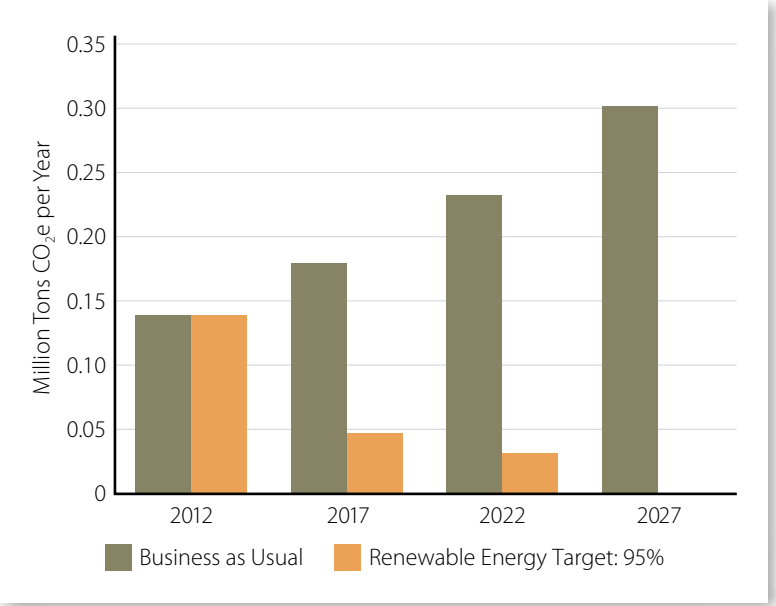
Dominica Electricity Sector Emissions



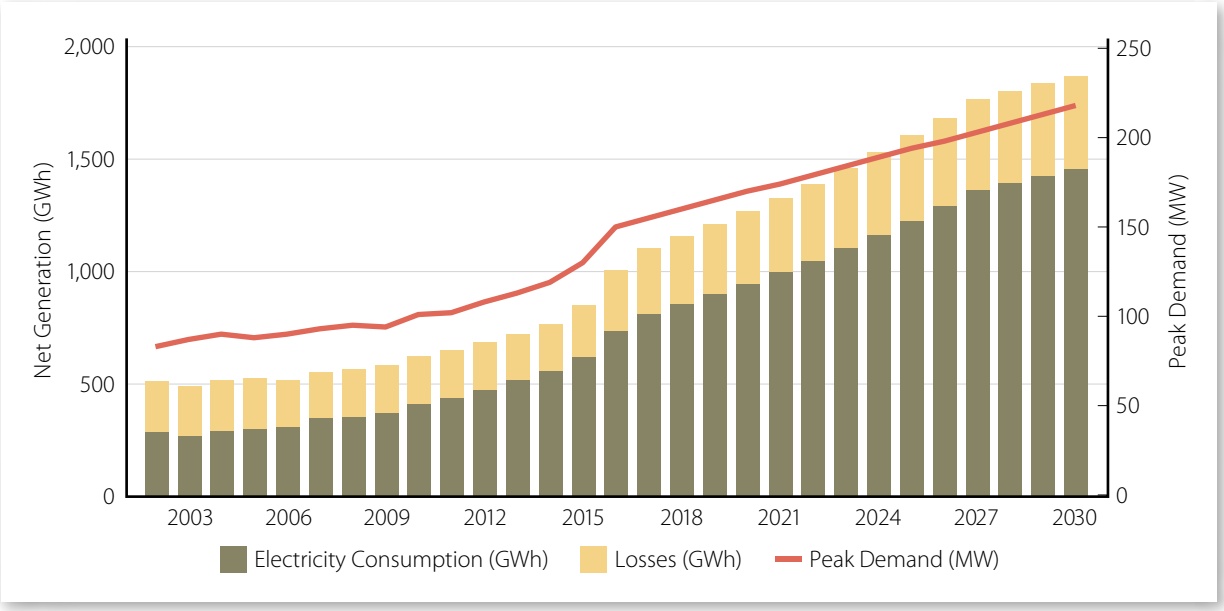
Grenada Electricity System Forecast, 2004–2030



