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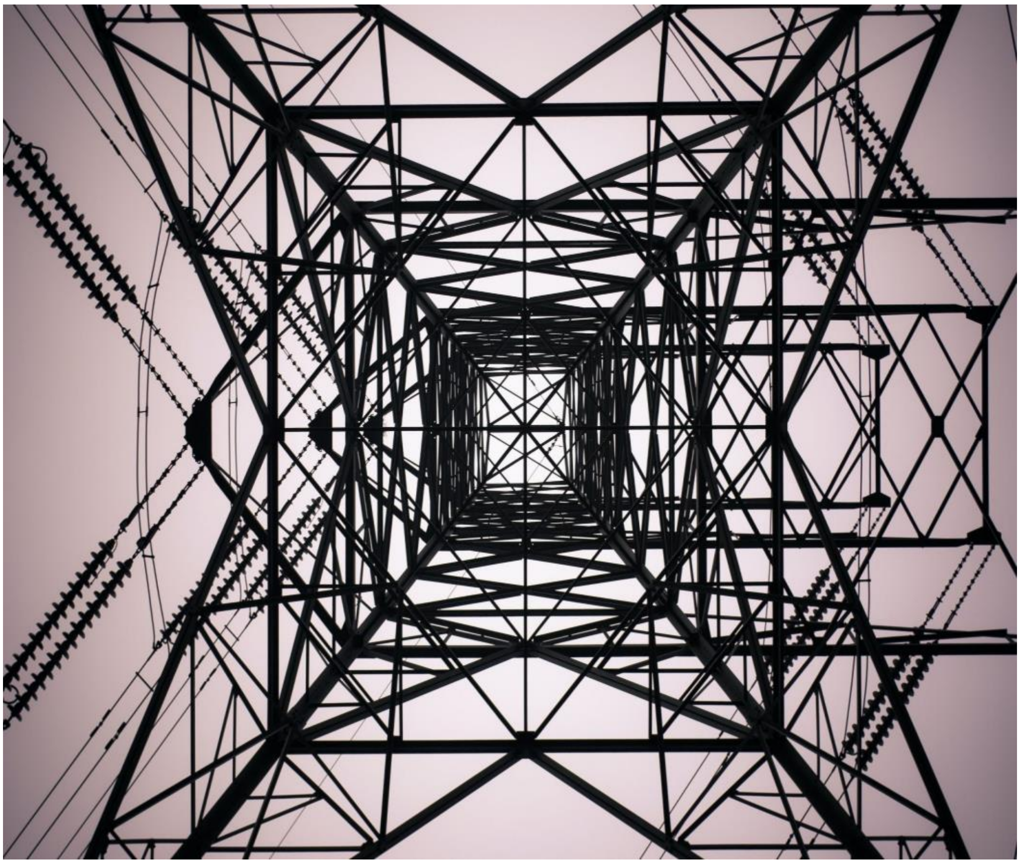
Final Research Report

The role of IPP in Power Generation in the Caribbean –
Government Policy, Incentives, Current and Future Regulatory Environment



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Abbreviations

AC	Alternating Current
APUA	Antigua Public Utilities Authority
BC&P	Barbados Light & Power Company Limited
BEC	Bahamas Electricity Corporation
BOT	British Overseas Territory
CARILEC	Caribbean Electric Utility Services Corporation
CARICOM	Caribbean Community
CO_2	Carbon dioxide
COM	Collectively Overseas
CSP	Content Security Policy
DC	Direct Current
DOMLEC	Dominica Electricity Services Limited
DSIRE	Database for State Incentives for Renewable and Efficiency
EE	Energy Efficiency
EIA	Environmental Effect Assessment
EOA	Electricity of Haiti
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EV	Electric Vehicle
FE	Fixed Effects
FiTs	Feed in Tariffs
GBPC	Grand Bahama Power Business
GDP	Gross Domestic Product
GRENLEC	Grenada Electricity Services Limited
GW	Gigawatt
ICT	Information and Communications Technology
IDB	Inter-American Development Bank
IRENA	International Renewable Energy Agency
IPP	Independent Power Producer
kW	Kilowatt
kWh	Kilowatt-hour
LCA	Life Cycle Analysis
LCOE	Leveled Cost of Energy
LUCLEC	St. Lucia Electricity Services Limited
MDPI	Multidisciplinary Digital Publishing Institute
MW	Mega Watt
NEVLEC	Nevis Electricity Services Limited
NREL	National Renewable Energy Laboratory
O&M	Operation & Management
OUR	Office of Utilities Regulations
PCE	Power Conversion Efficiency
PCSE	Panel Corrected Standard Error
PV	Photovoltaic
RE	Renewable Energy
REEEP	Renewable Energy and Energy Efficiency Partnership
RE-PPA	Renewable Purchase Agreement
ROM	Region Overseas
RPT	Revenue per Transactions
SKELEC	St. Kitts Electricity Services Limited
STEM	Science, Technology, Engineering and Mathematics
T&TEC	Trinidad & Tobago Energy Company
UIPP	Unsolicited Independent Power Producer
UOT	Unincorporated Organized Territory
US	United States
VINLEC	St. Vincent Electricity Services Limited
W	Watt
WEB	Water en Energie Bedrijf Aruba

Keywords

- IPP – Power Generation - Caribbean – Renewable Policies
- Smart Grid – Regulatory Environment – Energy Roadmap – Study Area – Government – Utilities – Climate Change

Abstract

This research paper includes a gap analysis of the role of Independent Power producers (IPP) in power generation in the Caribbean region, as well as policy framework, incentives, and regulatory environment potential. The obstacles faced by the increasing adoption of renewable technologies, as well as the exercises used to help traditional power systems migrate to the smart grid. By looking at how power generation and demand have changed on the islands. This research examines ethical dilemmas in regional and local contexts. The available technologies, as well as economic strategies for the independent power producer in the Caribbean, are discussed.

This investigation focuses on qualitative suggestions rather than quantifying and comparing the effects of policy initiatives in the Caribbean. This report employs an econometric analysis that determines the effectiveness of the following five policy interventions promoting the deployment of: Investment incentives; Tax incentives; Consumer regulated tariffs; Renewable policy Framework; and, Regulatory restructuring to allow market entry by independent power producers. Finally, the systematic databases of policies implemented in 30 Caribbean islands from 2002 to 2021 are compiled in this research.

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1. Introduction

Independent Power Producers (IPPs) or non-utility generators (NUGs) are private companies that own and/or run energy-generating facilities and then sell the electricity to a utility, a central government buyer, or end customers. Private facilities, cooperatives, and non-energy industrial businesses that can pump excess energy into the system are examples of IPPs. Investing in generation technologies, IPPs recoup their investment through power sales. Revenue can be extremely beneficial to a country's energy economy particularly when the public sector does not have the required financial capacity for investment and if proper tax incentives are involved.

The reliance on imported fossil fuels for power generation is a major issue for most Caribbean countries. Because power rates are tied to global petroleum markets and the majority of Caribbean nations are unable to rely on locally accessible fossil fuels, energy usage puts a burden on the balance of payments. Renewable energy adoption has been limited due to factors such as high initial prices, grid stability difficulties, and a lack of awareness of clean energy supplies. However, due to considerations of energy supply security, energy price stability, and climate change, interest in renewable energy has risen recently **[1].** The abundance of unexploited renewable resources across the Caribbean positions the region to become a leader in sustainable development. The primary focus in the Caribbean will be on improving solar photovoltaic and wind energy (Figure 1) penetration rates. In 2019, 56% of all newly commissioned utility-scale renewable power generation capacity provided electricity at a lower cost than the cheapest new fossil fuel-fired option. Battery storage is becoming a more realistic option for storing energy, with utilities using load-shifting technologies to "transfer" energy from times when the sun and wind are abundant to times when they are not **[2].**

This policy vision aims primarily to encourage the development of the role of IPPs, especially in the Caribbean communities, and secondarily on their participation in the expansion of inexpensive electrical supply choices now and in the future, while maintaining the integrity of the existing electrical infrastructure. Despite significant regional success, more work remains to be done at the policy level to solve the specific concerns of "grid access" and "power purchase agreements" that are required to spur the growth of utility-scale renewable energy power plants. Although these countries are sometimes thrown together in global policy circles, future energy realities may be vastly different. In this case, there is no such thing as a one-size-fits-all solution. It is vital to remember the unique characteristics of these islands while establishing successful policies **[3].**

Figure 1: Aruba Windfarm Vader Piet, Source: Aruba Exclusive Magazine

Problem statement and the study rationale

The role of IPP in Power Generation in the Caribbean, Government Policy framework, Incentives, Current and Future Regulatory Environment.

1.1 Target Research Questions, This IPP Power Generation, Policy, Incentives, and regulatory environment vision includes consideration of the following:

1. Which power generating idea may be used in the Caribbean in order to incorporate IPP power generation?
2. What are the strategic objectives of the Caribbean Islands' economic reality sectors?
3. How can public utilities and independent power producers (IPPs) work together to build new renewable energy supply projects that best serve the long-term interests of Caribbean customers?
4. What is included in an IPP renewable energy purchase agreement?
5. What regulatory settings can help the Caribbean Islands make the transition to renewable energy production?
6. What incentives can the government provide to encourage actions that fall inside the scope of the SDGs?
7. What are the most energy-efficient strategies for creating renewable energy on Caribbean islands?
8. How can the Caribbean implement Smart-grids with IPPs and the National Utilities within the Caribbean?
9. How do energy pricing and subsidies affect the economy?
10. How are renewable energy markets doing now and in the future (Figure 2)?
11. What are the best practices for IPP projects and the regulatory framework that underpins them?
12. What are the correct assessment criteria for granting cost-effective development power projects?
13. What can be done to make the competitive bid process easier?

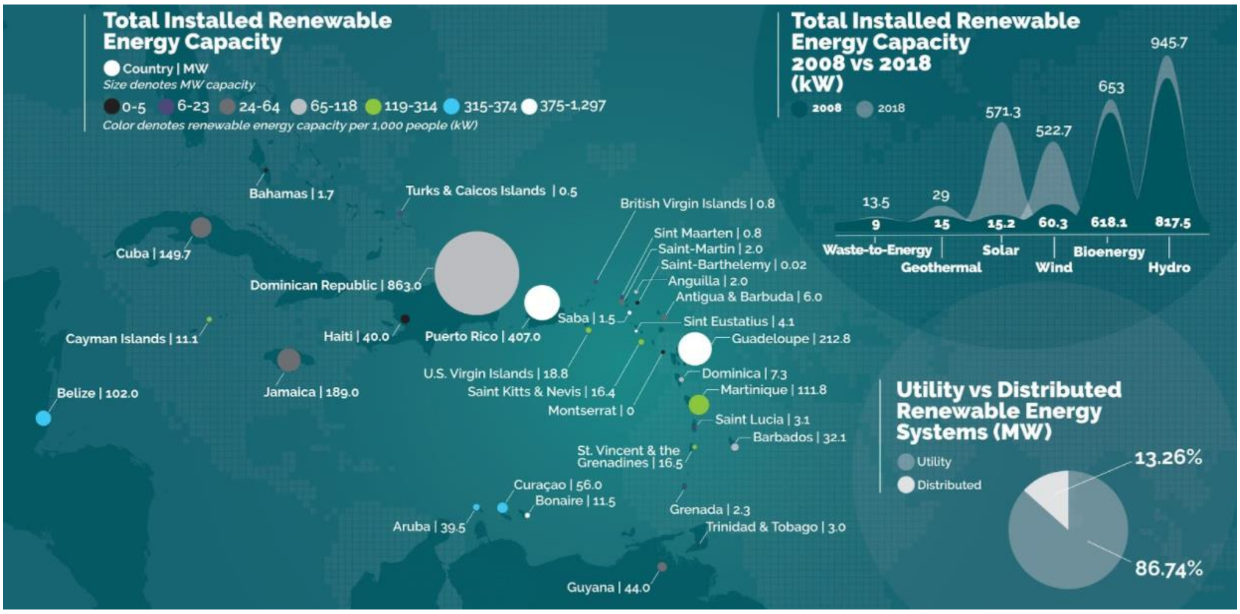


Figure 2: Total installed Renewable capacity, source: Newen Energy Events

1.2 Literature review

Context

In several of the Caribbean's established market economies, IPPs have been a key source of additional power production capacity. Many Caribbean islands have resorted to private investors to improve power supply because they are facing major capacity and energy constraints that cannot be addressed with public resources. In particular, by mobilizing direct foreign investment in the electricity sector, a shift toward the usage of IPPs has filled a substantial and urgent financial shortfall in emerging member nations. International capital markets have provided new sources of funding for IPPs in emerging nations. IPP projects that are well structured can also help to strengthen local capital markets and bring capital market discipline to effect on the power sector's competitiveness. Private sector engagement in the power industry has also resulted in significant improvements in construction and operating efficiency, and reforming initiatives targeting the power sector's structure and ownership have frequently preceded it. IPPs are not the sole way to meet the Caribbean Islands' power sector development needs, but they may certainly help provide an enticing option for funding future power infrastructure investments. As of yet, the vast majority of IPPs have been built in the absence of predictable and transparent regulatory systems attracting a small amount of capital to the industry. Member economies must accept that further growth toward competitive markets will take time in order to encourage investment in the industry.

The role of IPP

IPPs in developing economies have tapped new forms of financing in international capital markets. Properly structured IPP projects can also stimulate the development of local capital markets and bring the discipline of the capital market to support competition in the power sector. Private sector involvement in the power sector has also led to impressive construction and operational efficiency gains, and reform programs addressing the structure and ownership of the power sector have often preceded it. IPPs are not the only answer to power sector development needs in CARICOM member economies but handled correctly, they can undoubtedly make a major contribution and are an attractive option for financing future investments in power infrastructure. To date, a majority of IPPs have been developed in the absence of predictable and transparent regulatory mechanisms, an approach that has attracted a limited volume of capital to the sector. "To increase investment in the sector, member economies will need to recognize that further development towards competitive markets will take place over time" **[33].**

A policy analysis for the major obstacles and regulation

Research published in Caribbean Community Energy Policy indicates that Petroleum currently accounts for 80% of primary energy supply and is expected to remain the dominant fuel in the primary energy mix until 2035. However, its share is expected to diminish because of increased utilization of renewable energy sources, declining reserves, increased oil prices and fuel efficiency measures. Demand for coal rises until 2020 and then declines towards 2035. Furthermore, the study found that Natural Gas would be central to meeting the world's energy needs for at least the next two and a half decades. Global natural gas demand fell in 2009 due to the financial and economic crisis, but increases of 44% or averages of 1.4% per year is projected between 2008 and 2035. CARICOM found that Renewable energy based power generation is projected to triple between 2008 and 2035 and the share of renewable in global electricity generation will increase from 19% in 2008 to almost 33% by 2035. Wind and hydropower account for the largest increase, with the latter remaining dominant. Electricity produced from solar photovoltaics will increase rapidly but its share will reach only 2% in 2035. Since investments in renewable technologies are more capital intensive than those using fossil fuels, significant capital is required to produce the extra renewable energy capacity. While CARICOM States presently have no legal obligation to reduce their greenhouse gas emissions there is the need for these States to show leadership in tackling the issues associated with climate change. Accordingly, deployment of renewable energy resources, improved efficiency in the use of energy, and energy conservation, are increasingly high on the national development agenda of CARICOM States **[34].**

The most important reason behind the slow implementation of renewable energy projects in the Caribbean islands is the lack of a regulatory framework for private investors and independent power producers, such as the lack of adequate electricity supply. “This deficiency is worsened by the insurmountable gap between over-ambitious political goals for expansion and the actual transfer into real legal and regulatory frameworks” **[25].** Furthermore, energy-pricing policies, in particular, have been adopted as instruments to pursue economic, social, and, in some cases, even environmental objectives. Common pricing policies include lowering prices through direct subsidies, increasing prices through taxation, granting tax exemptions, transferring funds to beneficiaries directly, assuming part of the risk of either the consumer or producer of energy, and imposing entry barriers on energy markets. Previous studies provided estimates of the fiscal costs of energy subsidies and, for some countries, estimated the distributional impacts by analyzing household consumption patterns **[32].**

Resilience in the Caribbean

The resilience process is designed to assist decision making by assessing the potential risk of conducting business with a particular party. The purpose of the risk assessment process is to make an objective assessment of the likelihood of the developer and associated parties being a reasonable party for the regulatory agency to deal with from an ethical, legal, financial and technical perspective. The resilience process mainly focuses on the integrity, reputational and operational aspects of contracting with an IPP developer. The result of the process will be a view by regulatory agency of the risk it faces in entering into further discussions with the developer. If, in an agency’s view, the risk of involvement with the developer is high then the regulatory agency may decline to continue discussions. “Alternatively, the regulatory agency may determine that the developer represents an acceptable risk but may require further assurance or checks before it ultimately considers contracting with the developer” **[26].**

As opposed to other types of infrastructure like bridges, sea defenses, roads etc., there is a much larger emphasis on operational resilience, in power generation and distribution, which goes beyond the mere hardening of the infrastructure. Progress in some aspects of resilience building would need to be incremental as new capacity comes on stream to effect a shift to more resilient energy sources. With a significant amount of assets for power generation and distribution, the energy sector is extremely vulnerable to hurricanes and flooding that results in landslides. The distribution system consisting of poles, miles of electrical cabling, transformers, and other assets are usually the first to sustain damage during hurricanes. Electricity generation plants and other assets are also vulnerable to such events. As countries move to adopt renewable sources of energy, the power generation infrastructure is exposed to even greater vulnerability. In addition, the end-user interface is also important because even if the energy companies do a good job in ensuring the energy infrastructure remains usable after a disaster, consumers still need to be able to accept power. It is therefore critical that resilience framework addresses all aspects of the energy infrastructure **[3].**

Transition to smart grid

The evolutionary drivers, motivations and path followed by each region and country towards the implementation of smart grids is unique and must be respected. Each local situation is different in terms of energy mix, environment, legislation, regulation, market, customer response etc. The starting point in view of the evolution is also very scattered and will have a strong influence on the smart grids target reachable in a sound cost-benefits balance. As better discussed each country and region must formulate its own ideal technology mix, which best suits the development drivers and targets foreseen. Also in the Caribbean regions, a very wide range of energy mix situations and market environments have been detected and a single common motivation for the evolution towards smart grids could not be found in the course of the study, apart from a main unifying idea: the urgent necessity to reduce system losses and increase the electricity system efficiency. Each Caribbean country shall therefore find its own ideal balance of technologies and develop its own smart grids roadmap, possibly following the general indications and the Decalogue proposed in the study. The electricity system integrating the smart grids technologies and functionalities is constituted by an additional information layer applied on top of the power system and by additional power equipment. The information layer enables the implementation of system automation and protection features enhancing the capacity to integrate large shares of variable renewable energy sources on the generation side and allowing the implementation of load flexibility measures such as the demand response on the user side **[15].**