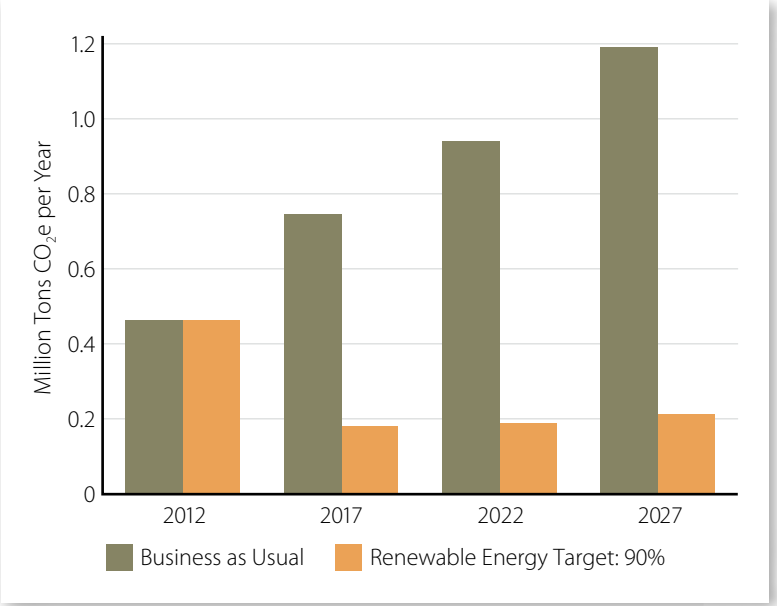
Grenada Electricity Sector Emissions



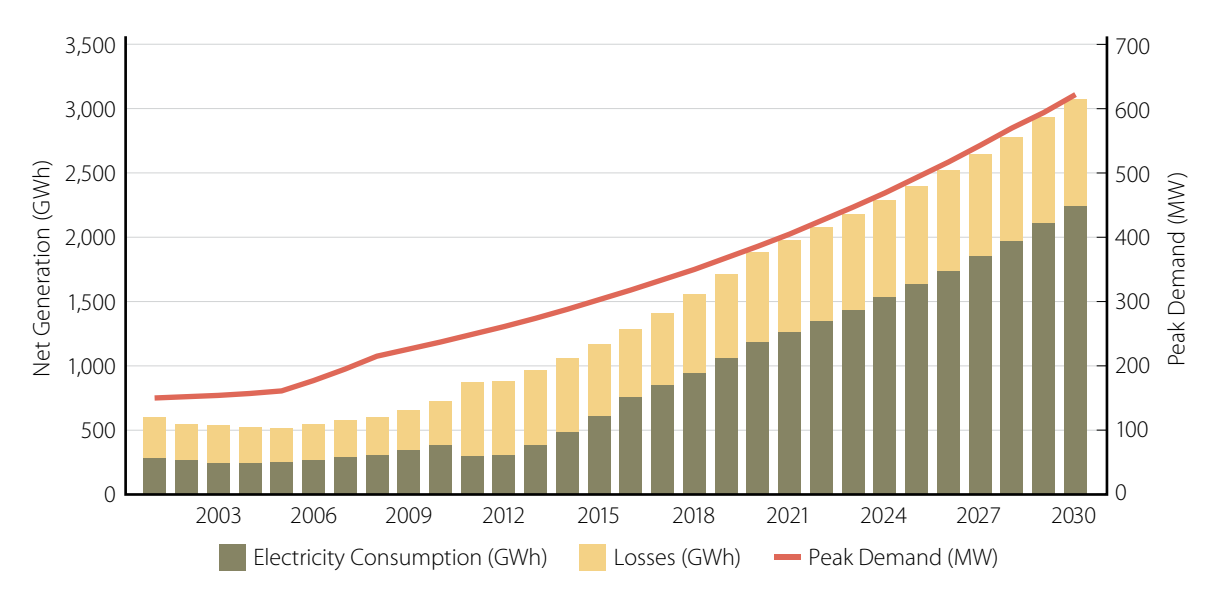
Guyana Electricity System Forecast, 2002–2030



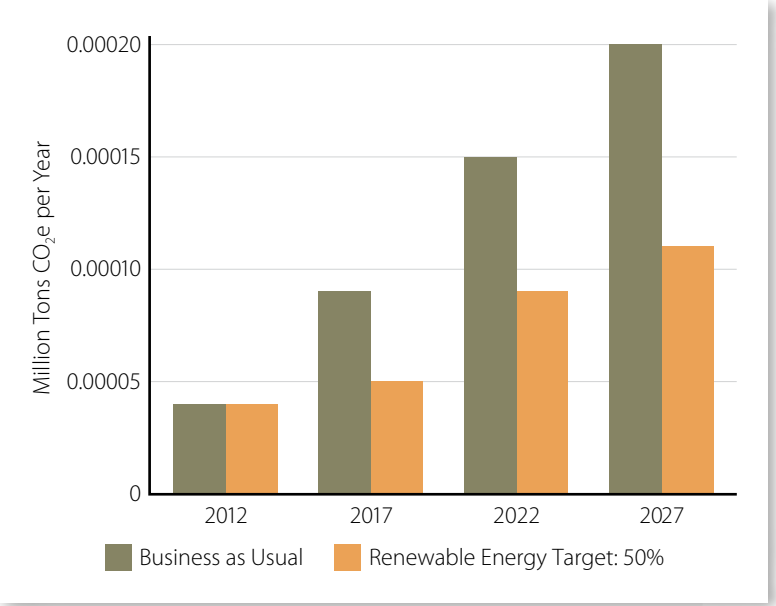
Guyana Electricity Sector Emissions



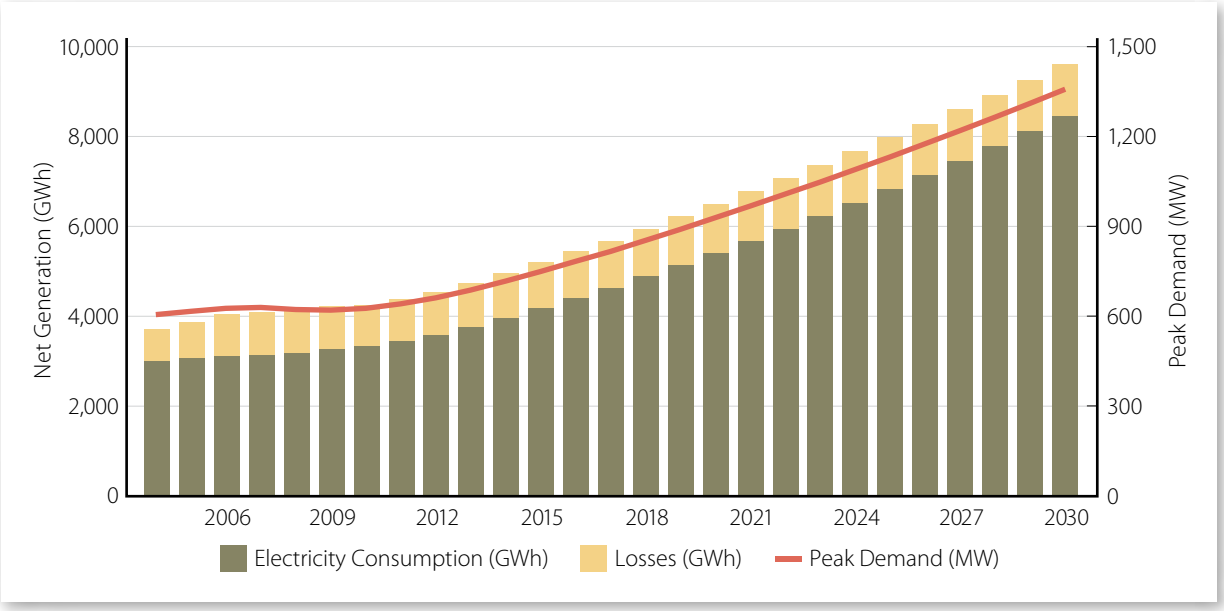
Haiti Electricity System Forecast, 2001–2030



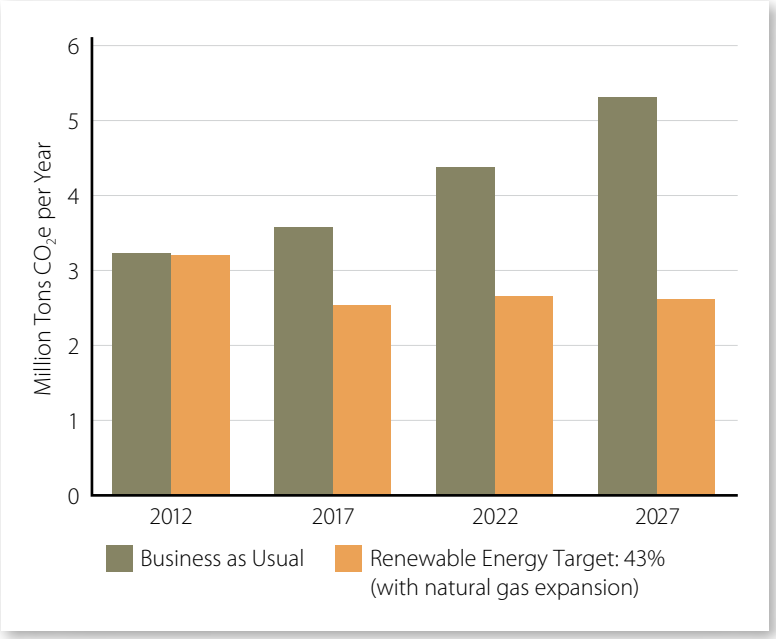
Haiti Electricity Sector Emissions



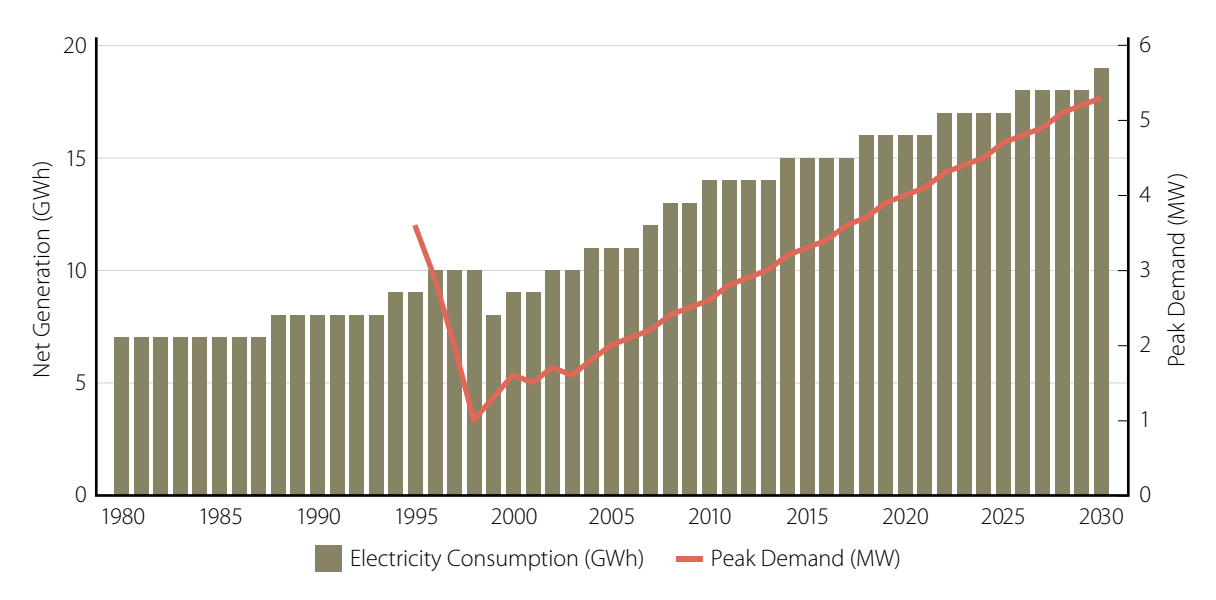
Jamaica Electricity System Forecast, 2004–2030