The smart grid can be thought of as the outcome of the evolutionary development of existing networks towards an optimized and sustainable energy system **[16].** The International Energy Agency (IEA) defines a smart grid as an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity demands of end-users. Smart grids coordinate the needs and capabilities of all generators, grid operators, end-users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimizing costs and environmental impacts while maximizing system reliability, resilience and stability. This will facilitate the distributed generation and co-generation of energy and allow for the integration of alternative energy sources and the management of a system’s carbon footprint. It will also enable utilities to make more efficient use of their existing assets through demand response, peak shaving and service quality control **[16].**

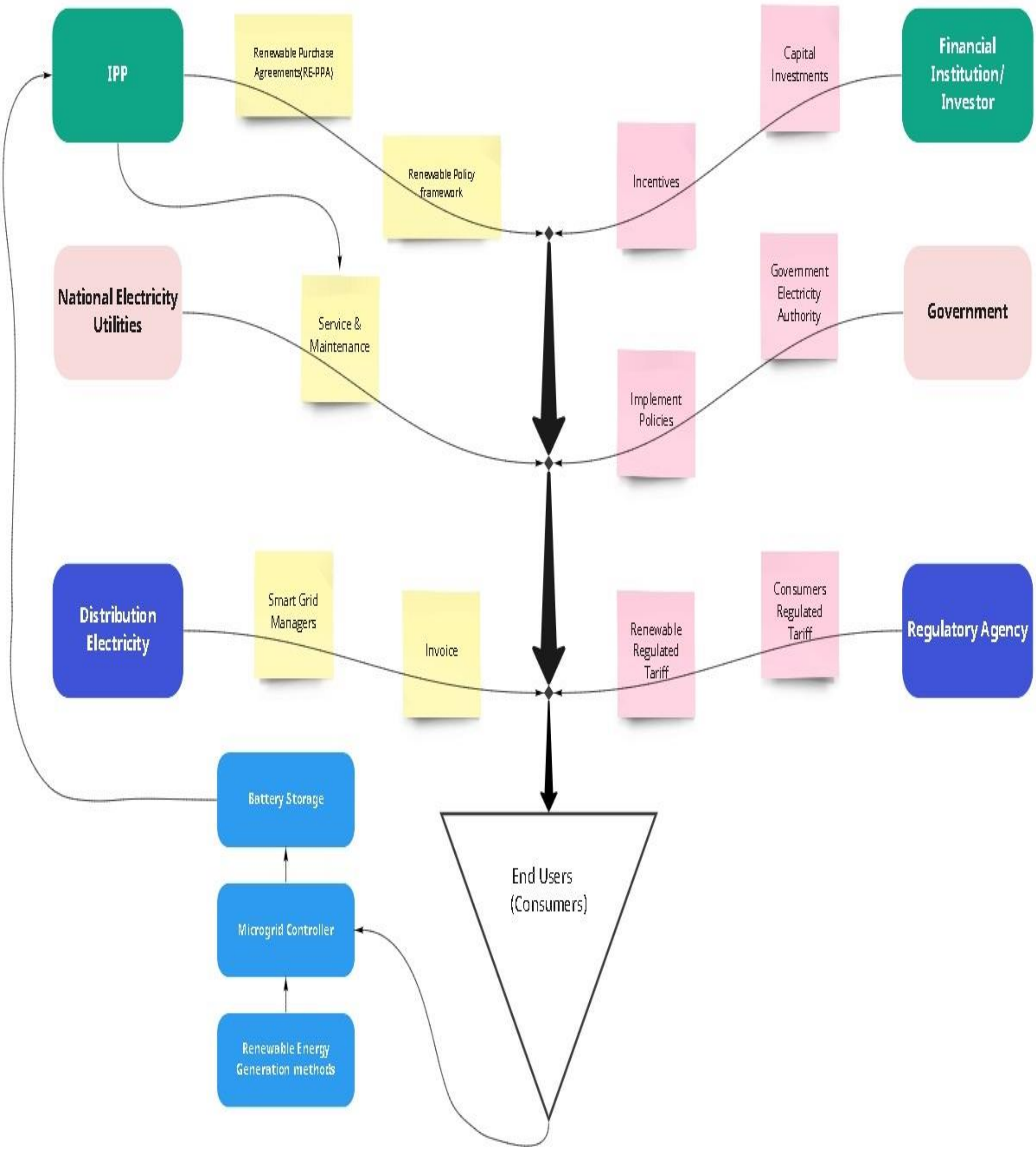
“A state of the art high capacity transmission line can conduct as much electricity as six standard lines, at one-third the cost, using 25% less land, and with one- tenth the line losses. Smart grid enabled distribution could reduce electrical energy consumption by 5-10%, carbon dioxide emissions by 13-25% and the cost of power related disturbances to business by 87%” **[1].** The global market for smart grid IT and management services will grow from $1.7 billion in 2014 to more than $11.1 billion in 2023. Services include home energy management, advanced metering infrastructure, distribution and substation automation communications, asset management and condition monitoring, demand response, software solutions, and analytics **[1].** Policies can influence not only the pace of rural electrification, but also the level of access, public spending, and, to some extent, customer satisfaction. All these aspects are related, such that improvements in one may come at the expense of another. For instance, a policy focus on solar DC mini-grids will result in fast- paced electrification with low government spending, but a relatively low level of electricity service. In contrast, a policy focus on micro-hydro would yield a higher level of service, but at a slower pace. The right policy mix can optimize development of the mini-grid sector, but an understanding of how policies affect different technology-tier combinations is essential. The Sustainable Development Goals (SDGs) propose to achieve universal access to electricity by 2030. To reach this goal, efforts will need to be redoubled; the traditional approach of extending the grid will not be enough. With demand outpacing capacity in most urban and semi- urban areas, extending the electrical grid to rural areas remains economically, technically or physically infeasible for most utilities. As a result, rural electrification is proceeding too slowly to address the deficit. In Sub- Saharan Africa, for example, the average electrification rate is around 17%; rapid population growth outpaces efforts to provide electricity **[19].**

The Renewable Energy Regulated Purchase Tariff for IPP in Power generation

According to The guaranteed Regulated Purchase Tariff’s value payments ($/kWh) for the renewable electricity delivered in grids can make renewable energy technologies economically attractive for local governments, smart-grid operators, and IPP investors. The implementation of the financial model in Developing Countries would increment predictability and consistency in electricity markets, dropping the financial risk in the capital investment for renewable energy technologies. The success of the implementation of RETs by RPT mechanism will require the umbrella of a strong policy support and a specific regulatory framework. Such frameworks are essential to support the proper economic and political climate for public and private investments in RETs under the RPT mechanism, helping to overcome the main barriers to its development and to extend modern energy services to populations currently without access **[8].** The central and local governments (or local regulatory agencies) should be involved from the beginning and demonstrate commitment to decentralized rural electrification by supporting the guaranteed RPT values **[18]** and act as a link between all actors involved. When rural electrification is under a regulated approach, the local government offers a regulated energy service concession in which a private-sector firm is competitively selected to provide off-grid electrification exclusively to designated rural areas **[28].** With the energy concession, the government selects one company exclusively to serve a specific geographic region, with the obligation to serve all potential electricity users. The government also provides subsidies and regulates the fees and operations of the concession.

1.3 Methodology

This research gathers data and conceptual modeling. The first step toward IPP power providers playing a "zero-constraint" role is to identify and classify constraints using a systematic manner by figuring out what the different methods of applying energy and the framework per country are. The second part of this research investigates the many forms of policy restrictions, incentives, and regulatory environments, as well as their features. Based on this knowledge, a classification system for categorizing constraint components was created for the purposes of identifying using the constraint detection model (see IPP framework 1). In the result stage of this study, constraint-modeling methods are identified based on a comprehensive review of current industry practices and academic research. The last segment of the results section features an interview with two Aruba-based experts.



Framework 1: IPP constraint framework for regulatory environment

2. Data

This data section outlines notable advancements in utility and distribution scale technologies achieved by both public utility corporations and independent power providers in the Caribbean. The present state of utility ownership, renewable energy production technologies, and the history of regulatory framework and their relations with utilities are all used to construct a picture of energy landscape trends on the islands. In terms of privatization, regulatory control, and government engagement, the island state power sectors differ substantially in form and operation. The establishment of a regional policy framework that is sensitive to these variations is critical. The Caribbean islands shown in this section were chosen for this research because they are among the region’s most forward thinking in terms of renewable energy production. They produce a range of sizes, levels of industrialization, economic complexity, energy consumption, government engagement, and utility collaboration.

2.1 Renewable Energy Technologies

The term "renewable energy source" refers to energy that is both sustainable and infinite, such as the sun. When the word "alternative energy" is used, it typically refers to renewable energy sources as well. It refers to energy sources that are not as harmful to the environment as the most often used non-sustainable ones, such as coal. Renewable energy has the potential to help the Caribbean achieve energy security while also lowering greenhouse gas emissions. Renewable energy can assist reduce energy imports and fossil fuel consumption, which is the major source of carbon dioxide emissions in the Caribbean. This section will go through the most common sources, which are reasonable for development on the Caribbean Islands with the current regulatory framework.

2.1.1 Onshore & Offshore wind turbines

Over the last decade, onshore wind turbine technology has advanced significantly. Increased capacity factors have been achieved by combining larger and more dependable turbines with higher hub heights and larger rotor diameters. In addition to these technological advancements, economies of scale, enhanced competition, and industry maturity have resulted in lower total installed costs, operating expenses, and maintenance. Onshore wind was only second to solar PV in terms of deployment in 2019. Improvements in turbine technology: As turbine, sizes and swept areas have grown in the Caribbean, the process of optimizing the rotor diameter and turbine ratings, or specific power, has resulted in greater energy production and consequently project viability for the asset owner, depending on site factors. Furthermore, with enhanced wind resource characterization and project design tools, improving the site configuration to better harness wind resources and decrease output losses due to turbulence has become more common. As a result, energy yields have grown, O&M expenses per unit of capacity have decreased, and LCOEs have decreased **[4].** Manufacturing, installation, and O&M expenses are all impacted. The combination of digital technologies and autonomous inspections has resulted in improved data analytics. Improvements in the reliability and durability of new turbines have been added to this, while larger turbines have reduced the number of turbines required.

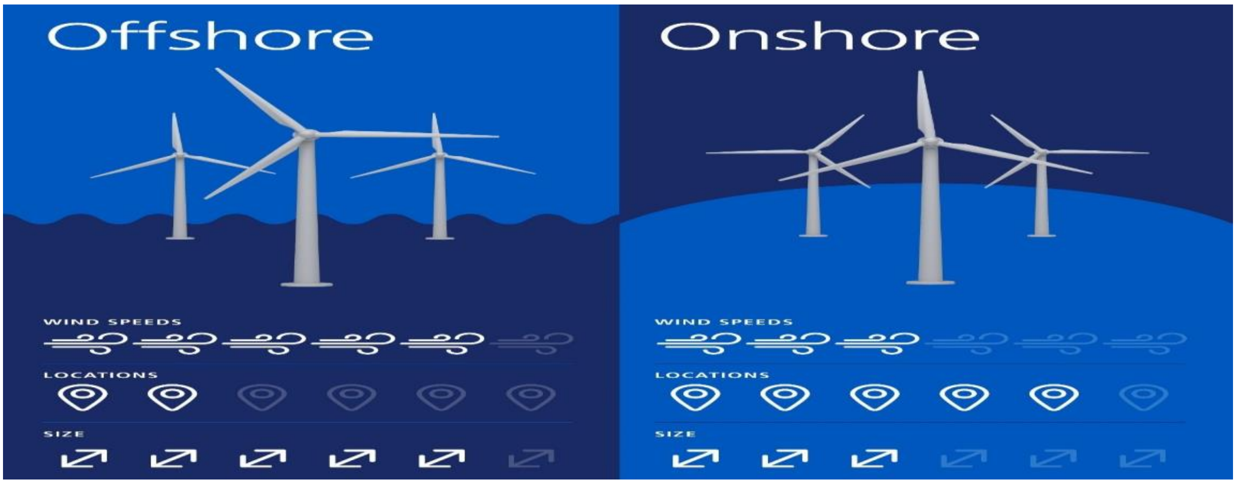


Figure 3: Offshore vs Onshore Wind Farms, Source: edffenergy.com

In comparison to onshore wind projects (Figure 3), offshore wind farms must deal with installation, operation, and maintenance in severe maritime conditions. Costs tend to rise as a result, and offshore wind projects have far longer lead periods. Offshore wind farm design and project development are more complicated, and construction is even more so, with the latter, in particular, raising total installed costs. They also have greater grid connection and building expenses due to their offshore location. Installed costs for offshore wind projects peaked around 2012-13, as projects were located farther from shore, in deeper waters, and used technology that is more advanced. Cost savings have been achieved because of the recent rise in deployments. Technology advancements, economies of scale, and more developer and turbine manufacturer experience have all contributed to this. A trend toward greater capacity turbines with higher hub heights and longer, more efficient, and durable blades has emerged, in addition to offshore wind farm projects being positioned farther out from ports and anchored in deeper seas. This can make it relative easy for the Caribbean islands to invest in offshore wind farms due to the availability of offshore capacity around the islands **[4].**

2.1.2 Solar Photovoltaics & Concentrating Solar Power

Figure 4: Aruba Airport Solar park, Source: greenAruba

For the solar photovoltaic, multiple parts functioning at the same time contribute to the formation of the global weighted-average capacity factor. The change in deployment to places with greater irradiation, the growing usage of tracking devices in the utility-scale segment in big markets, and a variety of other variables have all contributed to higher capacity factors in recent years. The data available demonstrates the rising usage of trackers and their components. The extraordinary reduction in the cost of energy from solar PV and the enhancement of its economic viability has been aided by the quick decline in total installed costs, improving capacity factors, and reducing expenses. Solar parks may be used for a variety of reasons, including as providing power to buildings while also protecting autos on parking lots (Figure 4).

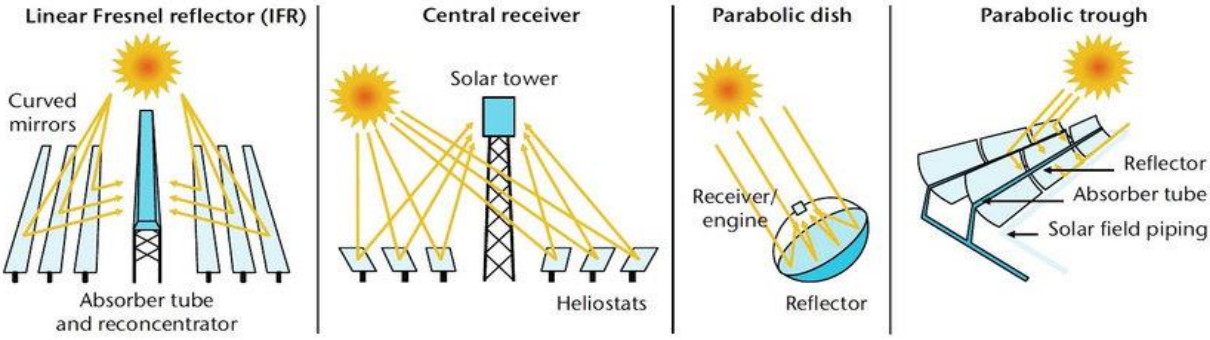


Figure 5: CSP systems, Source: csptechnologies

CSP (concentrated solar power, Figure 5) systems generate heat by focusing the sun's beams using mirrors. The heat generated by the sun's energy is transmitted to a heat transfer fluid in most modern systems. After that, electricity is created via a steam cycle, which uses the heat transfer fluid to make steam and generate electricity in the same way as traditional thermal power plants do. To decouple generation from the sun, CSP facilities now commonly integrate low-cost thermal storage technologies. A two-tank molten salt storage system is the most popular, however designs vary. Single-axis tracking systems have long been used to increase energy absorption throughout the day and ensure that the heat transfer fluid (often-thermal oil) reaches the highest temperature possible given the intensity of solar irradiation and the technical characteristics of the concentrators and heat transfer fluid. These transmit heat to superheated steam, which powers a turbine to create electricity, using a heat exchange system. In comparison to solar PV and onshore wind, CSP facilities have higher all-in O&M costs, which include insurance and other asset management costs. “With a few exceptions, the usual range of O&M expenses for CSP facilities in operation today is USD 0.02/kWh to USD 0.04/kWh” **[5].**

2.1.3 Hydropower

In some Caribbean islands where elevation is present, hydropower is applicable (Figure 6). Hydropower is a low-cost source of electricity that also gives flexibility if the project contains reservoir storage. This allows the facility to provide services like frequency responsiveness, black start capability, and spinning reserves, among others. This improves plant viability by expanding asset owner income streams. Hydropower may store electricity for weeks, months, seasons, or even years, depending on the size of the reservoir, in addition to providing grid flexibility. Hydropower projects, on the other hand, integrate energy and water supply services. Irrigation projects, municipal water supply, drought management, navigation and recreation, and flood control are examples of these, all of which assist the local economy. Indeed, in certain circumstances, hydropower is produced to meet an existing requirement for river flow management, and hydropower may be included into the design. Hydropower is a capital-intensive technique that frequently necessitates extensive lead periods, especially for large-scale projects. Development, permits, site development, building, and commissioning are all part of the lead-time. Hydropower projects are massive, complicated civil engineering projects, requiring lengthy site surveys, inflow data collecting (if not already available), environmental evaluations, and permitting, all of which take time and frequently require additional work before site access and preparation can begin **[6].**

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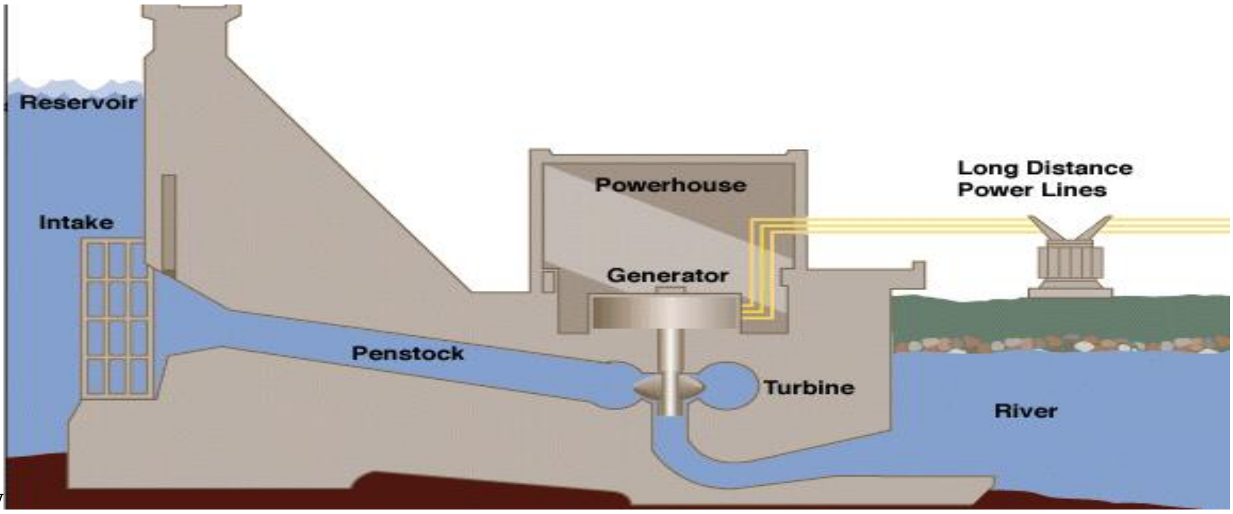