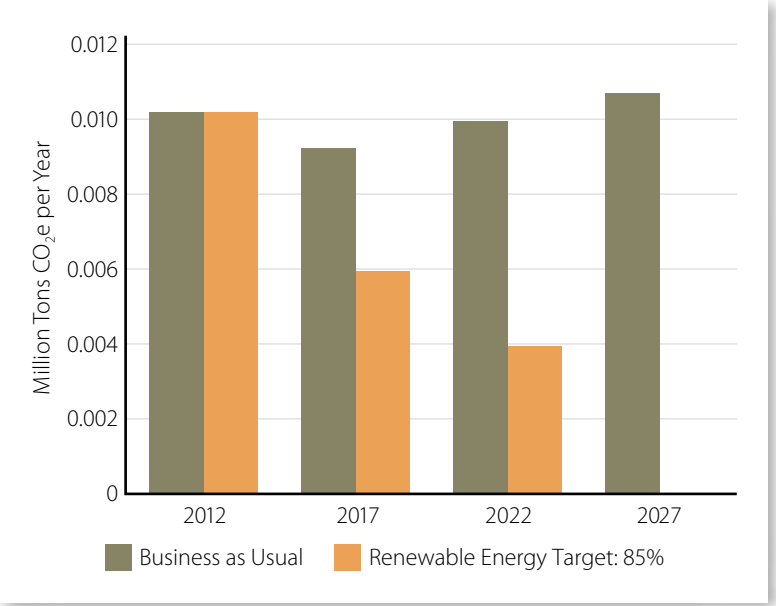
Jamaica Electricity Sector Emissions



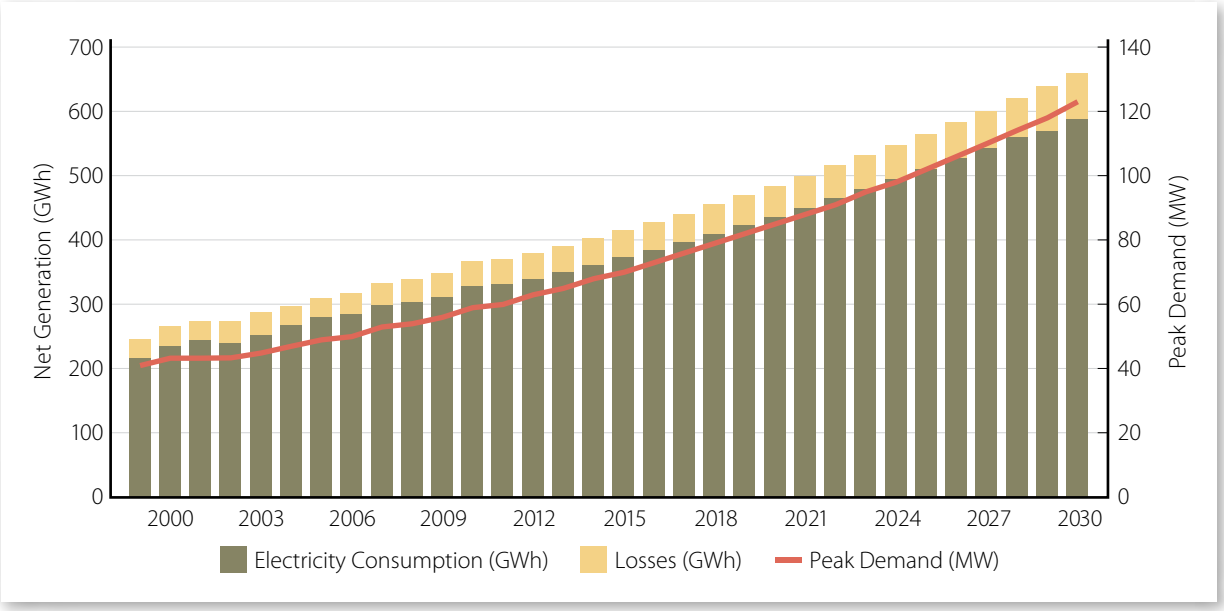
Montserrat Electricity System Forecast, 1980–2030



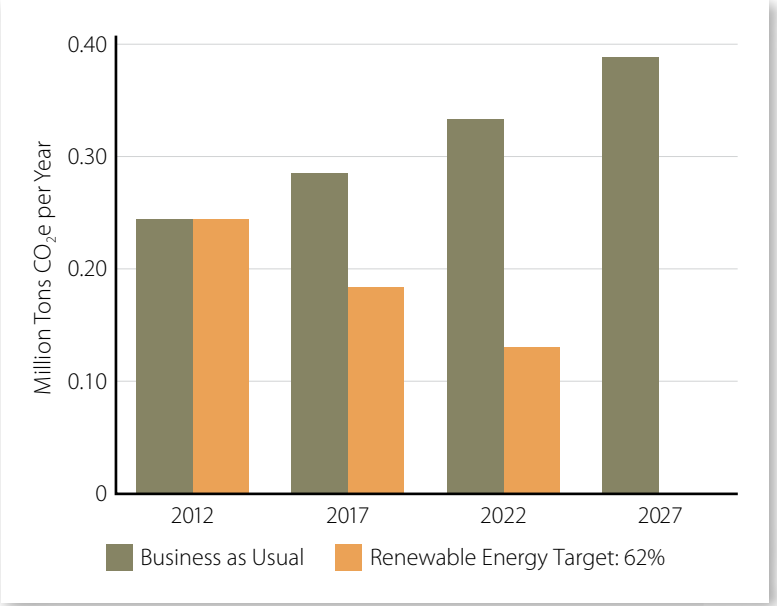
Montserrat Electricity Sector Emissions



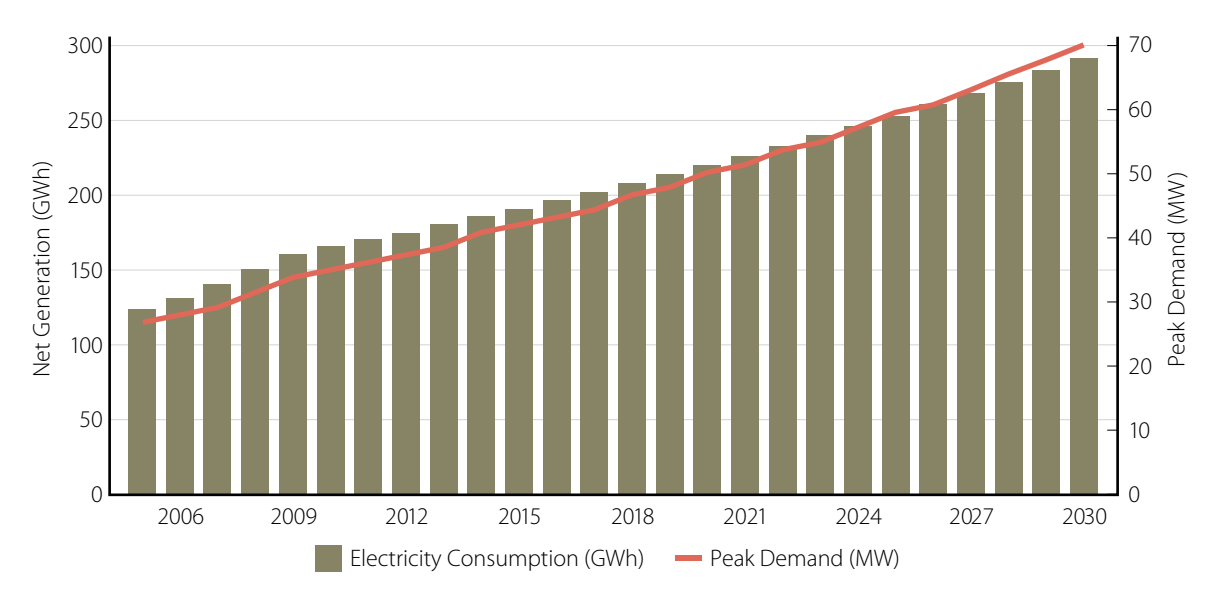
Saint Lucia Electricity System Forecast, 1999–2030