Figure 6: Hydroelectric generation, Source: EIA

2.1.4 Geothermal

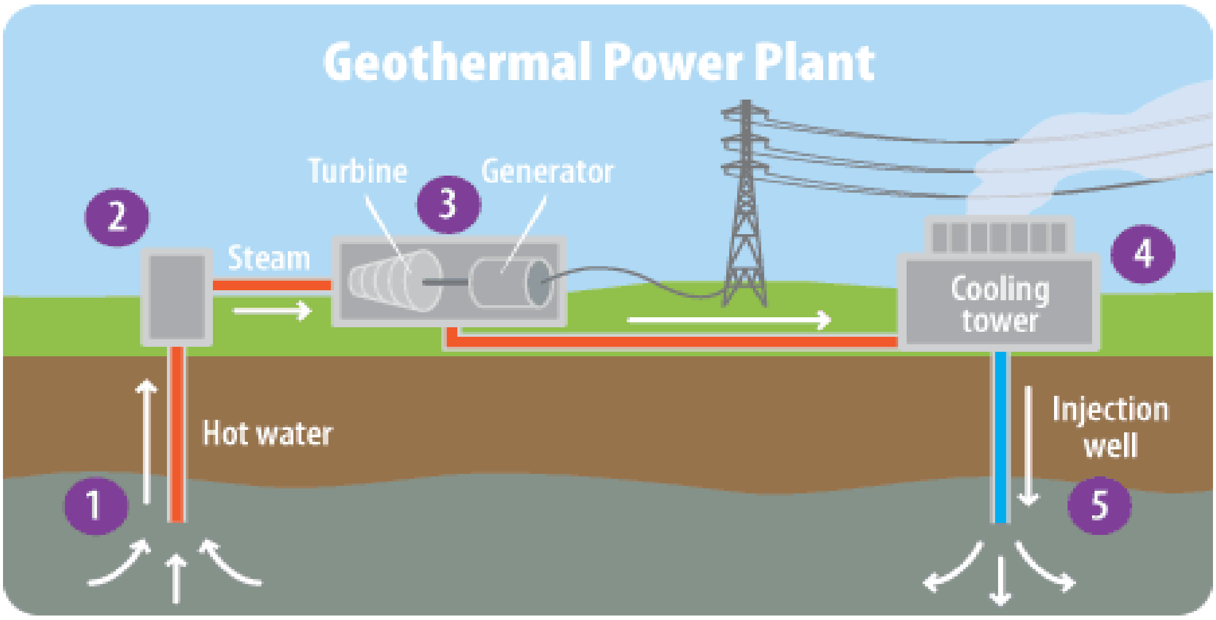

Figure 7: Geothermal Power plant, Source: US EPA

There are only some active geothermal locations in the Caribbean (for example: Dominica, Grenada, Montserrat, St. Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines and Guadeloupe) on or near the surface of the Earth's crust, as well as deeper depths, include geothermal resources. This naturally occurring steam or hot water may be utilized to create power in steam turbines by digging into the earth's surface. As a result, geothermal power generation (Figure 7) is fundamentally different from other renewable energy methods. Test wells will allow developers to generate models of the reservoir's extent and flows. Subsurface resource evaluations are costly to execute and must be validated by test wells. Much remains uncertain, however, regarding how the reservoir will operate and how best to manage it over the project operating life. Thermal energy is stored as heat in the rocks of the Earth's crust and interior, making geothermal resources possible. Fissures to deeper depths in places saturated with water will create hot water and/or steam, which can be accessed for comparatively low-cost energy generation.

The lack of adequate geothermal resource mapping is one of the most significant issues faced while establishing geothermal power producing plants. Where it is accessible, this lowers the risks that developers confront during the exploratory phase, potentially lowering development costs. This is because poorer-than-anticipated exploration results may necessitate further drilling or the deployment of wells across a considerably broader region in order to provide the expected energy. However, resource mapping is a costly and time-consuming procedure. The cost of installing a geothermal power plant is significantly dependent on the location. They have more in common with hydropower projects in this regard than with the more conventional solar PV and onshore wind installations. The quality of the reservoir, the kind of power plant, and the number of wells are all-important factors in geothermal plants **[7].**

2.1.5 Bioenergy

Bioenergy may be used to generate electricity from a number of feedstock's by using a variety of combustion processes. These range from well-established commercial cultivars with a lengthy record of accomplishment and a diverse selection of vendors to less well-established and novel technology. The latter includes methods such as atmospheric biomass gasification and pyrolysis, which are still in the early stages of research but are already being tested on a commercial scale. Direct combustion in stoker boilers; low-percentage co-firing; anaerobic digestion; municipal solid waste incineration; landfill gas; and combined heat and power are examples of mature technology. To evaluate the utilization of biomass power production, three primary variables must be considered: feedstock type and supply, conversion method, and power generation technology **[8].**

2.1.6 Tidal Waves

Ocean energy, like all other renewable energy sources, can help to ensure a more stable energy supply, but it is not ecologically benign. The production, operation, maintenance, and decommissioning of ocean energy devices have a variety of environmental consequences. Before ocean energy systems are deployed, governments and society require a thorough understanding of the environmental effects, as well as the ability to reduce or alter damage to acceptable levels. While Environmental Effect Assessments (EIA) are used to verify that actions have no negative environmental consequences, Life Cycle Assessments (LCA) are used to identify and quantify the environmental impact of industrial goods. The literature research shows that a small number of LCA on wave and tidal energy (Figure 8) converters have been performed. The focus was on devices at already more advanced stage of development (e.g. Pelamis, Oyster, Seagen, and Wave Dragon). So far, most of the studies addressed only energy and carbon as impact categories **[9].**

The complexity of the Caribbean tide is seen in Figure 8. Tidal wave energy may be examined in no fewer than seven unique zones of uniform tidal type (Buoys). The extreme eastern part of the sea and the western third both have mixed semidiurnal tides. Mixed diurnal tides exist in the Columbia Basin and along a curving strip of the Venezuelan coast until Antigua in the central part of the Caribbean strip. A large swath from Puerto Rico to Venezuela, where the tides are diurnal, separates these locations and the mean range is at its lowest. The many diverse zones of consistent tide type are most likely due to the complicated bathymetry, at least in part.

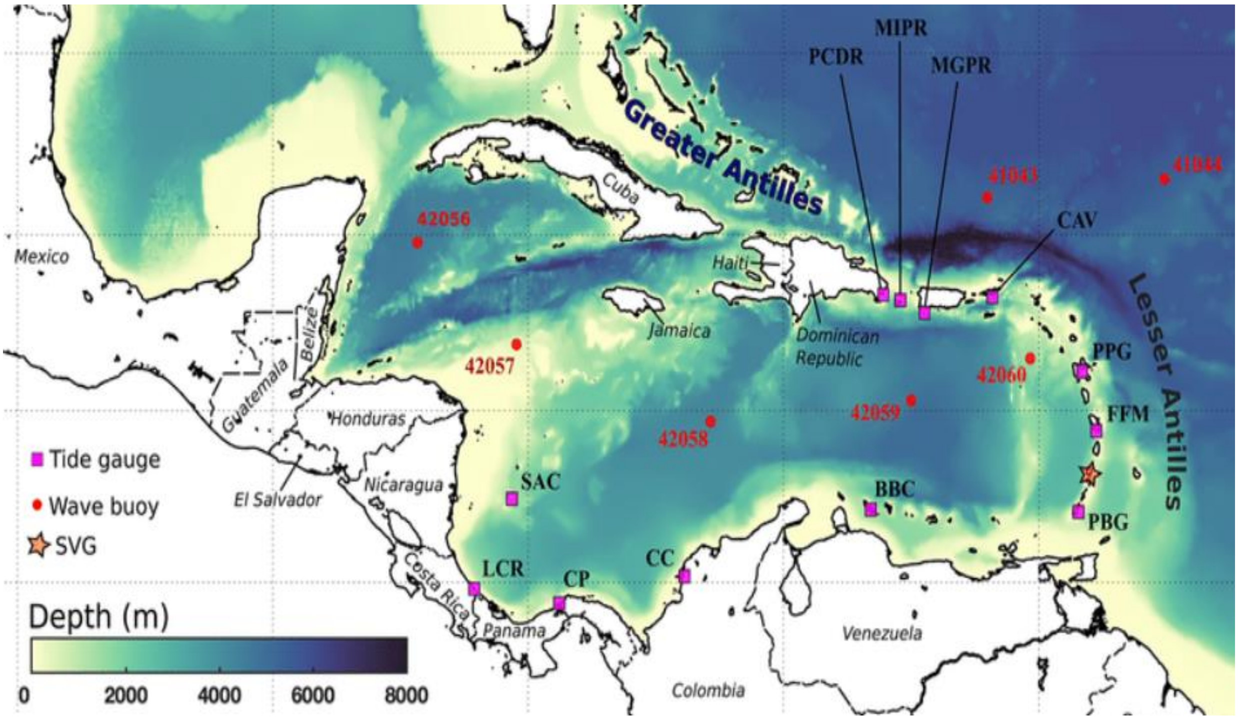

Figure 8: 12 Tide gauges and 7 Buoys in the Caribbean, Source: National Oceanography Centre

2.2 Legal Framework for some Caribbean islands

Aruba

The incumbent utility firm WEB & ELMAR, which has a monopoly on generating power until 2025 dominates the electricity generation industry. The government appears to be looking for ways to include renewable energy generation into the energy mix, which might pave the way for distributed IPPs to participate in electrical projects. WEB (Water en Energie Bedrijf) and ELMAR, a state-owned company, have an exclusive license to distribute power to Aruba's islands. Until 2025, the selected utilities have exclusive rights to generate, transmit, and distribute electricity. According to the legislative Act, only WEB and ELMAR can issue licenses to IPPs who seek to generate and sell power to the grid.

Dominican Republic

The Dominican Republic's power industry is liberalized, with excellent control and regulation. The regulatory authority establishes a policy and legislative framework that is clear and well-developed. Feed-in tariffs are in effect, and certified power generators benefit from fair pricing and long-term contracts.

“The World Bank ‘Doing Business’ 2013 report ranks the Dominican Republic 116th out of 185 countries assessed for their ease of doing business. The country was ranked 137th for starting a business, 108th for dealing with construction permits, 110th for registering property, 98th for paying taxes and 84th for enforcing contracts” **[10].**

Haiti

Haiti's electrical sector is restricted and un-transparent. For potential new entrants to the market, the lack of explicit feed-in legislation and publicly accessible industry information is a challenge. The Ministry of Public Works, Transport, and Telecommunications is in charge of Haiti's power industry. Electricity of Haiti (EdH), the country's principal utility business, owned by the Haitian government and responsible for electricity generation, transmission, and distribution, encounters little or no competition in the market. The corporation buys part of its electricity from independent power producers (IPPs), although the contractual agreements are opaque **[11].**

"According to the World Bank's 'Doing Business' 2013 report, Haiti is ranked 174th out of 185 countries for ease of doing business. Starting a business was ranked 183rd, dealing with building permits was 136th, registering property was 130th, paying taxes was 123rd, and enforcing contracts was 97th" **[10].**

Jamaica

In Jamaica, power generation is liberalized. Developers benefit from government grid, connection assistance as well as well-defined legislative and regulatory processes. Additionally, there are special assistance measures aimed towards waste-to-energy and renewable energy in general. Organic waste management and processing responsibilities are in place, and waste conversion to energy and organic fertilizer is already taking place on a modest scale. A one-stop shop' approach to project development and building authority approvals benefits potential project developers as well. The independent regulatory agency in charge of the electrical industry is the Office of Utilities Regulation (OUR). It was founded in 1995 and is responsible for processing all utility service license applications as well as making recommendations to the Minister of Science, Technology, Energy, and Mining on such applications.

"According to the World Bank's 'Doing Business' 2013 report, Jamaica is ranked 90th out of 185 countries for ease of doing business. The country was placed 21st in terms of beginning a business, 50th in terms of dealing with building permits, 105th in terms of registering property, 163rd in terms of paying taxes, and 129th in terms of enforcing contracts" **[10].**

Antigua & Barbuda

Antigua and Barbuda's main network utility business is the Antigua Public Utilities Authority (APUA), a state-owned institution formed under the Public Utilities Act of 1973. The Minister of Public Utilities supervises the authority, which has the only power to transmit and distribute energy throughout the country. Prior to the implementation of the Renewable Energy Act (2015), the government's position on small-scale distributed renewable power was clear; in December 2011, the APUA released its interconnection policy, which allowed distributed renewables to account for up to 15% of annual demand. Residential producers (up to 50 kW) and a small number of business producers (50 – 225 kW) were therefore allowed to connect to the grid via net metering. Antigua Power Company (APC), for example, is an IPP that has been supplying power to the APUA system under a PPA since 1996. The Act does speak to power purchase agreements and the ministers' role for determining contractual conditions.

"Antigua and Barbuda is ranked 63rd out of 185 countries in the World Bank's "Doing Business" report for ease of doing business. Starting a business was ranked 85th, dealing with building permits was 24th, registering property was 125th, paying taxes was 142nd, and enforcing contracts was 72nd" **[10].**

Bahamas

In terms of power generation, the primary electricity provider has a monopoly. This, along with a lack of well-defined renewable energy generating rules and objectives, as well as grid access for renewable energy providers, is a significant obstacle for potential IPP project developers. The Power Act created the Bahamas Electricity Corporation (BEC) as the principal entity in charge of the territory's electricity generation, transmission, and distribution. With the exception of Grand Bahama Island, BEC's supply reaches all of The Bahamas' major islands, covering about 85 percent of the population. Grand Bahama Power Business (GBPC) is a private utility company that serves roughly 19,000 consumers on Grand Bahama Island. The current Electricity Act grants BEC exclusive rights to generate, transmit, and distribute electricity, effectively prohibiting the development of grid-connected renewable energy. Because the government has not yet released an energy strategy, it is unknown what stance it will take on requirements for power generated from renewable energy sources.

"The Bahamas is ranked 77th out of 185 countries in the World Bank's 'Doing Business' 2013 report for ease of doing business. Starting a business was ranked 82nd, dealing with building permits was 68th, registering property was 179th, paying taxes was 51st, and enforcing contracts was 123rd" **[10].**

Barbados

By laying out regulations for connectivity and offering feed-in-tariffs, the Electric Light and Power Act (2013) looked to clear the way for IPP project developers to enter the grid. However, the Act established a licensing and approvals mechanism that allows the Minister responsible for Energy discretionary authority over the approvals process. Barbados Light & Power Company Limited (BL&P) has the sole legal right to transmit and distribute electricity in the country. Small-scale generation for household (up to 5 kW) and commercial (up to 50 kW) is allowed under the legislation, pending the approval of a license application. After receiving suggestions from an advisory council, the 'Minister responsible for Energy' grants licenses. The government released a National Energy Policy in 2007, and the Fair Trading Commission approved a renewable energy pilot project in 2010, allowing qualifying consumers with renewable energy producing capacity to sell excess electricity to the grid.

"Barbados is ranked 88th out of 185 countries in the World Bank's 'Doing Business' 2013 report for ease of doing business. The country was placed 70th in terms of beginning a business, 53rd in terms of dealing with building permits, 154th in terms of registering property, 121st in terms of paying taxes, and 105th in terms of enforcing contracts" **[10].**

Dominica

The lack of IPPs on the market should exacerbate the energy production worries. The potential for IPP-based energy projects is widely understood, but regulatory and legislative frameworks must evolve in order to provide project developers with an enabling environment. The Electricity Supply Act of 2006 is the main piece of legislation that governs Dominica's electricity sector. Dominica Electricity Services Limited (DOMLEC) was formed by legislation as the dominant entity in electricity generation, transmission, distribution, and sales until 2015. However, the law did not envision DOMLEC having a full monopoly in electricity generation, clearing the path for IPPs. However, IPPs have been deterred from joining the market due to a lack of clear regulatory and technical specifics.