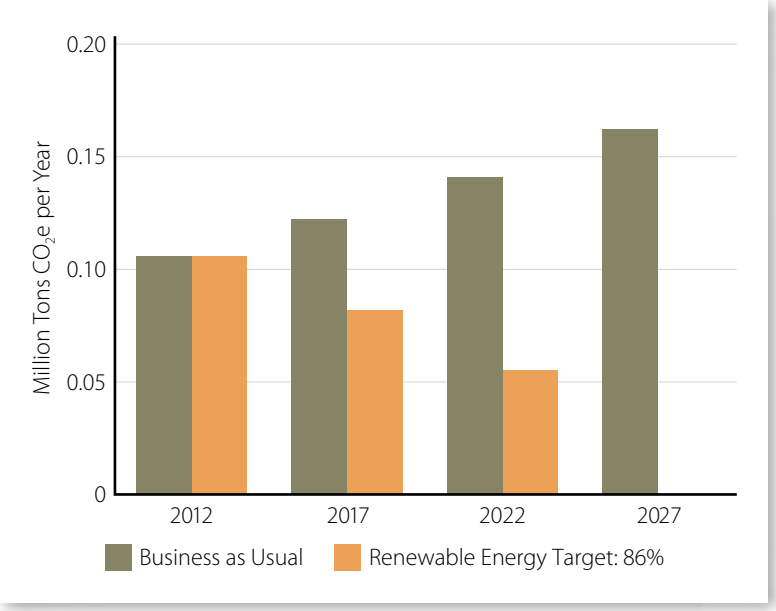
Saint Lucia Electricity Sector Emissions



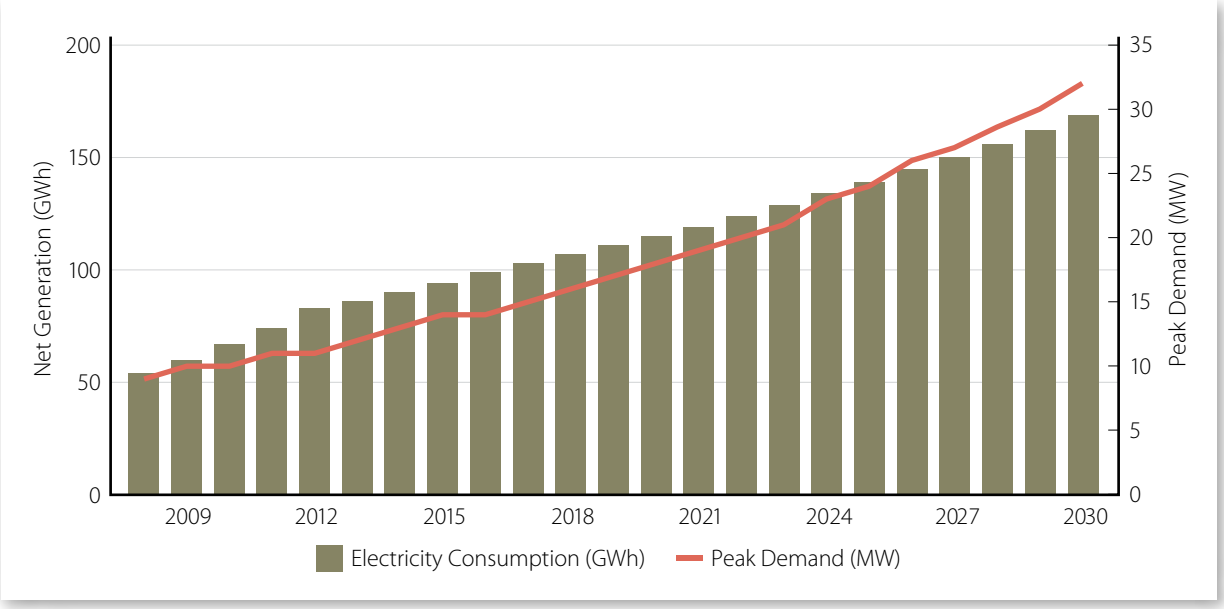
St. Kitts Electricity System Forecast, 2005–2030



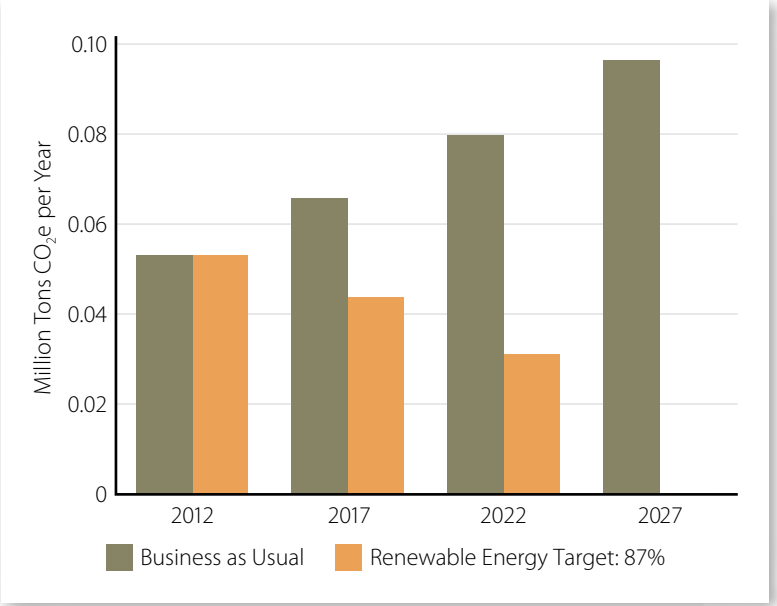
St. Kitts Electricity Sector Emissions



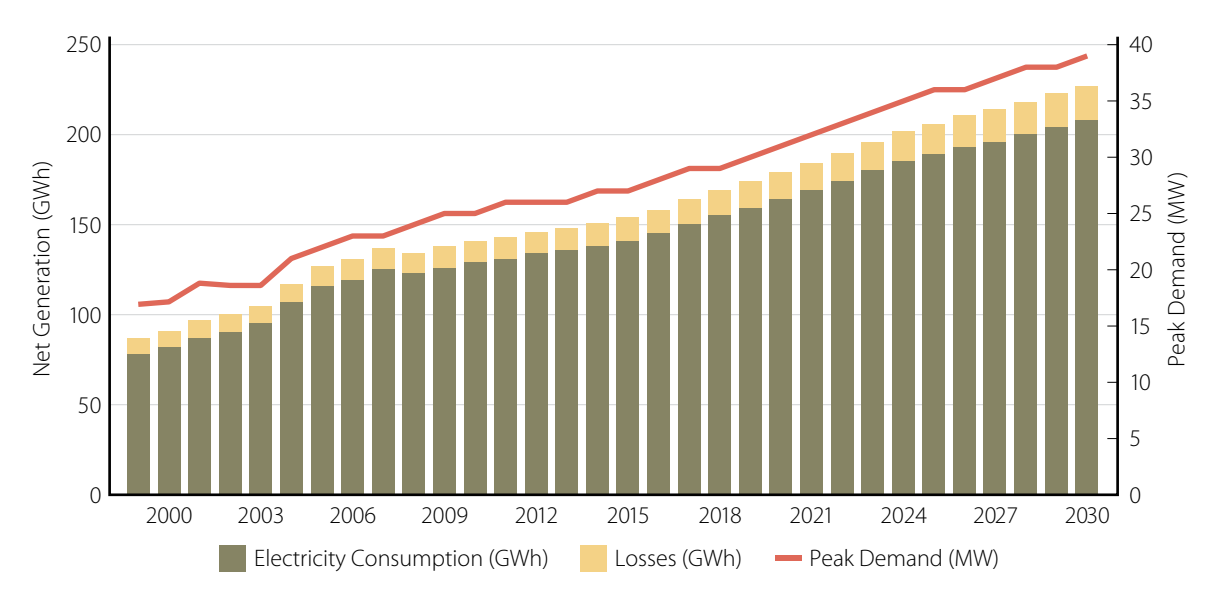
Nevis Electricity System Forecast, 2008–2030



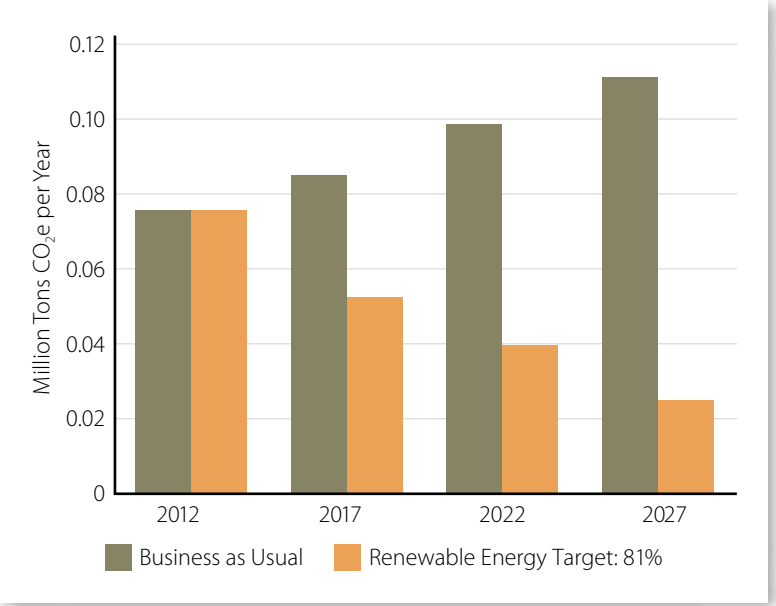
Nevis Electricity Sector Emissions



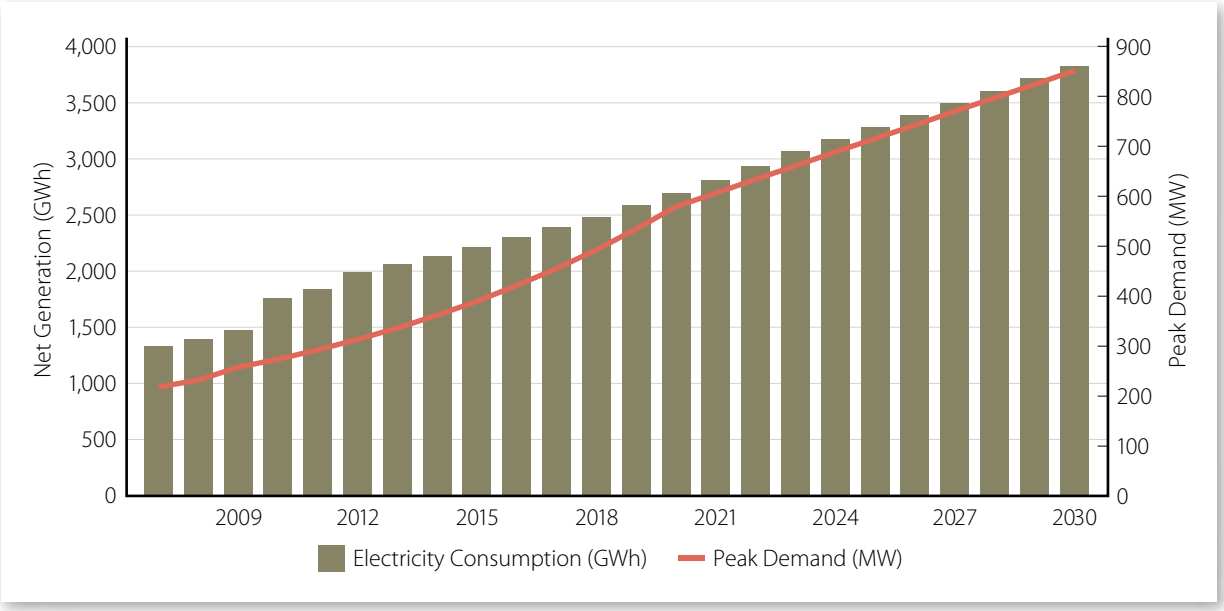
St. Vincent and the Grenadines Electricity System Forecast, 1999–2030