"Dominica is ranked 68th out of 185 countries in the World Bank's 'Doing Business' 2013 report for ease of doing business. The country was placed 46th in terms of beginning a business, 22nd in terms of dealing with building permits, 119th in terms of registering property, 74th in terms of paying taxes, and 170th in terms of enforcing contracts" **[10].**

Grenada

Because the primary utility has a monopoly, power generation in Grenada is a closed market. There does not appear to be much desire to overturn the status quo, therefore IPP project developers' options appear to be restricted. Grenada Electricity Services Limited (GRENLEC) is Grenada's sole electricity supplier, serving Grenada, Carriacou, and Petit Martinique. In effect from January 1, 1961, the Power Supply Ordinance awarded GRENLEC the only and exclusive license to create, transport, distribute, and sell electricity throughout Grenada for an 80-year term. As a result, the electrical market is devoid of competition. This aspect was emphasized in Grenada's National Energy Policy **[29].** Despite GRENLEC's monopoly, Grenada's government has vowed to support the development of small-scale, grid-connected renewable energy resources, as well as create protocols and standards for system interconnection, reciprocal rates, and simplified project approval processes. However, in order to go from policy goal to practical execution, Grenada's government must first liberalize electricity generation and grid access for IPPs. **[12]**

"Grenada is ranked 100th out of 185 countries in the World Bank's 'Doing Business' 2013 report for ease of doing business. The country was placed 65th in terms of beginning a business, 10th in terms of dealing with building permits, 151st in terms of registering property, 85th in terms of paying taxes, and 165th in terms of enforcing contracts" **[10].**

St. Kitts and Nevis

The twin island state's power generation is restricted to the existing utility firms. The government has taken a firm stance on opening up the generating market to the private sector. It would be difficult for an IPP project developer to estimate the near- to medium-term possibilities for such a project without explicit directives and specified timetables. Both utilities are in charge of power generation and delivery on their respective islands. SKELEC is the sole power generator on St. Kitts, whereas NEVLEC generates the majority of power on Nevis. They run a small wind farm

(2.2 MW) that provides a small portion of the island's electricity. There do not appear to be any official feed-in agreements in place for IPPs to get access to the grid. However, one of the government's stated policy objectives is to 'ensure fair access to the transmission/distribution grid for both centralized and decentralized electricity generation (including small scale household power generation) and provide a competitive basis for a stronger private sector involvement in electricity generation. **[13]**

"According to the World Bank's 'Doing Business' 2013 report, St. Kitts and Nevis is ranked 96th out of 185 countries for ease of doing business. Starting a business was ranked 69th, dealing with building permits was 15th, registering property was 166th, paying taxes was 135th, and enforcing contracts was 119th" **[10].**

St. Lucia

St. Lucia Electricity Services Limited (LUCELEC) is the island's sole energy supplier, having a 20-year exclusive license to create, transfer, and distribute electricity. The firm serves almost all of Saint Lucia's commercial, industrial, and home clients. There are no legal mechanisms in place for IPPs to access the grid or get PPAs, prompting calls for the industry to be deregulated and LUCELEC's monopoly to be lifted. However, the government of St. Lucia has indicated that "particular" renewable energy projects should be included in future Power Extension Plans provided their national potential is considerable and demonstrated, and their utilization is cost-effective [**13**]. It was also suggested that LUCELEC either build its own renewable energy generating facilities, form joint ventures with renewable energy companies, or hire appropriate IPPs to generate under PPAs. The policy also stated that if LUCELEC failed to meet the quota, potential IPPs would be invited to tender for the installation and operation of renewable electricity generation facilities to make up the shortfall, and that LUCELEC would be required to provide these IPPs with open access to the electricity network [**14].**

The National Energy Policy was never discussed in Parliament and so never became legally obligatory, but the government looks to be maintaining its position. St. Lucia is ranked 53rd out of 185 countries in the "World Bank's 'Doing Business' 2013 report for ease of doing business. The country was placed 51st in terms of beginning a business, 11th in terms of dealing with building permits, 117th in terms of registering property, 43rd in terms of paying taxes, and 168th in terms of enforcing contracts." **[10]**

St. Vincent and Grenadines

The existing utility corporation, which has a monopoly on generating until 2033, dominates the electricity generation sector. The government is looking for methods to incorporate IPP power generation into the energy mix, which might open the door to a distributed Smart-grid to electricity project. The state-owned firm St. Vincent Energy Services Limited (VINLEC) has an exclusive license to deliver electricity to the islands of St. Vincent, Bequia, Canouan, Union Island, and Mayreau. VINLEC has an exclusive license to create, transmit, and distribute electricity until 2033 under the Electricity Supply Act of 1973. Only VINLEC can give licenses to IPPs who want to generate and sell power to the grid, according to the Act.

According to the "World Bank's 'Doing Business' 2013 report, St. Vincent is ranked 75th out of 185 countries for ease of doing business. The country was placed 64th in terms of beginning a business, 5th in terms of dealing with building permits, 145th in terms of registering property, 72nd in terms of paying taxes, and 99th in terms of contract enforcement" **[10].**

Trinidad and Tobago

Given the Government's subsidies for petroleum-based power generation, the economics of IPP generation are expected to be tough in Trinidad. Furthermore, the lack of explicit renewable energy generating regulations, as well as legislation limiting interconnection, make for a difficult economic case. The Trinidad and Tobago Energy Commission (T&TEC) is in charge of electricity transmission and distribution in the country. PowerGen and Trinity Power generate and sell electricity to T&TEC under long-term power purchase agreements (PPAs) for transmission and distribution over the national grid. The suppliers, T&TEC, and the National Energy Commission negotiate the IPPs. The Foreign Investment Act allows and encourages foreign ownership of businesses (1990). In addition, the government exempts authorized projects from customs charges, as well as providing value added tax and income tax profits.

"Trinidad is ranked 69th out of 185 countries in the World Bank's 'Doing Business' 2013 report for ease of doing business. The country was placed 71st in terms of beginning a business, 101st in terms of dealing with building permits, 176th in terms of registering property, 90th in terms of paying taxes, and 170th in terms of enforcing contracts" **[10].**

2.3 Smart Grid opportunities in the Caribbean

In smart grid application, an extra information layer is added on top of the power system, and additional power equipment makes up the electrical system that integrates smart grid technologies and functions (Figure 9). On the generation side, the information layer enables the implementation of system automation and protection features, enhancing the capacity to integrate large shares of variable renewable energy sources, and on the user side, it enables the implementation of load flexibility measures like demand response. The smart grids system can handle bi-directional power flows to and from users, allowing them to become active participants in the electrical market with great flexibility and efficiency, while also including the contribution of user-side distributed production. In the Caribbean, the electrical network is considered to be antiquated as the current electrical infrastructure in most, if not all, Caribbean nations has remained unchanged for decades and is aging while electricity consumption is increasing. The current network operator's workers must manually read an electromechanical meter or an electronic meter with minimal or no communication characteristics to connect to the residential user's premises. These meters simply record the total energy consumption over a period of time – usually a month – at the home level. The transfer of energy from the utility to the user is unidirectional, and there is no direct movement of information to or from the user across the system. Constantly rising aggregate demand for electricity and the major challenges of climate change are placing a heavy burden on the infrastructure of the world electricity grid.

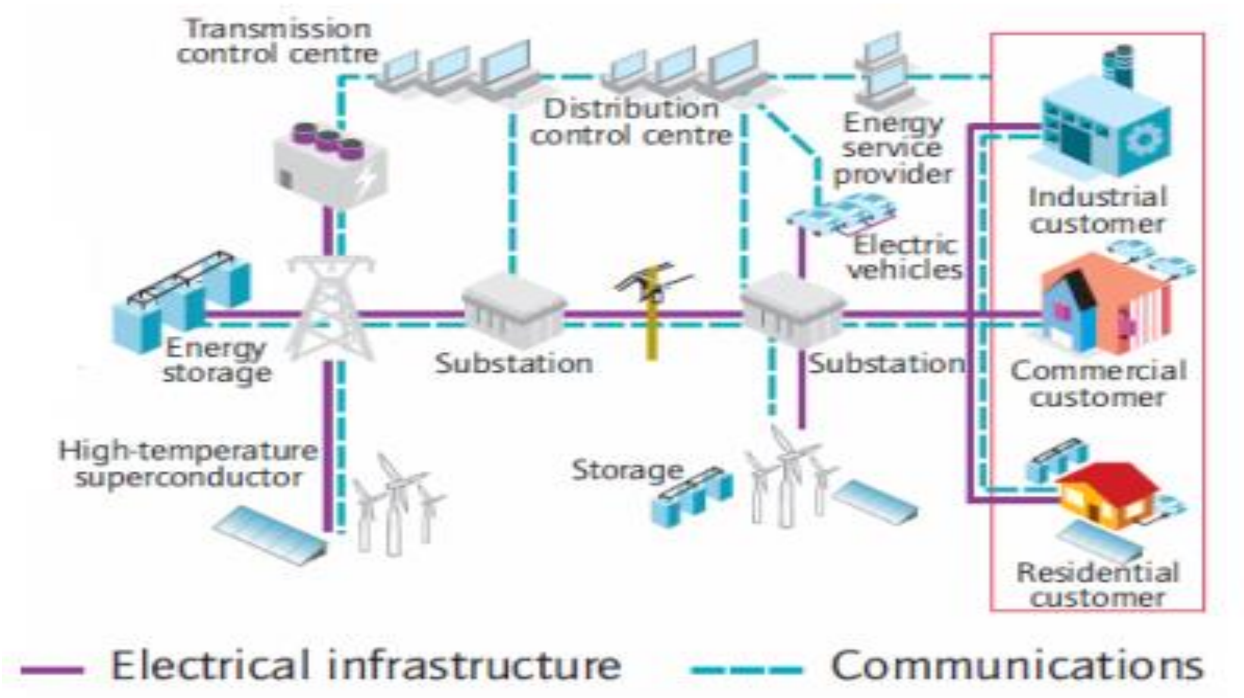

Figure 9: Smart electricity system full grid deployment, Source: IEA

These practices are part of a new policy area known as demand response (DR), which is strongly tied to the execution of a new vision of users playing an active role. Indeed, as the process progresses, technical instruments such as thermostats, timers, and systems that employ ICTs to carry out operations remotely will be developed and used, resulting in the creation of a "smart household." The advantages of enhancing energy quality are related to decrease generating costs (since this is another method of resource optimization) and increased productivity in the industries concerned. Indeed, avoiding productivity losses in the commercial and industrial sectors due to poor electrical quality is predicted to save the economy a significant amount of money, which may then be reinvested in the creation of new markets **[15].**

While there are various prospects for Smart Grid implementation in the region, there are also numerous problems that occur due to a variety of reasons, most of which are inevitable, as well as inadequate planning in the early phases. Existing grid infrastructure is a significant obstacle. All dangers to the old infrastructure, such as natural disasters and deliberate attack, are present in the smart grid. As the present grid evolves, the domains of energy, telecommunications, transportation, and financial infrastructures become interdependent, posing higher risk. Due to changed power flow patterns and quality issues, there are also potential challenges in the transmission and distribution networks. Upgrades to security, automation, and control systems may also be difficult. Several security solutions should be combined and implemented at each tier of a computer system to reduce the risk of unwanted access (people, networks, operating systems, applications, and databases) [**16].**

2.4 Study Parameter

The research and use of energy efficiency (EE) and renewable energy (RE) technologies has advanced dramatically during the previous decade. The International Renewable Energy Agency (IRENA), for example, says in its 2014-2015 report that Caribbean renewable energy generation capacity has increased by nearly 85% in the last ten years. Furthermore, according to IRENA assessments, “the cost of renewable energy technology has decreased by more than 70% during the time, making it viable to deliver competitive utility-scale electrical services from renewable sources in many countries” **[17].** While many Caribbean nations have joined the global transition to sustainable energy, the issue is so wide and all-encompassing that comprehensive energy policies are essential to achieve long-term, clean energy security. Despite significant regional success, more work has to be done at the policy level to solve the specific concerns of "grid access" and "power purchase agreements" that are required to stimulate the growth of utility-scale renewable energy power plants. Furthermore, four of the 17 Caribbean nations and territories have no energy efficiency policies or are in the planning stages, while the other four have only considered one strategy. As a result, it is reasonable to assume that no energy efficiency programs have been advocated in nearly half of these Caribbean countries.

2.5 Study Population

The Caribbean is a region with great economic discrepancy. It comprises the Bahamas, Barbados, and Trinidad and Tobago, the three nations in the area with the greatest per capita GDP, as well as Haiti, the poorest country in the region, which has been plagued by political instability and has yet to fully recover from a devastating 2010 earthquake. The Caribbean has a total installed electrical capacity of 20 GW, with Trinidad & Tobago and the Dominican Republic accounting for a third of it. The Caribbean generated 32 TWh in 2011, the lowest in the area. In the Caribbean, access to electricity varies greatly. Haiti has the lowest electrification rate in the area, as well as the highest number of people without power (nearly 8 million). Given the geography of Haiti and many other nations in the sub-region, distributed generation is the most cost-effective option to enhance power availability. Solar resources abound in the Caribbean, and lowering prices make solar PV an attractive option for addressing this problem. Wind, biomass, and small hydropower resources are abundant in several nations in the sub-region, offering more options **[17]**.

Nonetheless, oil and diesel power generating dominate in Caribbean countries. Because most of these nations lack domestic oil and natural gas resources and are too tiny to burn coal efficiently, they rely on oil and diesel imports at variable costs, resulting in high power tariffs. Jamaica is a good example, with average retail tariffs substantially higher in 2006 than in the rest of the Caribbean. This feature makes renewable energy particularly appealing in the sub-region; however, due to fossil fuel subsidies with high fiscal costs and a lack of economies of scale, such development is limited. Meanwhile, certain Caribbean countries, such as Trinidad and Tobago, Barbados, and Dominican Republic, have significant fossil fuel resources, which have stifled the growth of renewable energy and kept power prices low.

> “Hydropower is one of the Caribbean's primary renewable energy source, accounting for slightly over 0.8 MW of the sub-total region's installed capacity of 20 GW. Small hydro accounts for 23 percent of Haiti's renewable energy capacity; the Dominican Republic has 19 percent renewable energy capacity, with 11 percent large hydro and 7 percent small hydro; and Jamaica has 2% small hydro. The wind resources of Jamaica and the Dominican Republic have also been exploited, with 50 MW and 30 MW, respectively. At 0.02 GW, Guyana is the only country in the sub-region that has developed its biomass resources” **[17].**

3. Research Results

With the current situation, vulnerability is certainly a motivating factor for Caribbean islands to adopt renewable energy; there are also economic factors at play. The power generation portfolios of most Caribbean utilities are poorly diversified and dependent on centralized diesel generation assets. Over 87% of primary energy needs are currently met with imported petroleum, leaving the islands vulnerable to price shocks in the global oil market. As most utilities are allowed to pass these volatilities directly to customers through a fuel surcharge, tariffs in the region commonly exceed $0.30 per kilowatt-hour, which is more than twice as large as the average world residential tariff of $0.13 per kilowatt-hour. These expenses have far-reaching consequences for island economies, rendering them uncompetitive in international trade and even tourism **[18].**

Despite considerable abundant renewable resources, Caribbean islands have been slow to adopt renewable energy (Table 1). There are a number of technical, economic, political and social barriers, prominently financial resource shortages, monopolistic utility structures, and fossil lock-in dilemmas. Among those barriers, a lack of supportive policies and regulatory frameworks are identified as most important challenges for RE implementation. Government energy policies, roadmaps, integrated resource plans, and other strategy documents provided another source of information. According to J. Kersey, P. Blechinger, and R. Shirley:

> "Findings from these documents were cross-checked with the National Renewable Energy Laboratory's (NREL) Energy Snapshots publications, the Renewable Energy and Energy Efficiency Partnership's (REEEP) annual reports, the Inter-American Development Bank's (IDB) Energy Dossiers, Bloomberg NEF's Climate scope database, the Database of State Incentives for Renewables and Efficiency (DSIRE), and other gray literature documents from organizations such as the Rocky Mountain Institute" **[18]**.

Island Name	Political Status	Area (km2)	GDP (2020 USD/person)	Population	RE Growth% 2002-2020
Anguilla	BOT	102	$20,438	17,422	3.8
Antigua & Barbuda	Sovereign	440	$14,016	96,286	7
Aruba	Netherlands CC	180	$21,302	106,766	19
Bahamas	Sovereign	13,880	$29,216	393,248	0.2
Barbados	Sovereign	439	$15,191	286,641	4.6
Bonaire	Netherlands SM	288	$22,500	20,104	34
British Virgin Islands	BOT	153	$36,107	29,802	1.5
Cayman Islands	BOT	264	$85,134	64,174	2.6
Cuba	Sovereign	109,884	$8,940	11,338,000	9.1
Curaçao	Netherlands CC	444	$18,658	159,800	33
Dominica	Sovereign	751	$6,824	71,625	37

Dominican Republic	Sovereign	48,442	$7,253	10,627,000	13
Grenada	Sovereign	349	$9,360	111,454	1.5
Guadeloupe	France ROM	1,628	$22,024	395,700	21
Haiti	Sovereign	27,750	$792	11,123,000	7
Jamaica	Sovereign	10,991	$4,692	2,935,000	11
Martinique	France ROM	1,128	$25,927	375,435	24,9
Montserrat	BOT	102	$12,017	5,373	0.15
Puerto Rico	US UOT	9,104	$26,610	3,040,000	3
Saba	Netherlands SM	13	$22,877	1,933	38
St. Barthelemy	France COM	24	$37,898	9,131	0.1
St. Eustatius	Netherlands SM	21	$26,100	3,138	47
St. Kitts & Nevis	Sovereign	269	$16,502	52,441	5
St. Lucia	Sovereign	617	$8,335	181,889	1
St. Maarten	Netherland CC	34	$33,320	40,654	0.2
St. Martin	France COM	54	$19,300	37,264	0.2
St. Vincent & Grenadines	Sovereign	389	$6,998	110,049	19
Trinidad & Tobago	Sovereign	5,131	$15,557	1,390,000	0.1
Turks & Caicos	BOT	948	$26,866	41,369	0.2
US Virgin Islands	US UOT	346	$37,223	106,977	1.2

Table 1: Summary characteristics of the 30 islands in the study; Renewable Energy capacity as percent of total installed capacity in 2020; BOT = British Overseas Territory, CC = Constituent Country, SM = Special Municipality, COM = Overseas Collectivity (Collectivités d'outre-mer), ROM = Overseas Region (Régions d'outre-mer), UOT = Unincorporated Organized Territory. Source: unctadstat.unctad.org, energy.gov

Between 2002 and 2020, total renewable energy capacity in the 30 islands grew over 1,600% from 82 MW to an estimated 1,417 MW. As Figure 10 demonstrates, strong growth in solar PV and onshore wind drove this dramatic increase, with solar and wind accounting for 54% and 38% of growth in capacity, respectively. Modest growth in geothermal and bioenergy accounted for the remainder. The overall growth in the region is impressive considering that most islands had zero or negligible RE in 2002. By 2020, most islands had renewable energy penetration approximately 0-20%, with an average of 14.7% RE penetration. This regional figure compares unfavorably with global figures, which the International Energy Agency estimated to be around 26% in early 2020. The Dutch islands of St. Eustatius and Bonaire are remarkable outliers among the 30 islands, with 47% and 34% installed capacity RE by 2020 respectively **[19].**

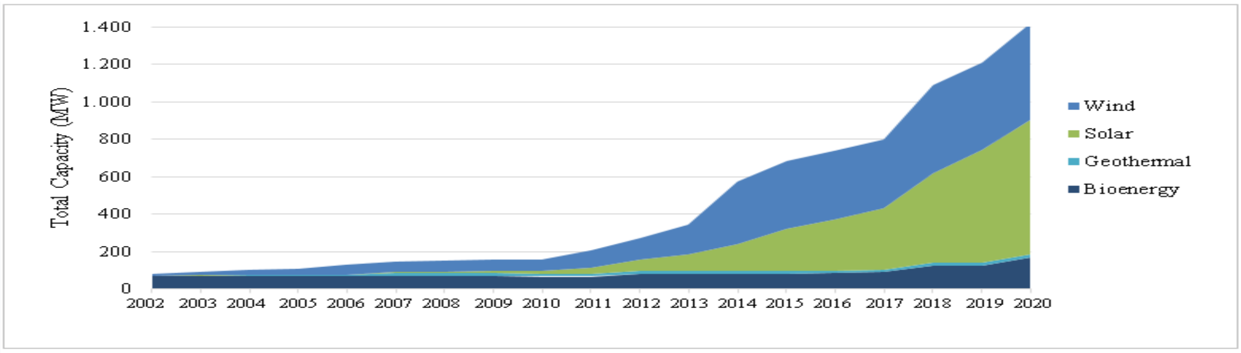

Figure 10: RE growth in the 30 study islands over time by renewable type, Source: Sciencedirect.com

Figure 11: Visualization of policy regression for FE (left) and PCSE (right), Source: rgshirley.com

Regardless of the fact that politicians have hundreds of potential policy alternatives for encouraging renewable energy, the policies evaluated in this study are limited to the following five instruments, which were found as the most often enacted among the 30 islands. These policy tools (Figure 11) have been adapted for use in the Caribbean, where certificate systems, FE, PCSE, and voluntary initiatives are used:

1. Investment incentives (InvestmentInc): grants or low-interest loans to help with the capital costs of renewable energy production. Puerto Rico, for example, uses a Green Energy Fund to subsidize up to 50% of wind or PV installations via a competitive grant procedure **[20].**

2. Tax incentives (TaxInc): policies that use the tax system to give incentives for renewable energy, such as import reductions or exemptions, tax deductions for RE enterprises, property tax exemptions, and value-added tax reductions or incentives. Antigua and Barbuda's 2015 Renewable Energy Act, for example, exempts plants, machinery, and parts imported for RE from import tariffs, waives customs fees, and gives corporation tax relief **[21].**

3. Feed-in tariffs (FiT) are a policy instrument that encourages the growth of renewable energy by providing attractive pricing regimes for RE in comparison to carbon-intensive output. FiTs are aimed at utility-scale RE production from independent power suppliers in the Caribbean (IPPs) **[22].**

4. Net-metering and net-billing systems (NMNB): similar to FiTs, net metering ensures a favorable price for RE generation, mainly through customer "prosumers" who earn credit for every net unit of energy put into the grid allowing interconnection with the utility grid and providing per kWh compensation.