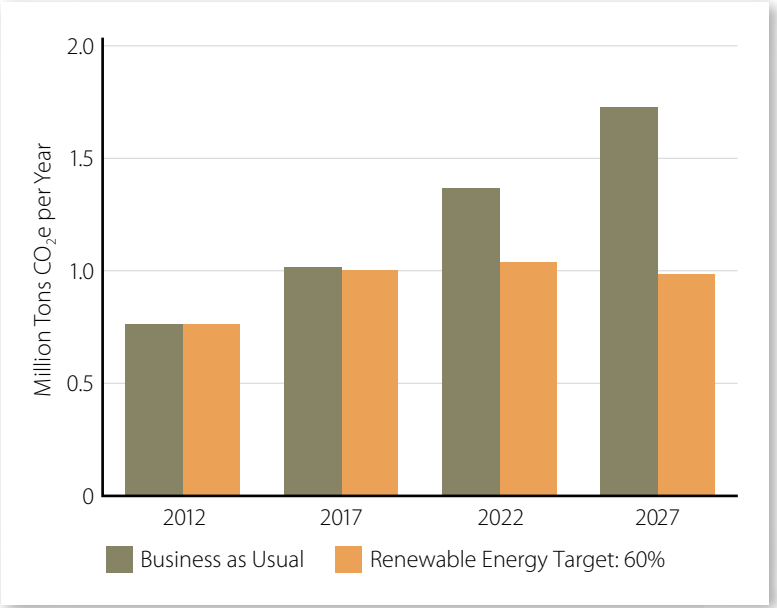
St. Vincent and the Grenadines Electricity Sector Emissions



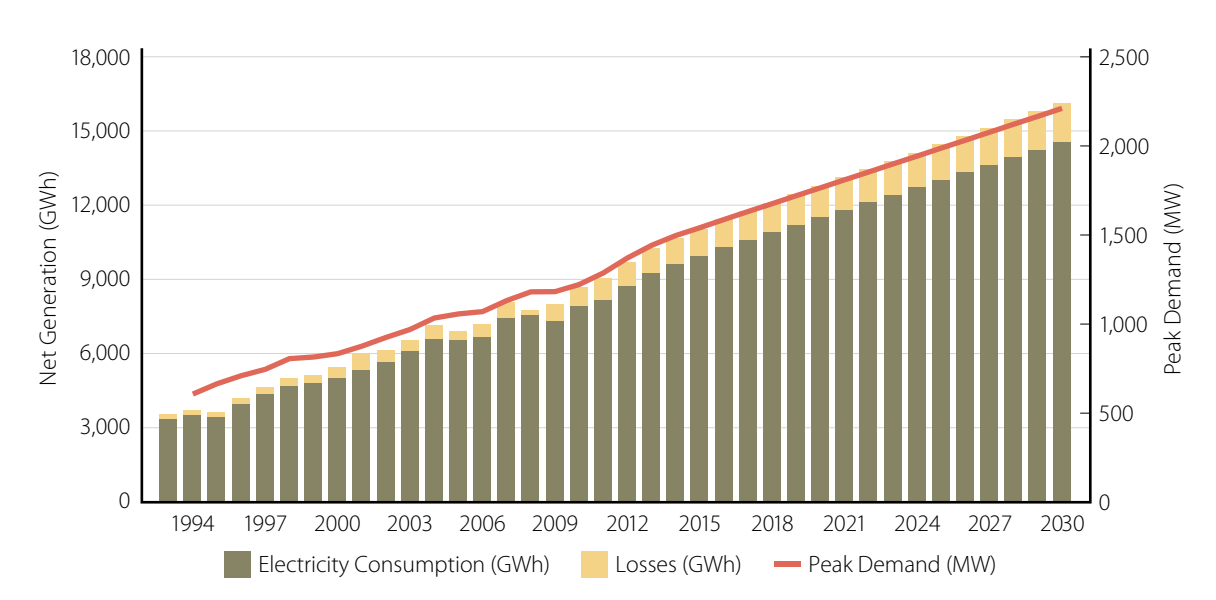
Suriname Electricity System Forecast, 2007–2030