5. Deregulation of the electricity sector to require utilities to accept interconnections from independent power producers (IPPs): this policy captures the deregulation of the electricity sector to require utilities to accept interconnections from IPPs, often by amending previous legislation to allow the government to grant licenses directly to IPPs. We omit policy interventions that are meant to attract IPPs, yet designate the utility as the decision-maker in issuing generating licenses, due to the monopolistic structure of most Caribbean utilities and their past reluctance to incorporate RE **[23].**

3.1 Policy, regulatory and conceptual frameworks

The power generation sector has been liberalized to allow the entry of IPPs, but they must obtain licenses from the government to operate. This process allows the government to manage the selection of power sources to ensure compliance with its electric power mix targets. If an IPP's business plan does not comply with the targets, the government will not issue a license. Shirley and Kammen (2013), as well as Blechinger (2016), have done extensive research on the technological, economic, and political challenges to RE development in the Caribbean, as well as the techniques that have been employed to overcome them. Figure 12 depicts the conceptual framework that underpins this analysis, which theorizes the connections between the key barriers to RE development identified in the literature, strategies used to overcome them, and finally the specific policy instruments through which these strategies are implemented. Though not full, this framework of obstacles, tactics, and policies is useful in comprehending the effect pathways of the policy instruments examined in this study **[24].**

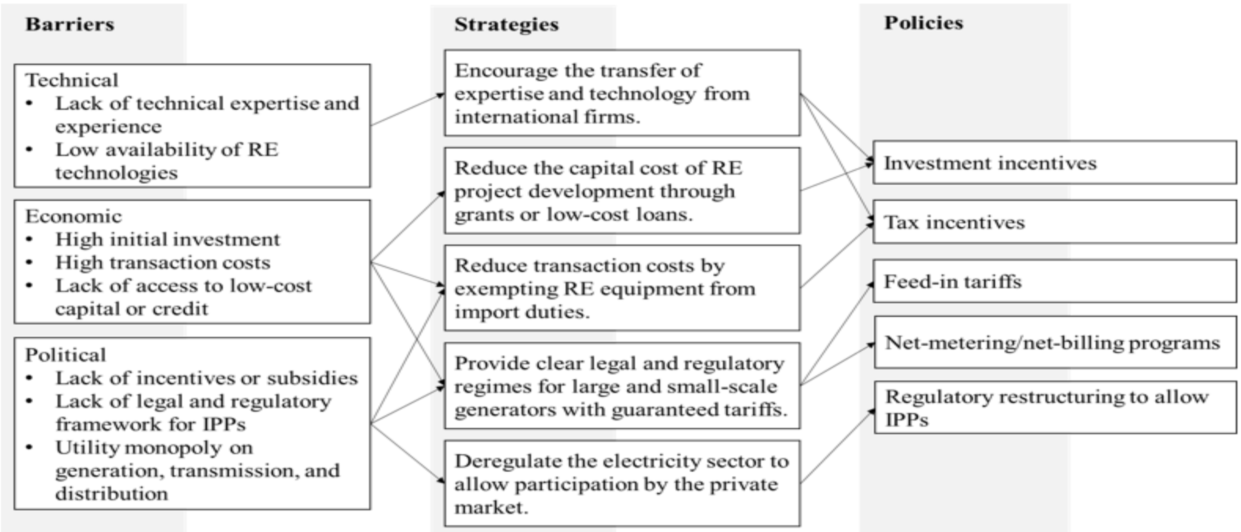

Figure 12: Conceptual framework of analysis, Source: CARICOM

Technical and financial proposals are used to acquire IPPs in a two-stage procedure. The procurement process includes clarification meetings and (where required) site visits. The final review processes for tenders are official, with strong probity criteria regulating these judgments. Figure 13 depicts the suggested overall IPP framework method to analyzing IPPs and developing needed milestone agreements. The IPP Evaluation purpose of the assessment is to see if the IPP can be contracted with subject to due diligence, review and if the IPP can be sole sourced or if it will be put through a competitive procedure when a suitable process is scheduled. The first stage is to make sure the IPP's expression of interest corresponds to the generation procurement strategy and the IRP **[25].**

The following are important measures to take while determining IPPs:
1. Is it in the public interest to work with an IPP?
2. Does the IPP have any special or distinctive intellectual property, trade secrets, exclusive rights, or other distinguishing features?
3. Cost-effectiveness
4. Proven technology
5. Risk management plan

If the IPP meets these criteria, it can advance to the full review and negotiating stage.

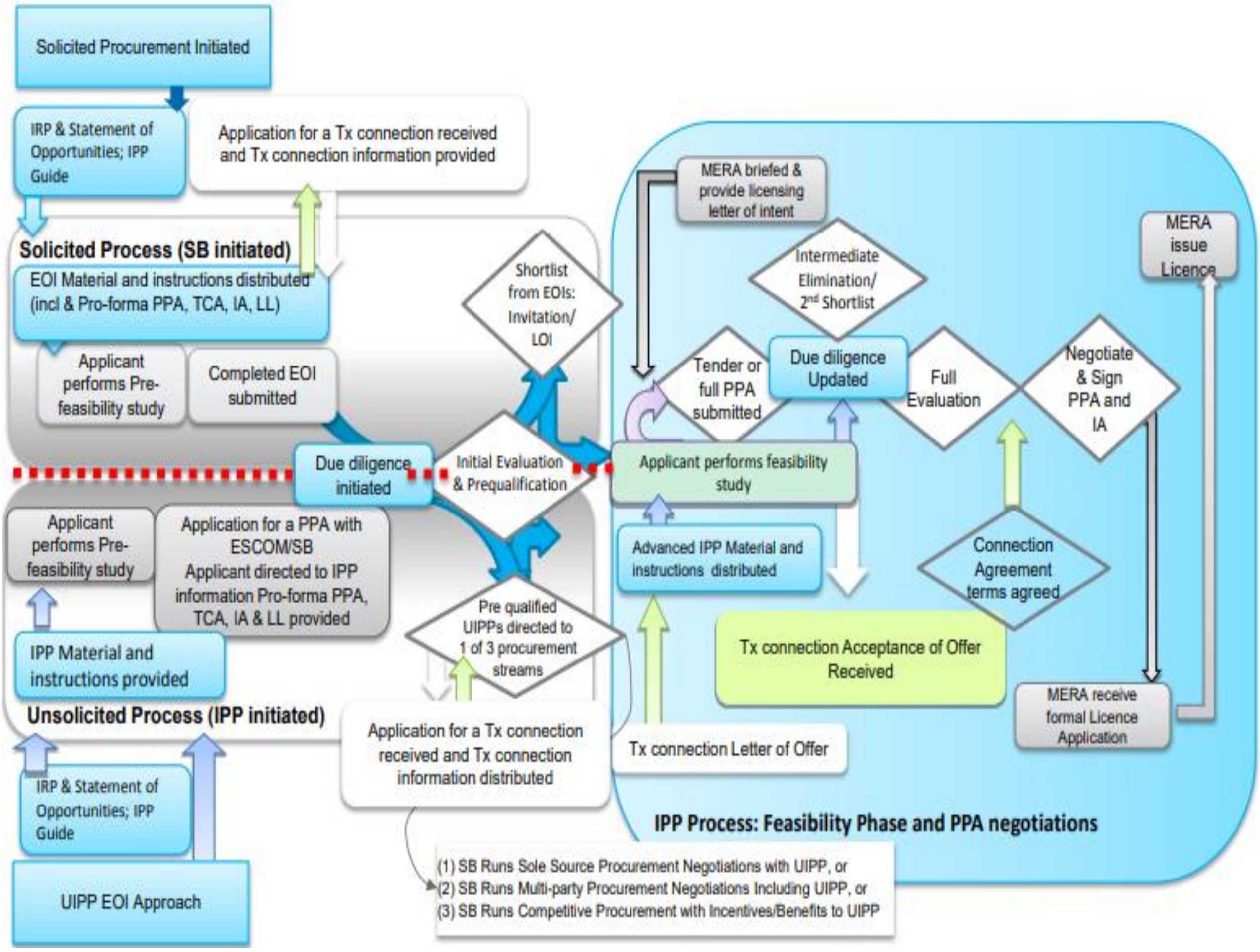

Figure 13: IPP Initial Assessment Process, Source: Worldbank.org

The IPP evaluation approach is typically carried out in five stages:

1. **Preliminary (mandatory) compliance:** Mandatory procurement rules are effective for swiftly limiting bidders by weeding out poor offers. All bids are evaluated to determine whether they meet the required standards that they were given, such as tender compliance, company viability evidence, and reference site information. If a bidder fails to submit the needed information at the requisite level, that bidder will be eliminated from further consideration.

2. **Technical evaluation:** The technical evaluation is used to see if bidders have the necessary skills and expertise to complete the project. The technical examination takes into account the bidders' experience, skills, and overall technological fit for purpose. The appropriateness of reference projects, the history of dependability and availability, environmental performance, and site-specific challenges are all taken into account. Developers who fail to satisfy a minimal standard in the technical evaluation does not progress.

3. **Due diligence:** Due diligence is a procedure for analyzing the risk of doing business with a particular party in order to aid decision-making. The goal of the due diligence and risk assessment procedure is to make an impartial evaluation of the developer and related parties' possibility of being a reasonable party for a single buyer to work with in terms of ethics, legal, financial, and technological considerations. Because of the due diligence, the single buyer will have a better understanding of the risk it will incur if it pursues further

conversations with the developer. If the danger of participation with the developer is substantial in the single buyer's opinion, the single buyer may decline to continue conversations. Alternatively, the single buyer may assess that the developer is an acceptable risk, but will seek further assurances or inspections before contracting with the developer. It is vital to keep in mind that due diligence is merely the first stage in assessing whether or not the single buyer enters into a contract with the developer. The single buyer can defend itself against numerous contractual issues through the contracts, and the due diligence procedure is not meant to give a comprehensive examination of the project or its competitors.

4. **Commercial evaluation:** It is required for the commercial component, in which bidders are asked to react to pro-forma contracts and advise on any revisions. At this point in the review, an indication of the projected amount of government support are meant to be taken into account across the board.

5. **Financial assessment:** The financial modeling for IPP and UIPP evaluations are different.

It is critical to develop political institutions in order to remove regulatory and political barriers. This must be done from the ground up, so that people can take on as many of the activities required for a local energy turnaround as feasible on their own. The bigger and smaller Caribbean island nations can be distinguished. This indicates an institutional strengthening of their individual (renewable) Energy Ministries and Regulators for the bigger Caribbean island republics (such as the Dominican Republic, Jamaica, Cuba, and Puerto Rico). The development of a transnational regulatory authority that can pool knowledge and talents is critical for smaller island nations, particularly in the eastern Caribbean. Thus, by utilizing enhanced national or international institutions, the need for a regulatory framework is fulfilled **[26]**.

3.1.1 Roles and responsibilities of Key Participants

IPPs contribute to the overall quantity of power required by the Caribbean islands' economies. The Minister of Energy of each nation must decide how much electricity to build new energy producing capacity based on the amount of power. In the Caribbean, IPPs are relatively recent phenomena, yet the private sector has always played a role in the power industry. The government, with minor IPP investments on select islands, now holds the majority of power plants. Each of the market participants has a duty to play in establishing a stable, realistic, and financially sustainable energy market. In an ideal world, the government, utilities, public interest organizations, and other essential stakeholders collaborate to define a country's energy policy and regulatory standards. Otherwise, policy and regulation are susceptible to whims and can be influenced by individual interests or movements in political regimes. Regulators aim to create a portfolio standard that is appropriate for their location in order to accomplish policy objectives, both technologically and economically. To accomplish shared goals, the policy in place must stay consistent while being practical and sensitive to market developments. Regulation can also assist in ensuring a well-defined tender process for energy and service procurement that specifies norms, responsibilities, and fair pricing models. Effective regulation and oversight necessitate an open and honest dialogue between utilities, government, and other stakeholders, including IPPs' roles:

1. Energy sustainability and affordability methods, both short and long term.
2. To compare the performance of government-owned power plants.
3. To encourage the growth of local market and economic circumstances.
4. To improve labor development ability, management skills, and access to efficient technology that will provide a dependable and inexpensive power supply.
5. To allow the government to focus precious resources on other priorities including health, poverty reduction, education, and agriculture.
6. To aid in the decrease of gas flaring **[27]**.

Appropriate policy and regulation may level the playing field, allowing reputable developers to provide viable, long-term energy alternatives. Developers may aid in the advancement of technology, innovation, and financial and technical models that can assist provide price certainty and predictability to the energy supply. A well-regulated energy market can also result in enhanced workforce development as well as other social and environmental advantages. Structured agreements for power purchase and renewable energy agreements can help to manage the market: Organizing a project or a company, as well as securing funding documents relating to credit agreements and collateral security environmental and social effect concerns, as well as equipment, technological options, permits, authorizations, and licenses insurance creating a tax structurer risk reduction.

It is vital to safeguard the companies, owners', and consumers' interests from a utility standpoint (Figure 14). Diversifying energy portfolios with more renewable energy should be done in a careful, balanced way to ensure long-term dependability, price stability, and public benefit by serving all consumers fairly. Electricity is essential for a country's economic development and inhabitants' existence. Utilities must evaluate how the nation's greatest interests are served vs private interests in partnership with government and legislators **[28].** As a result, putting in place a regulatory monitoring system may be the best alternative for a solid policy framework.

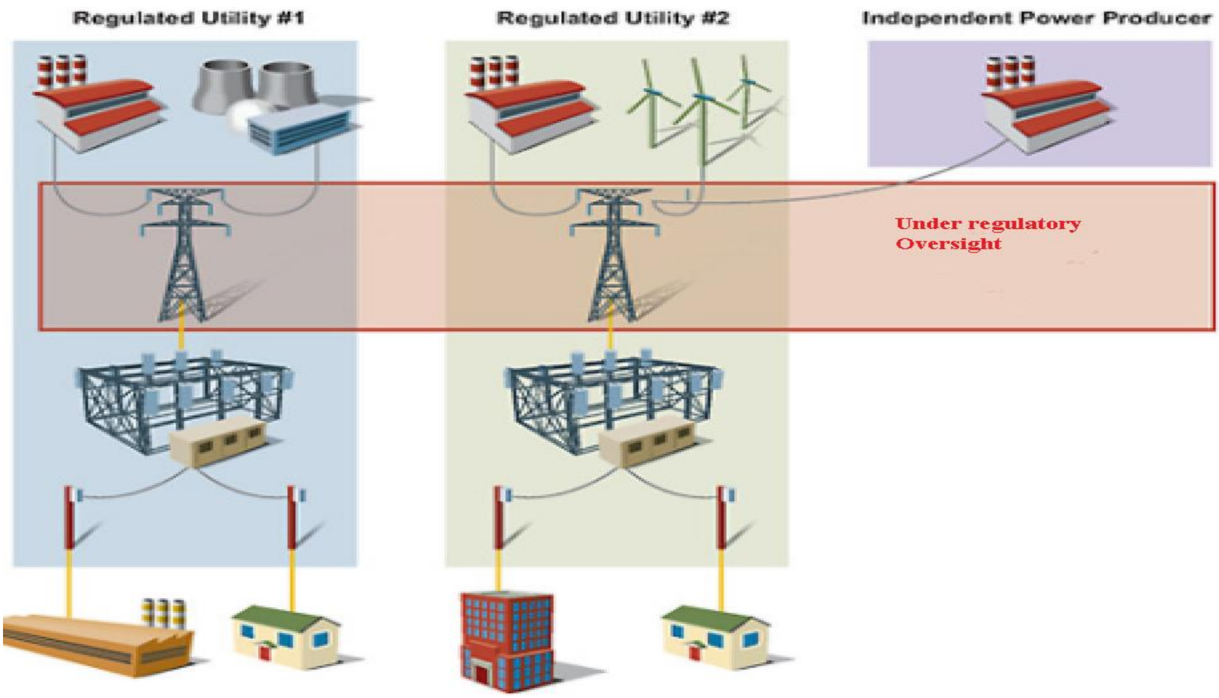

Figure 14: Role of Utility and IPP’s, Source: nap.edu

3.1.2 Renewable energy purchase agreement for IPP and regulated tariff

Under a renewable energy production agreement for independent power producers, or IPPs, the local government provides legal and regulatory frameworks to assist public and private project developers in installing solar, wind, biomass, small hydropower, and geothermal power generation technologies connected to a smart-grid. Under a renewable purchase agreement (RE-PPA, Figure 15), the IPP sells renewable power to the distribution utility, which then distributes the electricity to end customers at nationally/regionally controlled consumer rates. The IPP is in charge of collecting renewable regulated rates. An important part of the projects' viability under this regulated framework is assisting regulators and utility management in designing transparent renewable energy purchase prices and model power-purchase agreements (PPAs) for small renewable energy producers. The assurance of long-term capital reduces the financial risk for potential investors by assuring stability and a suitable rate of return **[29].**

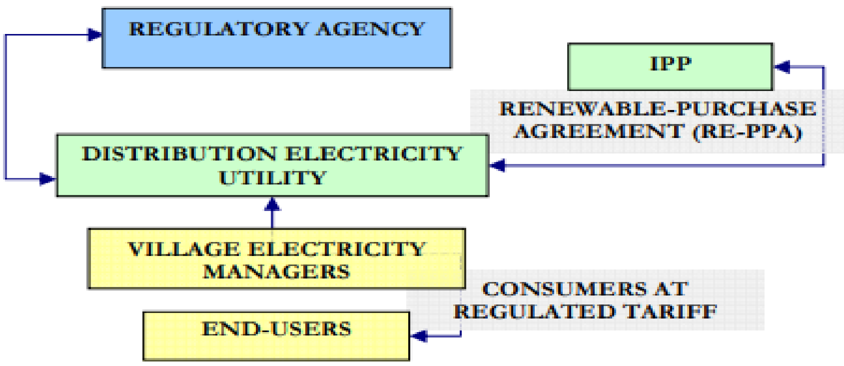

Figure 15: RE-PPA regulatory framework, Source: M.More (JRC)

The regulatory body creates a policy umbrella to supplement the RPT. The Electricity Utility (owner of the smart-grid) is in charge of the smart-financial grid's administration in order to ensure that subscribers' payments are paid. The Power Utility buys electricity from smart-grid-connected renewable energy producers (the IPP or co-operative) at a government-set rate that is guaranteed for a specific period of time (20 years). RPT subsidies are paid to IPPs for each kWh of renewable energy sent to the smart grid. In addition, the IPP has the responsibility of the installation, operation, and maintenance of the connected system. The producer's profile determines the level of ownership. The producer is in charge of the linked system's setup, operation, and upkeep. The utility provides RPT subsidies to renewable energy producers.