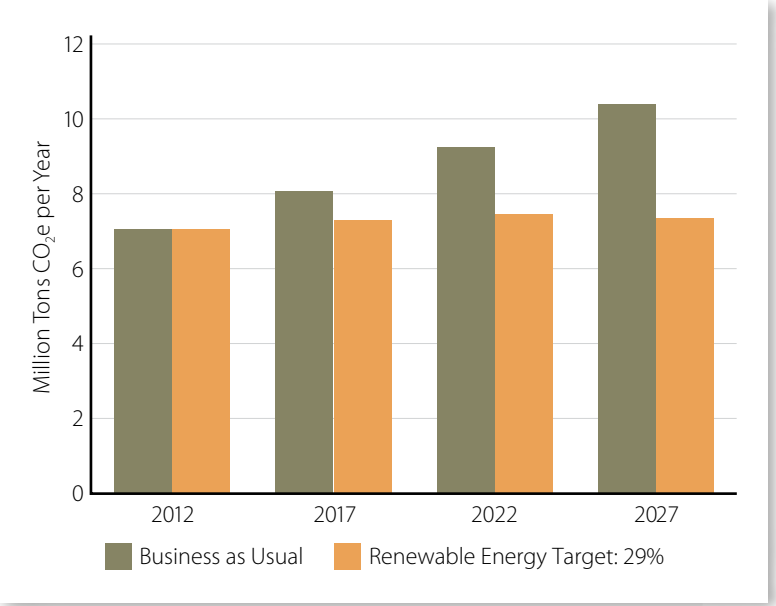
Suriname Electricity Sector Emissions



Trinidad and Tobago Electricity System Forecast, 1993–2030



Trinidad and Tobago Electricity Sector Emissions



Annex B

Priority Initiatives, Policies, Projects, and Activities (PIPPAs) for CARICOM

Priority Initiatives, Policies, Projects, and Activities (PIPPAs) for CARICOM		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Regional/National/Both
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, buildings, 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	Communicate key findings regarding grid and storage capabilities and introduce energy management systems	•	•	•	•	•									B
2	**Conduct and Communicate Electricity System Modeling**														
2.1	Facilitate country-specific LCOE+ modeling of all-inclusive electricity generation scenarios (including renewable energy, fossil fuels)	•													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 the national level	•	•												N
4	**Coordinate Information Gathering and Communication**														
4.1	Identify a set of key energy indicators	•													R
4.2	In cooperation with existing initiatives (CEIS, CIPORE, OLADE), fill identified gaps in energy system data	•	•	•											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
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
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 in cooperation with CDB and national development banks	•													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
9.4	Identify and communicate sources of funding for regional research, development, and innovation (RDI) in sustainable energy	•	•												B
10	**Utilize Government Resources to Promote Renewable Energy**														
10.1	Identify and implement high-impact opportunities for public procurement for renewable power generation and energy efficiency	•													N
10.2	Identify and implement high-impact opportunities for public procurement for sustainable transport options	•	•	•	•	•	•	•							N
10.3	Establish publicly backed demonstration projects	•	•	•	•	•	•	•							N
10.4	Support the development of public-private partnerships	•	•	•	•	•	•	•	•	•	•	•	•	•	B
11	**De-Monopolize Grid Access and Encourage IPP Generation**														
11.1	Facilitate dialogue among key stakeholders (e.g., policymakers, utilities, end-users) to identify action plan for enacting reform	•													R

11.2	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
12	**Set Regional Standards**														
12.1	Identify priority areas where regional standards can be set (e.g., building codes, technology standards, fuel efficiency standards, R&D, etc.)	•													R
12.2	Design and enact regional standards in collaboration with member states	•													R
12.3	Ensure that domestic policy reflects and enforces regional standards	•	•												N
13	**Incentivize Renewable Generation Through Regulatory Reform**														
13.1	Develop template for member states to systematically identify the most effective policy mix	•													R
13.2	Develop model legislation	•													R
13.3	Promote the adoption of net billing as agreed at COTED	•													R
13.4	Identify and implement renewable energy support policies. (Options for designing the appropriate policy mix include: establish a feed-in tariff, adopt a production tax credit, establish net metering/net billing, utilize auctions/tendering, develop dedicated rural electrification programs focused on renewable power)	•	•												N
13.5	Identify and implement policy mechanisms specifically targeting areas/ populations with limited access to electricity	•	•												N
14	**Support Energy Efficiency Through Targeted Legislation**														
14.1	Identify key sectors for efficiency improvements	•													R
14.2	Identify opportunities and strategies for demand-side management	•													B
14.3	Develop and enforce national building codes that promote energy efficiency	•	•												N
14.4	Mandate appliance labeling and efficiency standards	•													N
14.5	Offer fiscal incentives (e.g., rebates, tax exemptions) for energy audits and purchasing of energy-efficient products	•													N
15	**Implement Policies to Support the Growth of Renewable Energy in the Transportation Sector**														
15.1	Develop standards for inter-member state transport (e.g., shipping and air travel)	•													R
15.2	Conduct feasibility studies for alternative transportation systems	•													R
15.3	Coordinate the creation of a regional biofuel market	•	•												R
15.4	Establish support for public transportation	•	•												N
15.5	Create mandates and market incentives to promote fuel-efficient and alternative-fuel vehicles	•	•	•	•										N
16	**Ensure Policy Effectiveness**														
16.1	Identify key policy effectiveness indicators	•													R
16.2	Track, assess, and communicate effectiveness of policy framework across member states	•	•	•	•	•	•	•	•	•	•	•	•	•	R
16.3	Track effectiveness of domestic policy implementation	•	•	•	•	•	•	•	•	•	•	•	•	•	N
16.4	Ensure consistent policy implementation	•	•	•	•	•	•	•	•	•	•	•	•	•	N

17	**Coordinate International Initiatives in the Region**															
17.1	Compile past and ongoing international studies and projects across member states	•														R
17.2	Identify areas of duplicated effort and critical gaps	•														R
17.3	Work with outside actors (GIZ/CREDP, REETA, IRENA, etc.) to ensure that key needs are being met within the region	•	•	•	•	•	•	•	•	•	•	•	•	•		R
18	**Build Capacities with Key Supporting Stakeholders**															
18.1	Assess current human, institutional, and education/training/research capacity within CARICOM to identify key gaps	•														R
18.2	Create shared database of existing regional training materials, available training tools and curricula, education programs, etc.	•														R
18.3	Encourage development of regional professional networks, including a database of trained renewable energy and energy efficiency professionals	•														R
18.4	Facilitate training and education programs for key stakeholder groups, including: policymakers, financial institutions, job force, private sector	•	•													R
18.5	Establish renewable energy and energy efficiency technology centers throughout CARICOM (locations based on national resource potential and technological experience)	•	•	•	•											B
19	**Improve Institutional Effectiveness**															
19.1	Develop guiding framework for appropriate energy institution structure and operation	•														R
19.2	Assess effectiveness of existing energy institutions	•														N
19.3	Improve structure and operation of existing energy institutions based on regional recommendations and national assessments	•	•	•	•											N
20	**Support and Manage Regional Electricity Interconnection and Storage Options**															
20.1	Conduct feasibility studies examining interconnection scenarios	•	•													R
20.2	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
21	**Mainstream Renewable Energy**															
21.1	Integrate renewable energy and energy efficiency across government planning processes	•														N
21.2	Ensure the participation and coordination of all government branches and departments	•														N
21.3	Establish an effective platform for inter-ministerial dialogue	•														N
22	**Simplify Regulatory Compliance**															
22.1	Survey regional project developers to identify onerous regulatory barriers	•														R
22.2	Assess efficiency of existing regulations	•														N
22.3	Enact regulatory reform that prioritizes efficiency and simplicity (e.g., establish a one-stop shop for renewable energy project development)	•	•	•	•											N
22.4	Communicate regulations to project developers and stakeholders	•	•	•	•											N

23	**Maximize Societal Benefits of Sustainable Energy**																
23.1	Identify opportunities for mutually beneficial partnerships between cultural industries and the renewable energy sector	•															B
23.2	Develop programs to ensure that women benefit from sustainable energy and can participate fully in the energy transition	•															B
24	**Promote Capacity in Research, Development, and Innovation (RDI)**																
24.1	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
24.2	Develop R&D training programs in collaboration with regional STI associations	•	•														R