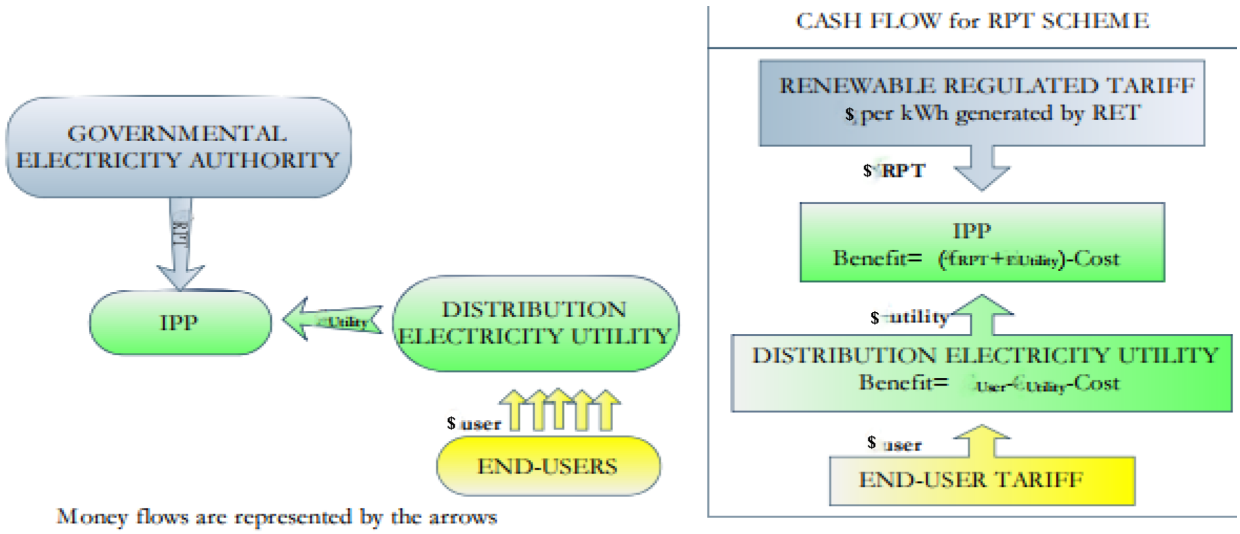

Figure 16: RE-PPA regulated tariff scheme for IPP, Source: M.Moner (JRC), A.Shanker

Because rural users in some developing countries lack financial capabilities, defining the financial flows involved in compensating the difference between cost and prices paid, as well as determining who should bear the cost of compensation for renewable energy production, is critical to the success of financial support. The tariffs (Figure 16) are set in accordance with the registered entities' expectations. When a Rural Energy Service Company or an Independent Power Producer (IPP) controls RE assets under a regulated generating system, for example, the distribution power utility manages its operations in accordance with numerous regulatory and consumer obligations, as well as profit requirements from the owners. Customers are connected to a single, exclusive company that provides them with electricity and pays them a certain amount of money as well as an RPT value as an incentive for generating RE electricity. Customers expect a certain degree of delivery quality in exchange for reasonable prices. The regulator represents these customers. In the case of a Co-op ownership (i.e. municipalities), the business is held by the customers and hence does not require any specific profit **[30].**

3.1.3 Cost and funding opportunities

Renewable energy power facilities in the Caribbean have much lower power production costs over their lifetimes than power plants predominantly powered by diesel or heavy fuel oil. Despite this, renewable energy's high investment prices are still considered as a significant implementation barrier. This indicates that because of the high beginning costs and relatively low ongoing expenses, renewable energy projects are more difficult to finance than conventional facilities with cheap starting costs but high fuel and running costs. There are distinct cost factors, especially on the smaller Caribbean islands, in addition to the cost structure of renewable energy projects in general. Because of the tiny market size, investment corporations face negative economies of scale and significant transaction costs, as they must create the market from scratch in each nation. Simultaneously, as previously said, there is a lack of a comprehensive regulatory framework or subsidy mechanisms to primarily lower the initial cost of renewable energy projects. Increased investment security would be the first step in closing the financing shortages. This means that by implementing the suggested regulatory tools, the risk of individual projects may be minimized, and therefore the ability to finance can be increased. Smaller initiatives should be able to obtain favorable financing from local banks, which should be supported by international development banks to decrease risk **[15].**

Local governments can employ subsidies, such as reduced import prices or tax incentives, to reduce capital expenditures directly. The establishment of a Caribbean-wide market, as well as the resulting reductions in trade obstacles and tariffs, would significantly reduce the cost of projects or project development. Simultaneously, promoting renewable energy projects in land use planning might result in more and less expensive land becoming accessible for such projects. The first step toward resolving the finance problems would be to improve investment security. This means that by implementing the suggested regulatory tools, the risk of individual projects may be minimized, and therefore the ability to finance can be increased. Smaller initiatives should be able to obtain favorable financing from local banks, which should be supported by international development banks to decrease risk. This combination of reduced investment costs and better financing (Figure 17) options can greatly speed up the implementation of renewable energy projects, since they already generate profits in the medium term and reduce total energy costs on the Caribbean islands.

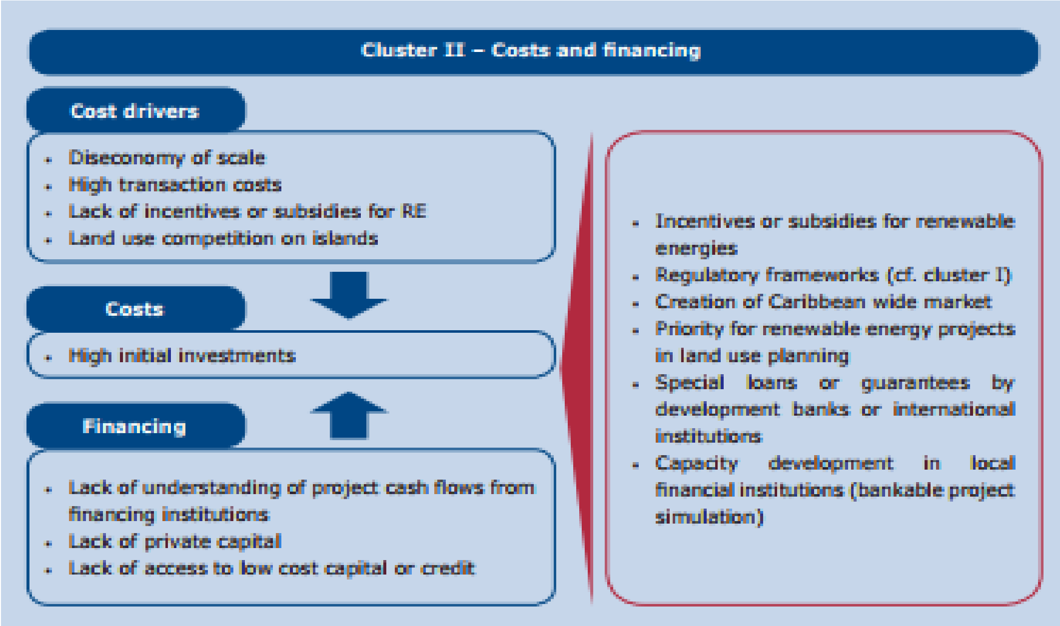

Figure 17: Cost and financing, Source: World Bank

3.2 Economic impacts of energy pricing and subsidy reforms

Energy subsidies and pricing policies, no matter how effective a government's goals may be, can result in unanticipated costs and distortions that undercut their intended effects. Subsidies, in particular, create fiscal imbalances by crowding out priority public spending and private investment, which are supported by distortive taxes or public debt. Other potential negative consequences of artificially low energy costs include promoting excessive use and reducing incentives for investments in renewable energy sources or energy-saving devices. Subsidies can put pressure on net energy importers' balance of payments and promote smuggling to neighbors with higher domestic costs. Finally, by encouraging increased energy use, subsidies raise greenhouse gas emissions and exacerbate global warming, compromising future generations' well-being **[31].**

Because energy is a critical input in the creation of many intermediate and final goods, energy prices have an impact on overall production costs. Despite the fact that economists seldom treat energy as a fundamental input, most sectors of production rely on energy products directly or indirectly. Some of the direct linkages are simple to understand, for example, most transportation vehicles require gasoline to operate. Other connections are less obvious, but no less powerful. Cleaning and pumping water for distribution may need a significant amount of power, depending on geographical conditions. The organization of production, the adoption of certain technologies, and the total amount of energy use may all be influenced by energy costs. In practice, businesses analyze energy prices in the same way they consider capital rents and labor costs when making decisions. This decision-making is reflected in the number of items a company produces and how much energy it consumes vs other inputs in the short run. Such decisions are reflected in the manufacturing technology that a firm decides to use or if it chooses to create a certain product, maybe for export, in the medium to long term. The aggregate of these impacts determines the economy's energy usage **[32].**

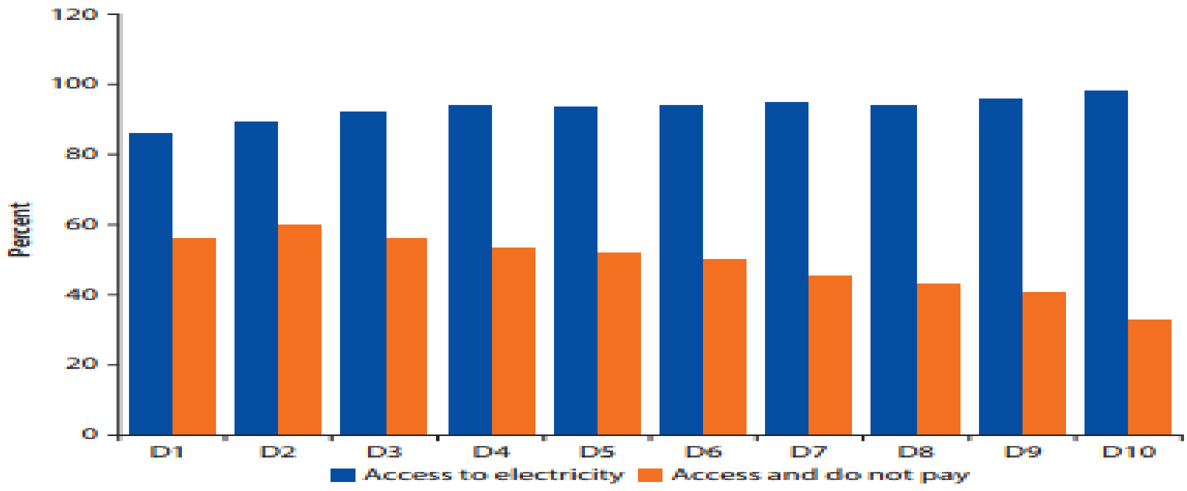

Figure 18: Access to electricity and electricity theft, Source: DR National household survey

The most important difference across countries arises for those countries where the electricity generation matrix is dominated by fossil fuels, such as Trinidad and Tobago and the Dominican Republic. In these countries, electricity and utilities show up as the expenditure categories with the highest price increases. In the Dominican Republic, access to electricity has improved substantially over the last decade, with only about 14 percent of households in the bottom decile lacking access. In the districts of Dominican Republic, the number of households without access to electricity declines with income (Figure 18).

3.3 Assessment of future needs and challenges

The regulatory framework must provide for a clear and well-defined approach for IPPs to enter the market. The evolving power market is seeing a greater diversity of distributed generation sources, thanks to the rapid development and evolution of smaller scale solar producing. As proven by various renewable energy and IPP projects in the region, transaction and approval processes are typically arduous and expensive, particularly for smaller IPPs. Furthermore, the Authority's ability to license and regulate a growing number of distributed producing sources may be put under undue strain. To address this, it is suggested that "small IPPs" be given their own licensing and regulatory process, as well as license exemptions. As a result, appropriate criteria for market participants who qualify for simplified fast-track licensing (registration) processes and license exemptions must be established. The license exemption standards and/or criteria for a fast-track registration procedure should incorporate the rising distributed/embedded generation and renewable energy industries. Despite their obvious advantages, Smart-grids and off-grid power supplies face significant obstacles in terms of deployment and long-term viability. These difficulties include, but are not limited to, the following:

1. High up-front capital costs;
2. Low capacity factors (due to the nature of the typical customers served);
3. Potentially higher tariffs than comparable utility customers;
4. Insufficient financing and specialized investment support;
5. Technology standards, quality and failures;
6. Lack of effective institutional arrangements to ensure reliable and efficient operation and maintenance over time;

7. Lack of or inadequate mechanisms to address grievances;
8. Uncertainty in the face of possible future central/national grid extension;
9. Lack of clear technical and commercial frameworks for feeding power from small scale embedded generation into the smart-grid or even into the wider national grid;
10. Policies and appropriate institutional arrangements along with effective financing mechanisms. **[33]**

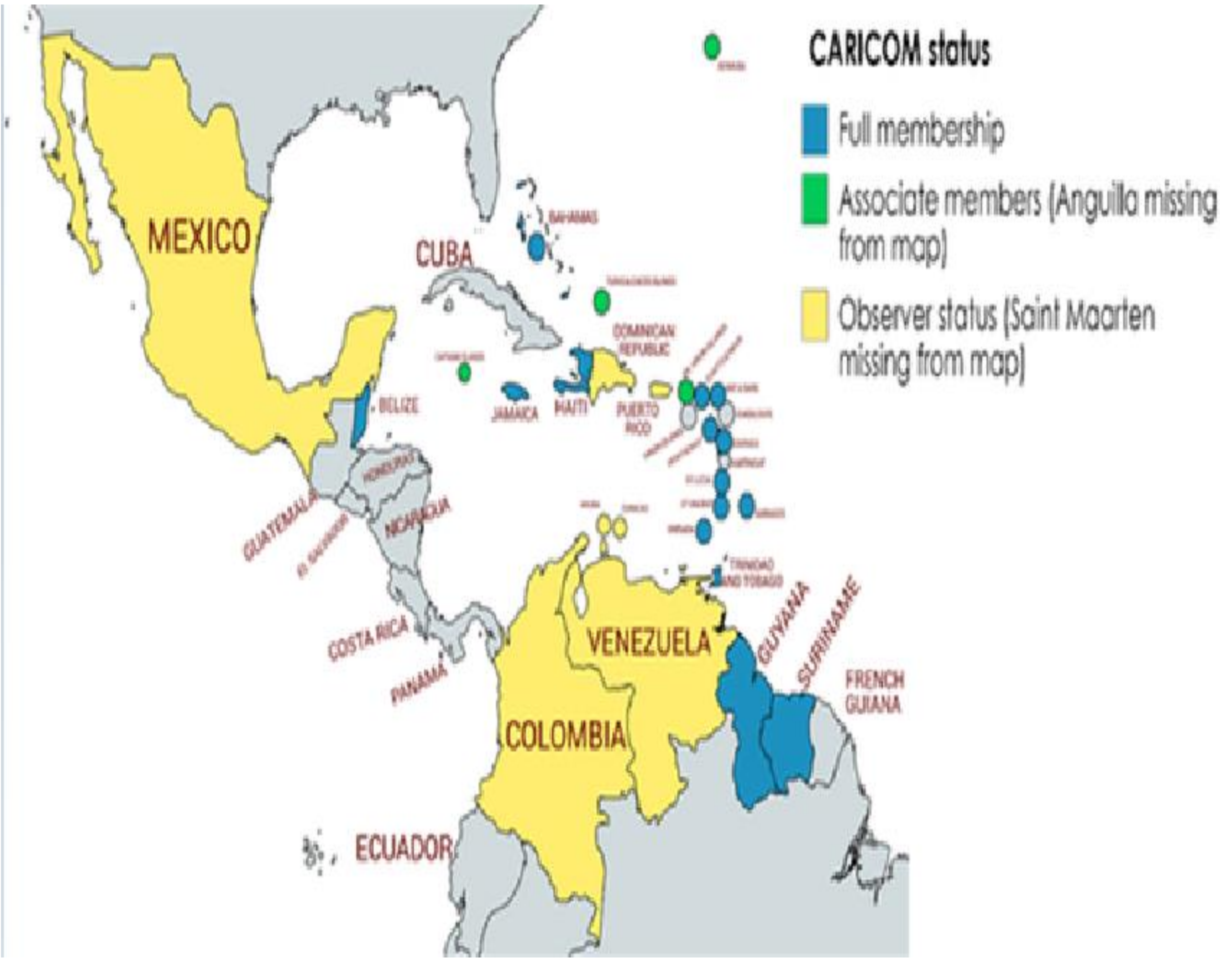

Figure 19: CARICOM Status 2021, Source: CARICOM

All of the utilities within CARICOM (Figure 19) are vertically integrated, except for Trinidad and Tobago that unbundled the transmission and distribution system from generation in the 1990s. While most of the utilities are market monopolies, others have an obligation to foster competition in generation and others have voluntarily adopted policies that allow for Independent Power Producers (IPPs). Accordingly, the practice of IPPs supplying power to the incumbent utility under Power Purchase Agreements (PPAs) is not uncommon in some of the Member States, for example: Antigua and Barbuda, Belize, Guyana, Jamaica, St. Kitts and Nevis, and Trinidad and Tobago. The national grid in some Member States is not fully interconnected. As such, power suppliers are required to maintain capital-intensive operations with relatively large reserves or margin of generation, which translates to high operating costs and limits economies of scale. To achieve a long-term decrease in such rates, Caribbean countries will need to interfere in the electrical industry in ways that go beyond the usual function of regulating power generation, transmission, distribution, and pricing. Identify, develop, and promote alternative or renewable energy sources, technologies, and systems for the generation of electricity:

1. Encourage the use of innovative high-efficiency power production technologies like combined cycle and cogeneration.
2. Create and execute a legislative and regulatory framework that encourages competition in power generation and the growth of independent power providers (IPPs).
3. Work together to ensure that industry best practices are followed and that suitable investment mechanism are in place to decrease system losses in the power sector.
4. Encourage utilities in Member States to collaborate and engage in collective purchase of fuel, power plants, and line hardware through regional networks like as CARILEC in order to achieve economies of scale and lower operating costs.
5. Support policies that force utilities to calculate and disclose their saved costs for various types of energy sources public to investors;
6. Educate the public on the advantages of "green power," particularly the advantages of energy conservation and efficiency.
7. For electricity networks under 300 MW, consider or retain a single buyer model.
8. Encourage utilities to implement appropriate technologies (such as pre-paid meters) as part of strategies to reduce non-technical losses caused by illegal electricity consumption or non-payment; and Foster institutional collaboration to produce electricity from municipal solid waste or other alternative fuels.
9. Encourage energy conservation, efficiency, and energy intensity reductions, as well as the adoption of suitable measuring and monitoring standards and recommendations at the regional level;
10. Encourage energy conservation measures by introducing economic and other incentives that encourage good environmental practices in the energy industry;
11. Develop suitable preparations for environmental responsibility and compensation regimes in the event of environmental activities and omissions that have a detrimental impact on the environment;
12. Create enabling framework to foster clean energy projects through financial or other incentives. [**34]**

3.4 Interview on Aruban policy and regulatory environment

This interview is a measurement tool used to gather information on the opinions of professionals in the field of renewable energy and policy. This interview was conducted in Aruba to measure the regulatory environment and to compare the results that are found in this research with the opinions of two professionals in the field. There are three questions asked in order to support the conclusion, and to further develop the recommendations.

The first professional interviewed is Eng. Henry De Cuba. Mr. De Cuba is the Co-Founder and President of the Americas Sustainable Development Foundation and has 37 years of experience in the fields of engineering and the environment. He spent 10 years as senior policy advisor for the Ministry of Environment in Aruba, and before his retirement, served as the head environmental inspector for the Aruban Government. His field of expertise includes mechanical process engineering, in particular operating high-pressure electrical powerhouses and desalination plants. In addition, he has had extensive experience in environmental and energy engineering with specializations in waste management, waste-to energy technologies and other environmental technologies.

The following Q&A's are listed below:

1. What, according to Mr. De Cuba, needs to be done in order to advance Aruba's renewable technology?

    1. *To identify which RE technology is more practically suited, and which can work with a high likelihood chance when integrated with nature, which provides prime material such as wind, sun, temperature, sea power, and more.*
    2. *Persuade the local population that there are other alternative energy sources than fossil fuels.*
    3. *Have trust in the RE technologies that Aruba has adopted, as well as those that are under development.*
    4. *Seek technology information on the different possibilities of generating renewable energies such as wind energy (wind turbines), solar photovoltaics, biomass (combustion solid to waste), biogas (fermentation process of wastewater), hydrogen (H_2O to H_2) and other technologies that nature can offer.*

2. What policies for renewable energy should be adopted on the island?

    1. *Aruba should establish a government or semi-government entity to independently coordinate, manage, and administer certified renewable and conventional energy producers.*
    2. *For a secure quality and continuity for the customer, precise procedures, norms, and agreements should be defined for the process coordination of products such as water and electricity.*

3. What is Mr. De Cuba's opinion on Independent Power Producers on the island?

    1. *Every company that generates renewable energy should be able to submit their responsible energy output to a central grid, ensuring the overall net system's accountability and security.*

    2. *In which the producer must be technically connected to the central grid while operating in a highly regulated environment.*

The second professional interviewed is Eng. Elthon Lampe. Mr. Lampe has an engineering degree in electrical energy conversion. After finishing his study, he worked and gained experience in several industries including utility and hotel sector. In the utility sector, he was the main driver for introducing a solar policy to the island of Aruba to help customers connect to the national electrical grid. He is now the Director of Activated Power, a company that sells electric vehicles and innovative products. Mr. Lampe is best known for his extracurricular activities of teaching electrical science and his contribution to many conferences and strategic plan platforms regarding sustainable development. He strongly believes that Aruba could already be 100% energized by using renewable energy. His recommendation for Aruba is: "Think big, start small, move fast."

The following Q&A's are listed below:

1. What, according to Mr. Lampe, needs to be done in order to advance Aruba's renewable technology?

   As technology progresses and the cost of creating this equipment decreases, the Level Cost of Electricity (LCoE) for producing energy from renewable energy is improving. To keep up in the race of nearby islands to become more sustainable, Aruba needs to build at least two new wind farms and double the capacity of the present one.

2. What policies for renewable energy should be adopted on the island?

   Renewable energy advancements include not just wind on the supply side, but also solar on the demand side. To encourage the renewable energy sector, policies must be implemented. For example, the home solar power restriction of 10 kW may be expanded to 25 kW, while the business solar power limit of 100 kW could be increased to 250 kW, to encourage greater use of renewable energy.

3. What is Mr. Lampe's opinion on Independent Power Producers on the island?

   The policy should be liberalized to allow IPPs, but only those based on renewable energy, not those based on nuclear energy or those that are environmentally dangerous. The next wind parks should be owned by WEB if there is no IPP in place, in order to reduce the risk of a "middle man" factor that affects the end price. Furthermore, IPPs are vital for extending the energy market since they provide competition and dynamic rates based on the production produced. IPP will assist the community in obtaining lower energy costs.

This section can conclude that such experts can be regarded one of the sources for reaching the final findings based on the interviews performed.

4. Ethical Considerations

Energy difficulties have ramifications for a variety of different facets of human civilization. As it is seen, the use of fossil fuels is a significant contribution to global climate change, with important ethical concerns. Dam building and floods are required to replace fossil fuels with hydroelectricity, which displaces rural communities, ruins forest and animal habitats, interferes with fish populations, and alters sediment transport and deposition patterns. Concrete dam building emits huge volumes of greenhouse gases into the atmosphere, and dams have a finite lifespan in many places. Nuclear power development, long thought to be the answer to the energy crisis, has proven to be complex, a probable health hazard, and less dependable and costly than projected. In some regions, solar, geothermal, and wind energy offer considerable potential for generating power, yet they may cause aesthetic changes to human habitats that are regarded undesirable. While tidal and wave action as a source of energy have been underdeveloped, they may have limited relevance due to energy storage and distribution challenges, as well as environmental and aesthetic restrictions. As a result, the Caribbean is confronted with a huge ethical quandary: How to weigh the immediate costs of moving to a more sustainable society and protecting the global environment, which are borne primarily by the poor, the disadvantaged, and developing countries. Costs that may widen the gap between rich and poor in the near future against a longer-term benefits of moving to a more sustainable society and protecting the global environment.

Ethics play a critical role in future development challenges by explaining the values at stake in policy decisions and providing moral justifications for alternative actions. Environmental and development issues are fraught with moral ramifications that must be grasped and thoroughly examined before wise decisions can be taken. This should aid in the resolution of value conflicts that stymie environmental conservation and development efforts. A new social paradigm should emerge, guided by ethics, which promotes sustainable growth while maintaining cultural variety, social fairness, and equity **[35].**

Some ethical considerations to take in account:

1. The use or abuse of scientific information, as well as people's moral obligation to act, or not, on accessible knowledge, are all ethical considerations surrounding scientific knowledge. Who is in charge of upgrading data-gathering networks in order to verify that information is accurate? Should we take precautions to avoid information that is not accurate enough? What are our options for dealing with knowledge gaps?
2. A process of political negotiation on sustainable outcomes at the island, or even community, level that articulates the essential ethical dilemmas is preferable to a general approach across the Caribbean. When planning resource management, public authorities, company executives, and other decision-makers must consider residents' sentiments about new, large-scale economic activity. This is crucial, since people's attitudes, worries, and behaviors differ depending on their proximity to resources critical to their livelihoods, such as coastal zones and wetlands.
3. New types of social learning, such as active involvement at the community level, are required

for socially inclusive and equitable sustainability with strong ethical underpinnings.

4. In the Caribbean, more individuals are becoming active in developing solutions to environmental deterioration. This should imply that those who have historically been shut out of decision-making processes would now have greater opportunity to express themselves.
5. Everyone, regardless of where they live, has a responsibility to the environment. Their responsibilities, however, may range due to a variety of social and economic situations, historical contributions to global environmental problems, and varying levels of ability to solve environmental challenges. The inherent vulnerabilities of Caribbean island governments should be weighed in any form of shared obligations, given the widely acknowledged idea of common but differentiated responsibilities.
6. International cooperation for sustainability in the Caribbean must focus on individual island nations to be effective. Knowledge and expertise should be developed, local organizations should be strengthened, the local community should be engaged, and academics and industry should be involved in community life.
7. Through participatory policy procedures, Caribbean island governments must properly examine environmental and socioeconomic demands from civil society, particularly marginalized populations. **[36]**

In order to prevent the unintended consequences of battery storage technology, governments, industry leaders, and researchers in the Caribbean must address the challenges quickly. Accelerating battery reuse instead of, or in addition to, recycling or landfill disposal is one critical intervention that requires more research. Around one-third of the world's lithium the most important component of batteries, is mined on salt flats in Argentina and Chile, where the substance is extracted using massive amounts of water in an otherwise parched environment **[37]**. Lithium for batteries can also be made by exposing the material to extremely high temperatures, a process that consumes a lot of energy and is used in China and Australia. There are techniques to harvest lithium more sustainably; for example, trial operations in Germany and the United Kingdom are filtering lithium from hot brines beneath granite rock.

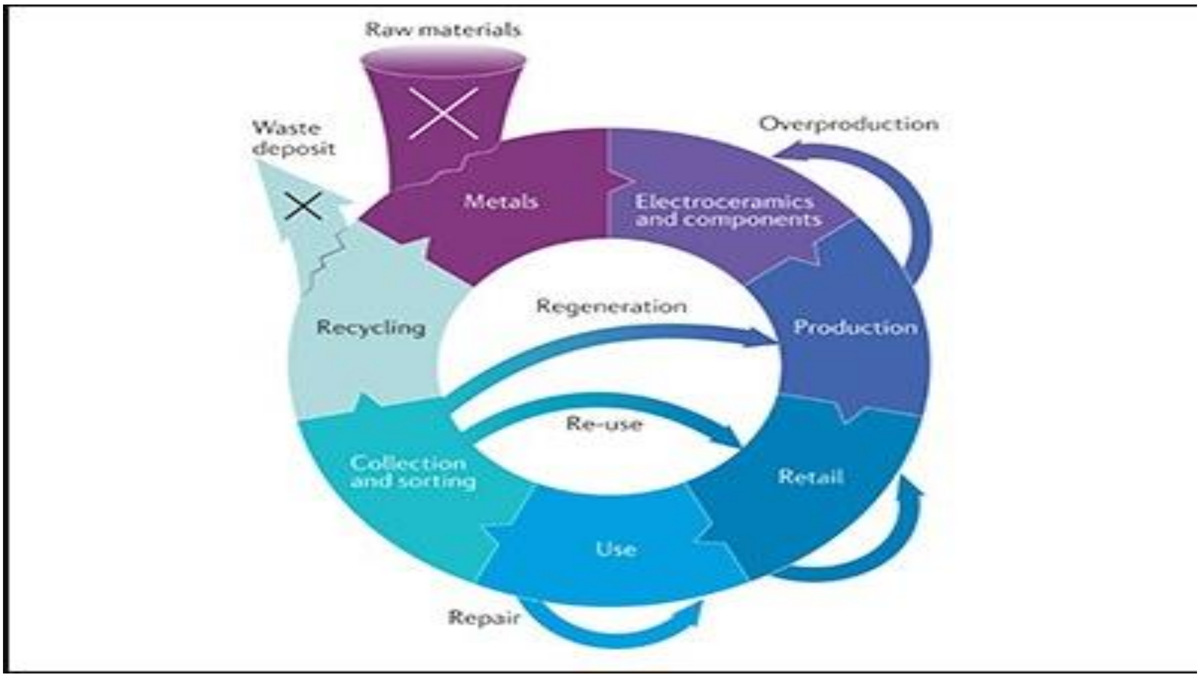

Figure 20: Battery electronic waste cycle, Source: nature.com

Many nations recognize the necessity for mining to be done properly and sustainably. However, some people are pushing measures that might harm the environment, particularly in the case of battery recycling. Battery reuse is one possible option that additional nations should examine, although it is not yet included in the Caribbean plan. Although batteries do ultimately run out, many are retired because they have become inefficient for a certain use, such as powering a car, but still have plenty of life left in them for less-demanding applications, such as renewable-energy storage. Incinerating batteries or transporting them overseas for recycling will remain more cost-effective without incentives for battery reuse and repurposing. It is time for a paradigm shift: scientists should think about how materials may be recycled, reused, and used as they develop them (Figure 20). Batteries are essential for a low-carbon future on Earth. It is in everyone's best interests to ensure that they are clean, safe, and long lasting **[37].**

Conclusion

Concluding the role of IPP in power generation, Caribbean Member States are considering renewable energies as an option for the energy mix. The major issue is that there is a great deal of diversity in who participates in the energy mix. Some member state islands have a high renewable proportion, while others have a low renewable percentage of energy mix. The Caribbean has a significant renewable energy since it is an area with abundant renewable energy resources. There is the sun, wind, and waves, as well as geothermal, bioenergy and hydropower alternatives. With this in mind, the Caribbean has a bright future ahead of it in terms of renewable energy.

Almost all of the government enterprises have a monopoly on the utilities, which might be due to the small-scale operations on the islands. This is why their governments must implement legislative changes to ensure that communities benefit from the low-cost energy implications of the IPP sector. This may be accomplished by combining incentives and a regulatory framework with power purchase agreements to ensure a reliable smart grid, in order to function cost-effectively. To reduce risk, IPP efforts should be able to secure favorable funding from local banks, which are be backed by international development banks. Local governments can use subsidies, such as lower import prices or tax advantages to reduce capital expenditures directly.

The creation of a Caribbean-wide market, as well as the reductions in trade barriers and tariffs that would occur, would greatly cut the cost of projects or project development. The growing distributed/embedded generation and renewable energy businesses should be incorporated into the license exemption rules and/or criteria for a fast-track registration procedure. Investment incentives, tax incentives, feed-in tariffs, net metering, and deregulation of the power industry are all policy mechanisms that should be applied.

If an IPP fits the requirements, it can proceed to the full negotiating stage, which includes preliminary compliance, technical review, due diligence, commercial evaluation, and financial assessment. The regulatory agency, government, and stakeholders must all work together to effectively regulate IPP functions. IPPs would benefit locating on a number of islands. Most member state islands must cooperate and collaborate on measures to ensure the provision of affordable, ample, clean, and high-quality energy to the region's consumers, as well as engage in purposeful and concrete actions to minimize, reduce, and mitigate any economic distress caused by high petroleum prices to the majority of member states.

The research findings are consistent with the responses made by the experts (Eng. De Cuba and Eng. Lampe) in the interview. As a result, Aruba needs greater developments in government policy, as well as the establishment of an energy regulating body, and a comprehensive strategy for educating the public on various energy generation techniques while moving the country's reliance on fossil fuels to renewable energy. To maintain the island's surroundings, Aruba has to enhance its solar panel policy as well as establish new wind parks.

Recommendations

A proper legislation and policy framework should be constructed at the various responsibility levels, from local government to the districts, based on the indications of the energy road maps. Local governments and districts should focus on the potential of smart grids in the context of smarter and more sustainable cities, taking into account the reduction of non-renewable energy sources. National governments can also help by co-funding pilot projects demonstrating the applicability of Power Purchase agreements and thus extending research for the energy efficiency in IPPs for commercial, residential, and public buildings employing smart renewable technologies. National governments and public policymakers should develop, publish, and disseminate local plans to address the role of distributed generation, climate change mitigation, market competitiveness, loss reduction, and energy accessibility and prices. This regional strategy will go a long way toward raising awareness and commitment among all stakeholders to IPP policies, incentives, and regulatory environment for equal participation minimizing the monopoly on the islands.

According to the findings, Aruba need more government participation in electricity sector regulation. Together with an established regulatory framework that must capture energy, capacity by enacting more binding rules that take use of local market possibilities. Utilities frequently want government assurances before venturing into the riskier world of renewables, and establishing a supporting legal and policy framework is a critical step in electrifying the local market. Aruba could study the example of Bonaire, which is the leading island in the Lesser Antilles in terms of renewable energy development and now has an IPP in place. Feed-in tariffs are another crucial policy to pursue, which Bonaire already has set up.

The Caribbean islands should follow the Dominican Republic's energy strategy, which has the potential to increase its renewable energy contribution to 27% by 2030. About half this potential is in the power sector and the other half in the direct use of renewables in IPP sectors. The Dominican Republic has made sure that they are in line with other national energy goals and that they have a robust institutional and regulatory framework in place, as well as the necessary financial incentives, to attract renewable energy investments. The Dominican Republic created suitable incentives to support this goal, as well as updated generation growth plans with intermediate goals. Also, develop and implement suitable incentives and market mechanisms to encourage the development of a flexible power system that can cope with the new operating constraints imposed by the predicted high percentage of variable renewables. The Dominican Republic has currently various existing policies and regulatory framework in place to optimize their energy production.

Appendix

Energy Policy and Regulatory Framework, Source: Energy.gov/eere/island-energy-snapshots

Anguilla

Existing Policy and Regulatory Framework

Renewable Energy	Feed-in Tariff	
	Net Metering	
	Interconnection Standards	
	Energy Access (Electrification Rate)	
	Renewables Portfolio Standard and Quotas for Set Asides	
	Tax Credits	○ Proposed
	Tax Reduction or Exemption	○ Proposed
	Public Loans or Grants	○ Proposed
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Rebates	○ Proposed
Energy Efficiency	Energy Efficiency Standards	
	Tax Credits	
	Tax Reduction or Exemption	○ Proposed
	Public Demonstration	
	Restrictions on Incandescent Bulbs	○ Proposed
	Appliance Labeling Standards	○ Proposed
	Minimum Energy Performance Standards	
	Building Codes	○ Proposed
	Green Building Certification Program	
	EE Loan Programs	
	Transportation	○ Proposed
Targets	Renewable Energy	● In Place
	Energy Efficiency	
	Transportation	

● In Place ○ Proposed

Antigua & Barbuda

Existing Policy and Regulatory Framework

Renewable Energy	Feed-in Tariff	○ Proposed
	Net Metering	
	Interconnection Standards	● In Place
	Energy Access (Electrification Rate)	● In Place
	Renewable Portfolio Standard	
	Tax Credits	
	Tax Reduction or Exemption	● In Place
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	● In Place
	Tax Credits	
	Tax Reduction or Exemption	● In Place
	Public Demonstration	
	Restrictions on Incandescent Bulbs	● In Place
	Appliance Labeling Standards	○ Proposed
	Minimum Energy Performance Standards	
	Building Codes	● In Place
	Green Building Certification Program	● In Place
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	● In Place
	Energy Efficiency	● In Place
	Transportation	● In Place

● In Place ○ Proposed

Aruba

Existing Policy and Regulatory Framework

Renewable Energy	Feed-in Tariff	
	Net Metering	● In Place
	Interconnection Standards	● In Place
	Energy Access (Electrification Rate)	
	Renewable Portfolio Standard	
	Tax Credits	
	Tax Reduction or Exemption	● In Place
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	● In Place
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	
	Tax Credits	
	Tax Reduction or Exemption	● In Place
	Public Demonstration	● In Place
	Restrictions on Incandescent Bulbs	
	Appliance Labeling Standards	
	Minimum Energy Performance Standards	
	Building Codes	
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	● In Place
	Energy Efficiency	
	Transportation	

● In Place ○ Proposed

Bahamas

Existing Policy and Regulatory Framework

Renewable Energy	
Feed-in Tariff	In Development
Net Metering/Billing	In Development
Interconnection Standards	
Renewables Portfolio Standard/Quota	
Tax Credits	
Tax Reduction/Exemption	
Public Loans/Grants	
Green Public Procurement	
Energy Efficiency	
Energy Efficiency Standards	
Tax Credits	
Tax Reduction/Exemption	
Public Demonstration	
Restrictions on Incandescent Bulbs	In Place
Appliance Labeling Standards	
Targets	
Renewable Energy	In Place
Energy Efficiency	In Place

In Place ■ In Development

Barbados

Existing Policy and Regulatory Framework		
Renewable Energy	Feed-in Tariff	●
	Net Billing	●
	Interconnection Standards	●
	Energy Access (Electrification Rate)	
	Renewable Portfolio Standard	
	Tax Credits	●
	Tax Reduction or Exemption	●
	Public Loans or Grants	●
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	●
	Tax Credits	●
	Tax Reduction or Exemption	●
	Public Demonstration	●
	Restrictions on Incandescent Bulbs	●
	Appliance Labeling Standards	●
	Minimum Energy Performance Standards	●
	Building Codes	
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	●
	Transportation	

● In Place ○ Proposed

Bonaire

Existing Policy and Regulatory Framework		
Renewable Energy	Feed-in Tariff	●
	Net Metering	
	Interconnection Standards	●
	Energy Access (Electrification Rate)	
	Renewable Portfolio Standard	
	Tax Credits	
	Tax Reduction or Exemption	
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	
	Tax Credits	
	Tax Reduction or Exemption	
	Public Demonstration	
	Restrictions on Incandescent Bulbs	
	Appliance Labeling Standards	
	Minimum Energy Performance Standards	
	Building Codes	
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	
	Transportation	

● In Place ○ Proposed

British Virgin Islands

Existing Policy and Regulatory Framework https://bvi.gov.vg/sites/default/files/resources/energy_policy_of_the_virgin_islands_oct_2016.pdf		
Renewable Energy	Feed-in Tariff	
	Net Metering and Billing	
	Interconnection Standards	●
	Energy Access	
	Renewable Portfolio Standard and Quotas for Set Asides	●
	Tax Credits	○
	Tax Reduction or Exemption	
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	○
	Tax Credits	
	Tax Reduction or Exemption	
	Public Demonstration	
	Restrictions on Incandescent Bulbs	●
	Appliance Labeling Standards	○
	Minimum Energy Performance Standards	
	Building Codes	○
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	○
	Transportation	○

● In Place ○ Proposed

Cayman Islands

Existing Policy and Regulatory Framework		
Renewable Energy	Feed-in Tariff	●
	Net Metering and Billing	
	Interconnection Standards	●
	Energy Access (Electrification Rate)	●
	Renewable Portfolio Standard and Quotas for Set Asides	
	Tax Credits	
	Tax Reduction or Exemption	
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	●
	Energy Storage	
	Duty Waivers	●
Energy Efficiency	Energy Efficiency Standards	
	Tax Credits	
	Tax Reduction or Exemption	
	Public Demonstration	
	Restrictions on Incandescent Bulbs	●
	Appliance Labeling Standards	
	Minimum Energy Performance Standards	
	Building Codes	●
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	○
	Transportation	

● In Place ○ Proposed

Cuba

Curaçao

Existing Policy and Regulatory Framework		
Renewable Energy	Feed-in Tariff	
	Net Metering and Billing	
	Interconnection Standards	○
	Energy Access (Electrification Rate)	
	Renewable Portfolio Standard	●
	Tax Credits	
	Tax Reduction or Exemption	
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	○
	Tax Credits	
	Tax Reduction or Exemption	
	Public Demonstration	
	Restrictions on Incandescent Bulbs	○
	Appliance Labeling Standards	○
	Minimum Energy Performance Standards	○
	Building Codes	○
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	●
	Transportation	

● In Place ○ Proposed

Dominica

Existing Policy and Regulatory Framework https://c-serms.org/wp-content/uploads/2018/12/DM-Dominica-Draft-National-Energy-Policy-2014.pdf		
Renewable Energy	Feed-in Tariff	
	Net Metering	
	Interconnection Standards	●
	Energy Access (Electrification Rate)	●
	Renewable Portfolio Standard	
	Tax Credits	
	Tax Reduction or Exemption	
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	●
	Tax Credits	○
	Tax Reduction or Exemption	
	Public Demonstration	○
	Restrictions on Incandescent Bulbs	●
	Appliance Labeling Standards	○
	Minimum Energy Performance Standards	●
	Building Codes	●
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	
	Transportation	

● In Place ○ Proposed

Dominican Republic

Existing Policy and Regulatory Framework		
Renewable Energy	Feed-in Tariff	●
	Net Metering	●
	Interconnection Standards	●
	Energy Access (Electrification Rate)	
	Renewable Portfolio Standard	
	Tax Credits	●
	Tax Reduction or Exemption	●
	Public Loans or Grants	●
	Auctions or Reverse Auctions	●
	Green Public Procurement	
Energy Efficiency	Energy Efficiency Standards	●
	Tax Credits	
	Tax Reduction or Exemption	●
	Public Demonstration	
	Restrictions on Incandescent Bulbs	●
	Appliance Labeling Standards	●
	Minimum Energy Performance Standards	●
	Building Codes	
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	
	Transportation	

● In Place ○ Proposed

Grenada

Existing Policy and Regulatory Framework http://www.oas.org/en/sedi/dsd/Energy/Doc/NEP_Grenada_web.pdf	
Renewable Energy	Feed-in Tariff
	Net Billing ●
	Interconnection Standards ●
	Grid Codes ●
	Energy Access (Electrification Rate)
	Renewable Portfolio Standard
	Tax Credits
	Tax Reduction or Exemption ●
	Public Loans or Grants
	Auctions or Reverse Auctions
	Green Public Procurement
	Energy Storage
Energy Efficiency	Energy Efficiency Standards ●
	Tax Credits
	Tax Reduction or Exemption
	Public Demonstration ●
	Restrictions on Incandescent Bulbs ●
	Appliance Labeling Standards ○
	Minimum Energy Performance Standards ●
	Building Codes ●
	Green Building Certification Program
	EE Loan Programs
	Rebates
Targets	Renewable Energy ●
	Energy Efficiency
	Transportation
	● In Place ○ Proposed

Guadeloupe

Existing Policy and Regulatory Framework	
Renewable Energy	Feed-in Tariff ●
	Net Metering ●
	Interconnection Standards ●
	Energy Access (Electrification Rate)
	Renewable Portfolio Standard and Quotas for Set Asides
	Tax Rebates ●
	Tax Reduction or Exemption ●
	Public Loans or Grants
	Auctions or Reverse Auctions
	Green Public Procurement
	Energy Storage ●
Energy Efficiency	Energy Efficiency Standards ●
	Tax Credits
	Tax Reduction or Exemption
	Public Demonstration
	Restrictions on Incandescent Bulbs ●
	Appliance Labeling Standards ●
	Minimum Energy Performance Standards ●
	Building Codes ●
	Green Building Certification Program
	EE Loan Programs ●
	Rebates
Targets	Renewable Energy ●
	Energy Efficiency ●
	Transportation ●
	● In Place ○ Proposed

Haiti

Existing Policy and Regulatory Framework http://www.bme.gouv.ht/energie/Declaration%20de%20politique%20energetique_ebauche9.pdf	
Renewable Energy	Feed-in Tariff
	Net Metering and Billing
	Interconnection Standards
	Energy Access (Electrification Rate)
	Renewables Portfolio Standard and Quotas for Set Asides
	Tax Credits
	Tax Reduction or Exemption ●
	Public Loans or Grants ○
	Auctions or Reverse Auctions
	Green Public Procurement
	Energy Storage
Energy Efficiency	Energy Efficiency Standards ●
	Tax Credits
	Tax Reduction or Exemption ●
	Public Demonstration
	Restrictions on Incandescent Bulbs ○
	Appliance Labeling Standards ○
	Minimum Energy Performance Standards ●
	Building Codes ●
	Green Building Certification Program
	EE Loan Programs
	Rebates
Targets	Renewable Energy ●
	Energy Efficiency
	Transportation
	● In Place ○ Proposed

Jamaica

Existing Policy and Regulatory Framework https://www.mset.gov.jm/all-energy-related/	
Renewable Energy	Feed-in Tariff
	Net Billing ●
	Interconnection Standards ●
	Energy Access (Electrification Rate)
	Renewable Portfolio Standard ●
	Tax Credits
	Tax Reduction or Exemption ●
	Public Loans or Grants
	Auctions or Reverse Auctions ●
	Green Public Procurement ●
	Energy Storage
Energy Efficiency	Energy Efficiency Standards ●
	Tax Credits
	Tax Reduction or Exemption ●
	Public Demonstration ●
	Restrictions on Incandescent Bulbs ○
	Appliance Labeling Standards
	Minimum Energy Performance Standards ●
	Building Codes ●
	Green Building Certification Program
	EE Loan Programs
	Rebates
Targets	Renewable Energy ●
	Energy Efficiency
	Transportation
	● In Place ○ Proposed

Martinique

Existing Policy and Regulatory Framework		
Renewable Energy	Feed-in Tariff	●
	Net Metering and Billing	
	Interconnection Standards	
	Energy Access (Electrification Rate)	●
	Renewable Portfolio Standard	
	Tax Credits	●
	Tax Reduction or Exemption	●
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	
	Tax Credits	
	Tax Reduction or Exemption	
	Public Demonstration	
	Restrictions on Incandescent Bulbs	
	Appliance Labeling Standards	
	Minimum Energy Performance Standards	○
	Building Codes	
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	
	Transportation	

● In Place ○ Proposed

Montserrat

Existing Policy and Regulatory Framework http://www.gov.ms/wp-content/uploads/2016/02/The-Power-to-Change-MNEP-Cabinet-Approved.pdf		
Renewable Energy	Feed-in Tariff	
	Net Metering	
	Interconnection Standards	
	Energy Access (Electrification Rate)	●
	Renewable Portfolio Standard	
	Tax Credits	●
	Tax Reduction or Exemption	
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	○
	Tax Credits	○
	Tax Reduction or Exemption	
	Public Demonstration	
	Restrictions on Incandescent Bulbs	●
	Appliance Labeling Standards	○
	Minimum Energy Performance Standards	●
	Building Codes	○
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	
	Transportation	

● In Place ○ Proposed

Puerto Rico

Existing Policy and Regulatory Framework https://programs.dsireusa.org/system/program?state=PR		
Renewable Energy	Feed-in Tariff	
	Net Metering	●
	Interconnection Standards	●
	Renewables Portfolio Standard and Quotas for Set Asides	●
	Tax Credits	●
	Tax Reduction or Exemption	●
	Public Loans or Grants	●
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	●
Energy Efficiency	Energy Efficiency Standards	
	Tax Credits	
	Tax Reduction or Exemption	
	Public Demonstration	
	Restrictions on Incandescent Bulbs	
	Appliance Labeling Standards	
	Minimum Energy Performance Standards	
	Building Codes	●
	Green Building Certification Program	
	EE Loan Programs	●
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	●
	Transportation	

● In Place ○ Proposed

St. Kitts & Nevis

Existing Policy and Regulatory Framework http://www.oas.org/en/sedi/dsd/Energy/Doc/NationalEnergyPolicyStKittsandNevis.pdf		
Renewable Energy	Feed-in Tariff	
	Net Metering	
	Interconnection Standards	○
	Energy Access (Electrification Rate)	●
	Renewable Portfolio Standard and Quotas for Set Asides	
	Tax Credits	●
	Tax Reduction or Exemption	●
	Public Loans or Grants	
	Auctions or Reverse Auctions	
	Green Public Procurement	
	Energy Storage	
Energy Efficiency	Energy Efficiency Standards	●
	Tax Credits	
	Tax Reduction or Exemption	
	Public Demonstration	
	Restrictions on Incandescent Bulbs	●
	Appliance Labeling Standards	
	Minimum Energy Performance Standards	●
	Building Codes	●
	Green Building Certification Program	
	EE Loan Programs	
	Rebates	
Targets	Renewable Energy	●
	Energy Efficiency	●
	Transportation	●

● In Place ○ Proposed

St. Lucia

Existing Policy and Regulatory Framework	
Renewable Energy	Feed-in Tariff
	Net Metering ●
	Interconnection Standards
	Energy Access (Electrification Rate) ●
	Renewable Portfolio Standard
	Tax Credits ●
	Tax Reduction or Exemption ●
	Public Loans or Grants
	Auctions or Reverse Auctions
	Green Public Procurement
	Energy Storage
Energy Efficiency	Energy Efficiency Standards ●
	Tax Credits
	Tax Reduction or Exemption ●
	Public Demonstration
	Restrictions on Incandescent Bulbs
	Appliance Labeling Standards
	Minimum Energy Performance Standards ●
	Building Codes ●
	Green Building Certification Program
	EE Loan Programs
	Rebates
Targets	Renewable Energy ●
	Energy Efficiency ●
	Transportation ●
	● In Place ○ Proposed

St. Maarten

Existing Policy and Regulatory Framework http://www.sintmaartengov.org/Policy%20and%20Reports/140822-National%20Energy%20Policy%20SXM%20-DEF%202-0.pdf	
Renewable Energy	Feed-in Tariff ○
	Net Metering ○ ○
	Interconnection Standards ●
	Energy Access (Electrification Rate)
	Renewables Portfolio Standard and Quotas for Set Asides
	Tax Credits ○
	Tax Reduction or Exemption
	Public Loans or Grants ○
	Auctions or Reverse Auctions
	Green Public Procurement
	Rebates
Energy Efficiency	Energy Efficiency Standards
	Tax Credits ○
	Tax Reduction or Exemption
	Public Demonstration ○
	Restrictions on Incandescent Bulbs ○
	Appliance Labeling Standards
	Minimum Energy Performance Standards
	Building Codes ○
	Green Building Certification Program
	EE Loan Programs
	Transportation ○
Targets	Renewable Energy ●
	Energy Efficiency
	Transportation
	Dutch: ● In Place ○ Proposed
	French: ● In Place ○ Proposed

St. Vincent & Grenadines

Existing Policy and Regulatory Framework	
Renewable Energy	Feed-in Tariff ●
	Net Metering & Billing
	Interconnection Standards ●
	Energy Access (Electrification Rate)
	Renewables Portfolio Standard and Quotas for Set Asides
	Tax Credits
	Tax Reduction or Exemption ●
	Public Loans or Grants ●
	Auctions or Reverse Auctions
	Green Public Procurement ●
	Public Demonstration ●
Energy Efficiency	Energy Efficiency Standards ○
	Tax Credits
	Tax Reduction or Exemption ●
	Public Demonstration ●
	Restrictions on Incandescent Bulbs ●
	Appliance Labeling Standards
	Minimum Energy Performance Standards
	Building Codes
	Green Building Certification Program
	EE Loan Programs
	Vehicles & Fuels ●
Targets	Renewable Energy ●
	Energy Efficiency ●
	Transportation ●
	● In Place ○ Proposed

Trinidad & Tobago

Existing Policy and Regulatory Framework http://www.energy.gov.tt/wp-content/uploads/2014/01/Framework-for-the-development-of-a-renewable-energy-policy-for-TT-January-2011.pdf	
Renewable Energy	Feed-in Tariff ○
	Net Metering ○
	Interconnection Standards ○
	Energy Access (Electrification Rate)
	Renewable Portfolio Standard
	Tax Credits ●
	Tax Reduction or Exemption ●
	Public Loans or Grants
	Auctions or Reverse Auctions
	Green Public Procurement
	Energy Storage
	Public Demonstration ●
Energy Efficiency	Energy Efficiency Standards ●
	Tax Credits ●
	Tax Reduction or Exemption ●
	Public Demonstration
	Restrictions on Incandescent Bulbs ○
	Appliance Labeling Standards ○
	Minimum Energy Performance Standards ●
	Building Codes ●
	Green Building Certification Program
	EE Loan Program
	Rebates
Targets	Renewable Energy ●
	Energy Efficiency ●
	Transportation
	● In Place ○ Proposed

Turks & Caicos

Existing Policy and Regulatory Framework https://fliphtml5.com/pejq/sccs/basic	
Renewable Energy	Feed-in Tariff
	Net Billing ●
	Interconnection Standards ●
	Energy Access (Electrification Rate)
	Renewables Portfolio Standard and Quotas for Set Asides
	Tax Credits
	Tax Reduction or Exemption ●
	Public Loans or Grants
	Auctions or Reverse Auctions
	Green Public Procurement
	Energy Storage
	Public Demonstration
Energy Efficiency	Energy Efficiency Standards
	Tax Credits
	Tax Reduction or Exemption ●
	Public Demonstration
	Restrictions on Incandescent Bulbs ●
	Appliance Labeling Standards
	Minimum Energy Performance Standards
	Building Codes ●
	Green Building Certification Program
	EE Loan Program
	Rebates
Targets	Renewable Energy
	Energy Efficiency
	Transportation
	● In Place ○ Proposed

US Virgin Islands

Existing Policy and Regulatory Framework https://programs.dsireusa.org/system/program?state=VI	
Renewable Energy	Feed-in Tariff ●
	Net Metering / Net Billing ●
	Interconnection Standards ●
	Energy Access (Electrification Rate) ●
	Renewables Portfolio Standard ●
	Tax Credits
	Tax Reduction or Exemption ●
	Public Loans or Grants
	Auctions or Reverse Auctions
	Green Public Procurement
	Energy Storage
	Rebates ●
Energy Efficiency	Energy Efficiency Standards
	Tax Credits
	Tax Reduction or Exemption
	Public Demonstration
	Restrictions on Incandescent Bulbs
	Appliance Labeling Standards
	Minimum Energy Performance Standards
	Building Codes ●
	Green Building Certification Program
	EE Loan Programs
	Rebates ●
Targets	Renewable Energy ●
	Energy Efficiency ●
	Transportation
	● In Place ○ Proposed

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